The Used of Storet Index to Assess Water Quality in Perancak Estuary, Bali, Indonesia

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Abstract. Water quality in the environment is influenced by anthropogenic activity and natural process. Anthropogenic activities such as fishing activities, fish ponds, fishing ports, residential waste provide the greatest contribution to water quality conditions. The condition of water quality is very important in supporting the survival of the organisms living on it. Determination of the status of water quality should be done as a reference for pollution monitoring in an aquatic system for both marine tourism development and biota life purposes, especially in the mangrove ecosystem. This study aims to assess the status of water quality in Perancak Estuary Jembrana Bali for marine tourism and the mangrove ecosystem. Water quality measurement was conducted from January to March 2018 at 10 observation stations which divided into 3 zones based on the representation of area characteristics. These zones include: zone I represent water quality conditions close to residential areas, zone II represent water quality conditions close to mangrove and aquaculture ecosystems, and zone III represent sea water quality transition conditions. The sampling procedure was based on APHA standard method. The water quality data then analysed using the STORET method. Stored index for marine tourism and marine biota (mangrove) in zone I, II, III showed lightly contaminated to moderately polluted (-10 until -16) for physical parameters, heavily polluted (-40 until -80) for chemical parameter and biology parameters is still in accordance with quality standards until lightly contaminated (0 until -6). Based on the value of the pollution index shows the water quality status of Perancak Estuary from January-March is classified as bad/severe pollution both for marine tourism and the mangrove ecosystem. Chemical parameters (nitrate, phosphate, ammonia) contribute the most to the level of pollution.

1. Introduction
Perancak Estuary is located geographically directly facing the Bali Strait which is a strategic area supporting the economy of Jembrana community. Human activities such as fishing activities, fish ponds, fishing ports, residential waste have an effect on water quality in Perancak Estuary. To know the condition of water quality in Perancak Estuary, it is necessary to do a periodic monitoring system so that environmental quality status can be monitored intensively. Through this periodic monitoring system, it is expected to provide an overview of the changing conditions of Perancak Estuary going basis and a scientific justification for recommendations on managing Perancak Estuary. In the future, Perancak Estuary can be developed into potential areas for eco-tourism destinations that are able to support the lives of surrounding communities. Water quality monitoring activities in Perancak Estuary can be a model of water quality monitoring system that can be applied in other areas that have similar characteristics. Operationalization of Nature Laboratory aims to provide time-series information related to environmental issues based on the ecosystem approach, especially information on water quality status in Perancak Estuary every month.

Surface water was used for various purposes threatens the integrity of aquatic ecosystems as a result of changing its quality and quantity. Therefore, representative and reliable monitoring and assessed water quality are critical [1,2]. Surface water quality is traditionally assessed by water quality...
standards and objectives [3]. However, this traditional approach cannot provide sufficient information on the overall quality of water or the spatial and temporal trends [4]. Therefore, researchers and environmental authorities have strived to derive a simple expression of water quality of surface waters by a single number is water quality index (WQI) [5]. Water quality index describes condition times series data of water quality into simple terms (quality standard, lightly contaminated, polluted moderately, heavily polluted) for reporting to management and the ordinary people. Water quality aim giving simple value to the water quality of the source reducing a great number of parameters into simple expression and enabling interpretation of monitoring data [6].

The environmental sustainability of aquaculture, the fastest growing food industry due to the expansion of an annual average ground of 8.3% for the past three decades [7], is a concern because it can have serious negative impacts on aquatic ecosystems as a result of nutrient and organic matter enrichment [8]. Environmental impacts of fish farming activities have been well documented and have increasing in the last decades. One of the significant effects of fish farming is the enrichment of aquatic bodies with phosphate, ammonia, copper, organic matter and other nutrients and decreases in dissolved oxygen [9]. This study aims to assess the status of water quality in Perancak Estuary for marine tourism and marine biota (mangrove ecosystem). The status of water quality obtained from monitoring of water quality parameters was and was analyzed using the STORET method.

2. Research Methods
2.1. Study area
The information on water quality status in Perancak Estuary, Jembrana, Bali was obtained based on the measurement result of water quality indicator at 10 (ten) fix station. Perancak Estuary is located between 08°22’0’’LS – 08°24’0’’LS dan 114°29’20’’BT – 114°35’20’’BT with total surface area 17 ha. Surface water sampling was conducted 3 times at survey representing January, February and March 2018. Determination of the station was based on the representation of the characteristics of the area either estuary area, aquaculture, around mangrove forest, agriculture, and settlement of citizens. The measurement station are given PRC1 through PRC10 (Figure 1).
2.2. Sampling stations
Of the 10 stations were divided into 3 zones where the zone division was based on water quality conditions that are affected by settlement activity, mangrove ecosystem, aquaculture, and marine transition ecosystem. The three zones are: zone I include PRC1 and PRC2 that stations representing water quality conditions close to residential areas, zone II includes PRC3 - PRC7 was stationed representing water quality conditions close to mangrove and aquaculture ecosystems, zone III includes PRC8 - PRC10 represents sea water transition quality conditions. Parameter of water quality measured consist of 11 parameters: temperature, turbidity, total suspended solid (TSS), pH, salinity, dissolved oxygen (DO), biochemical oxygen demand (BOD), ammonia (NH₃-N), phosphate (PO₄-P), nitrate (NO₃-N), plankton, temperature, turbidity, TSS, pH, salinity, DO parameters were carried out ex-situ using WQC (Water Quality Cekker) tool while BOD, NH3, PO4, NO3, and plankton were conducted in-situ at the Water Quality Laboratory of Institute for Marine Research and Observation Ministry of Marine Affairs and Fisheries. Water quality parameters measured and compared with seawater quality standards for marine tourism and marine biota based on The Ministry of Environment Regulation Republic of Indonesia No. 51/2004 [10].

2.3. Water quality analysis
The results of monitoring the water quality parameters were then was analyzed using the STORET method in environmental quality standard based on The Ministry of Environment Regulation Republic of Indonesia No.115/2003 [11]. STORET method is one method to determine the status of water quality. STORET method, we can know the parameters that have met or exceeded the water quality standard by comparing the water quality data with the water quality standard that is adjusted to its designation to determine the water quality status. The score for the number of observations is more than 10 than the minimum and maximum values that do not meet the quality standard-2 (for physical parameters), -4 (for chemical parameters) and -6 (for biological parameters). If the average value does not meet the quality standards, it will be given a score of -6, -12 and -18 for each physical, chemical, and biological parameter. Furthermore, for all scores in each parameter, it is summed and compared with the total score to determine the classification of water quality according to the STORET method. The method of determining the status of water quality is to use a value system from US-EPA (Environmental Protection Agency) by classifying water quality in 4 classes, as shown in Table 1.

| Total Score | Class | Pollution level               | Quality value |
|-------------|-------|-------------------------------|---------------|
| 0           | A     | meet the quality standards    | 4             |
| -1 s/d -10  | B     | lightly contaminated          | 3             |
| -11 s/d -30 | C     | polluted moderately           | 2             |
| < -30       | D     | heavily polluted              | 1             |

3. Results and Discussion
The condition of water quality is used as an indicator of the survival of marine biota and other activities such as marine tourism and ports must have quality standards of physics, chemistry, and biology. All the 11 parameters were measured in January, February and March 2018. Temperature, salinity and biochemical oxygen demand (BOD) were recommended level for aquatic life while low in ambient pH and DO. High level for aquatic life was total suspended solid (TSS), nitrate (NO₃-N), ammonia (NH₃-N) and phosphate (PO₄-P). The value of water quality that exceeds the maximum threshold for its designation such as marine tourism, mangrove ecosystems, and ports will be classified as polluted waters. The results of measurements of water quality parameters are shown in Table 2. Based on the results of the largest pollutant analysis in Perancak Estuary was a
physical parameter (TSS, turbidity), the chemical parameter (nitrate, ammonia, phosphate). For biological parameters (plankton) in zones II and III are slightly above the standard quality threshold or experience mild contamination. The high levels of ammonia and phosphate nitrate in Perancak estuary due to the input of domestic waste, household, agriculture livestock, and aquaculture. Pollution by nitrogen fertilizers, including anhydrous ammonia as well as animal and human organic waste, can increase nitrate levels water. In the area of agriculture, orthophosphate comes from fertilizer materials that enter the river through drainage and rainwater flow. Polyphosphates can enter rivers through residents and industrial wastewater using phosphate-containing detergents. Organic phosphate is present is the wastewater of population (feces) and food scraps.

| ZONE | St. | Month | Physical | Chemical | Biology |
|------|-----|-------|----------|----------|---------|
|      |     |       | TSS | Turb | NO₃⁻N | NH₄⁻N | pH | PO₄-P | BOD | S | DO | Plankton |
|      |     |       | mg/l | °C  | ntu   | mg/l | mg/l | mg/l | mg/l | mg/l | %/o | mg/l | sel/100ml |
| PRC 1 | J   | 3     | 25.5 | 10.5 | 0.29  | 0.038 | 8.12 | 0.018 | 0.78  | 0    | 5.19 | 1.2 |
| I     | F   | 5     | 29.3 | 29.1 | 0.392 | 0     | 8.16 | 0.048 | 0     | 0    | 5.2  | 0   |
| M     | 42.2 | 30.6  | 0    | 0.38  | 0     | 7.97 | 0.064 | 6.99  | 5.6  | 6.52 | 8.1 |
| M     | 5.7  | 26.2  | 18   | 0.259 | 0.08  | 7.78 | 0.052 | 0     | 0    | 5.16 | 4.5 |
| M     | 3.4  | 26.7  | 8.5  | 0.226 | 0     | 8.16 | 0.026 | 0     | 0    | 5.28 | 1.2 |
| M     | 13.4 | 31    | 0    | 0.139 | 0     | 7.99 | 0.034 | 8.4   | 0.33 | 3.9  |     |
| PRC 2 | J   | 6.4   | 26.1 | 24.1 | 0.221 | 0.068 | 7.87 | 0.052 | 0     | 0    | 4.97 | 0   |
| F     | 7.1  | 27.7  | 0    | 0.219 | 0.068 | 8.24 | 0.029 | 0     | 0    | 3.94 | 0   |
| M     | 6    | 31.1  | 0    | 0.131 | 0     | 7.99 | 0.068 | 0     | 14   | 4.49 | 0   |
| PRC 3 | J   | 3.9   | 26.3 | 21.6 | 0.184 | 0.103 | 7.92 | 0.071 | 0.37  | 0.3  | 4.52 | 1.5 |
| F     | 4.9  | 28.9  | 0    | 0.212 | 0.026 | 8.14 | 0.034 | 0     | 28.9 | 3.93 | 0.6 |
| M     | 13.9 | 29.9  | 0    | 0.004 | 0     | 8.5  | 0.022 | 0.5   | 30.1 | 5.51 | 4.5 |
| J     | 4.6  | 26.3  | 24.9 | 0.254 | 0.131 | 7.91 | 0.063 | 0     | 0.2   | 4.35 | 0   |
| F     | 24.9 | 27.8  | 9.1  | 0.246 | 0.054 | 8.08 | 0.042 | 0     | 5     | 3.8  | 0   |
| M     | 16.1 | 29.9  | 0    | 0.012 | 0     | 8.18 | 0.028 | 0     | 31.7  | 3.8  | 0   |
| PRC 4 | J   | 45.6  | 26.9 | 41.7 | 0.207 | 0.118 | 8.05 | 0.081 | 0     | 1.3  | 4.85 | 0   |
| F     | 10.7 | 30.4  | 0    | 0.246 | 0     | 8.4  | 0     | 0     | 31.6  | 4.09 | 0   |
| M     | 16.1 | 30.1  | 0    | 0.005 | 0     | 8.38 | 0.02  | 0     | 32    | 5.39 | 0   |
| J     | 57.7 | 26.9  | 41.7 | 0.248 | 0.195 | 7.91 | 0.132 | 1.19  | 1.4   | 3.62 | 4.2 |
| F     | 46.3 | 28.8  | 20.4 | 0.16  | 0.016 | 8.11 | 0.025 | 0.88  | 19.9  | 3.8  | 11.7 |
| M     | 78.9 | 26.9  | 0    | 0.01  | 0     | 7.94 | 0.031 | 0.81  | 32.4  | 5.29 | 17.1 |
| PRC 5 | J   | 17.8  | 26.7 | 33.2 | 0.23  | 0.144 | 8    | 0.087 | 0     | 1.2  | 4.3  | 0   |
| F     | 20   | 30.1  | 4.3  | 0.023 | 0     | 8.29 | 0     | 0     | 30.9  | 3.97 | 0   |
| M     | 51.9 | 29.7  | 0    | 0.008 | 0     | 8.38 | 0.023 | 0     | 32.2  | 5.43 | 0   |
| J     | 36.8 | 26.8  | 33.3 | 0.235 | 0.151 | 8.05 | 0.092 | 1.19  | 1.6   | 4.78 | 0   |
| F     | 23.4 | 30.2  | 0    | 0.023 | 0     | 8.3  | 0     | 0     | 30.5  | 4.05 | 0   |
| M     | 43.6 | 29.7  | 0    | 0.007 | 0     | 8.25 | 0.023 | 0.51  | 32.4  | 5.34 | 0   |
| J     | 11.1 | 29.3  | 2.5  | 0.108 | 0.066 | 8.3  | 0.019 | 0     | 23.7  | 3.91 | 1.2 |
| F     | 7.2  | 29.7  | 0    | 0.012 | 0     | 8.4  | 0     | 0     | 32    | 4.22 | 1.2 |
| M     | 46.7 | 29.6  | 0    | 0.001 | 0     | 8.55 | 0.019 | 0     | 32.5  | 5.59 | 15.3 |

Table 2. Water quality in physical, chemical and biology parameters of Perancak Estuary.
Based on data from 10 stations observation (Figure 1), then each parameter is determined maximum, minimum and average values. These values are compared with the quality standards for marine tourism and marine biota (mangrove) as in [10] (Table 4.a and Table 4.b).

| No | Parameters | units | Quality standards (marine tourism) | ZONE I (PRC1,2) | ZONE II (PRC3-7) | ZONE III (PRC8-10) |
|----|------------|-------|------------------------------------|----------------|----------------|----------------|
|    |            |       |                                    | Measurement     | Measurement     | Measurement     | Score |
|    |            |       |                                    | Min  | Max  | Average | Min  | Max  | Average | Min  | Max  | Average | Score |
| 1  | TSS        | mg/l  | 20                                 | 3.00 | 42.20| 12.12   | -2   | 7.90 | 25.05   | -8   | 7.20 | 51.90   | -16  |
| 2  | Temperature| °C    | neutral +/- 3                      | 25.60| 30.70| 28.47   | 0    | 26.20| 31.00   | 0    | 26.70| 30.20   | 0    |
| 3  | Turbidity  | ntu   | 5                                  | 0.00 | 20.80| 9.60    | -8   | 0.00 | 41.70   | -8   | 0.00 | 33.90   | -8   |
| 4  | NO3-N      | mg/l  | 0.008                              | 0.14 | 0.39 | 0.28    | -2   | 0.00 | 0.14    | 0.28 | 0.00 | 0.24    | 0.07 |
| 5  | NH3-N      | mg/l  | nihil                              | 0.04 | 0.08 | 0.06    | -2   | 0.02 | 0.20    | 0.09 | 0.07 | 0.15    | 0.12 |
| 6  | pH         |        | 7-8.5                              | 7.78 | 8.19 | 8.04    | 0    | 7.91 | 8.50    | 8.17 | 8.05 | 8.55    | 8.29 |
| 7  | PO4-P      | mg/l  | 0.015                              | 0.02 | 0.06 | 0.04    | -2   | 0.02 | 0.13    | 0.05 | 0.02 | 0.09    | 0.05 |
| 8  | BOD        | mg/l  | 10                                 | 0.78 | 6.99 | 3.88    | 0    | 0.37 | 1.19    | 0.57 | 0.51 | 1.19    | 0.85 |
| 9  | Salinity   | 0/00  | natural                            | 0.00 | 8.40 | 2.33    | 0    | 0.00 | 32.50   | 13.97| 1.20 | 32.50   | 13.97|
| 10 | DO         | mg/l  | >5                                 | 5.16 | 8.42 | 5.82    | 0    | 3.62 | 5.51    | 4.55 | 3.91 | 5.59    | 4.63 |
| 11 | Plankton   | cell/100ml | No blooming (<15 cell/l) | 0.00 | 8.10 | 3.15    | 0    | 0.60 | 17.10   | 6.60 | 1.20 | 15.30   | 5.90 |

**Tabel 4.a Storet Index for marine ecotourism in Perancak Estuary**

**Class A:** meet the quality standards 0

**Class B:** lightly contaminated -6

**Class C:** moderately polluted -16

**Class D:** Heavily Polluted -80
| No | Parameters          | units | Quality standards (marine tourism) | ZONE I (PRC1,2) | ZONE II (PRC3-7) | ZONE III (PRC8-10) |
|----|--------------------|-------|-----------------------------------|----------------|----------------|-------------------|
|    |                    |       | Measurement                        | Measurement    | Measurement    | Measurement        |
|    |                    |       | Min      Max      Average   | Score  | Min      Max      Average | Score  | Min      Max      Average | Score  |
|    | PHYSICAL           |       |          |                | Score  |          |                | Score  |          |                | Score  |
| 1  | TSS                | mg/l  | mangrove 80 | 3.00  | 42.20  | 12.12  | 0    | 3.90  | 78.90  | 25.05  | 0    | 7.20  | 51.90  | 28.72  | 0    |
| 2  | Water temperature  | °C    | mangrove 28-32 | 25.60  | 30.70  | 28.47  | -2   | 26.20  | 31.00  | 28.47  | -2   | 26.70  | 30.20  | 29.10  | -2   |
| 3  | Turbidity          | ntu   | <5       | 0.00  | 20.80  | 9.60   | -8   | 0.00  | 41.70  | 12.22  | -8   | 0.00  | 33.90  | 8.27   | -8   |
|    | CHEMICAL           |       |          |                | Score  |          |                | Score  |          |                | Score  |
| 4  | NO3-N              | mg/l  | 0.008    | 0.14  | 0.39   | 0.28   | -20  | 0.00  | 0.14   | 0.28   | -16  | 0.00  | 0.24   | 0.07   | -16  |
| 5  | NH3-N              | mg/l  | 0.3      | 0.04  | 0.08   | 0.06   | 0    | 0.02  | 0.20   | 0.09   | 0    | 0.07  | 0.15   | 0.12   | 0    |
| 6  | pH                 |       | 7.8-5    | 7.78  | 8.19   | 8.04   | 0    | 7.91  | 8.50   | 8.17   | 0    | 8.05  | 8.55   | 8.29   | -4   |
| 7  | PO4-P              | mg/l  | 0.015    | 0.02  | 0.06   | 0.04   | -20  | 0.02  | 0.13   | 0.05   | -20  | 0.02  | 0.09   | 0.05   | -20  |
| 8  | BOD                | mg/l  | 20       | 0.78  | 6.99   | 3.88   | 0    | 0.37  | 1.19   | 0.75   | 0    | 0.51  | 1.19   | 0.85   | 0    |
| 9  | Salinity           |       | 0/00     | 0.00  | 8.40   | 2.33   | 0    | 0.00  | 32.50  | 13.97  | 0    | 1.20  | 32.50  | 13.97  | 0    |
| 10 | DO                 | mg/l  | >5       | 5.16  | 8.42   | 5.82   | 0    | 3.62  | 5.51   | 4.55   | -4   | 3.91  | 5.59   | 4.63   | -4   |
|    | BIOLOGY            |       |          |                | Score  |          |                | Score  |          |                | Score  |
| 11 | Plankton           | cell/100ml | No blooming (<15 cell/l) | 0  | 8.1 | 3.15 | 0 | 0.6 | 17.1 | 6.6 | -6 | 1.2 | 15.3 | 5.90 | -6 |
|    | Total Score        |       | Class A: meet the quality standards | 0 | Class B: lightly contaminated | -6 | Class B: lightly contaminated | -6 |
|    |                    |       | Class D: Heavily Polluted | -50 | Class D: Heavily Polluted | -56 | Class D: Heavily Polluted | -60 |
3.1. Storet analysis to a physical parameter

Total suspended solid (TSS) is one of the measured parameters of water quality. TSS has a positive correlation value which is the higher the turbidity, but conversely, the high dissolved solids are not always followed by high turbidity. Seawater has a high dissolved solid value but does not mean high turbidity [11]. TSS is based on The Ministry of Environment Regulation No. 115 of 2003 for marine tourism and mangrove ecosystems of 20 mg/l and 80 mg/l, respectively. TSS for marine tourism and mangrove ecosystems based on measurement results 3 times January - March 2018 in zones I, II, III each have a minimum value of 3 mg/l, 3.9 mg/l, 7.2 mg/l. The average TSS concentrations in these three zones were 12.12 mg/l, 25.05 mg/l and 28.75 mg/l. The maximum TSS concentrations in these three zones each have of 42.2 mg/l, 78.9 mg/l, and 51.9 mg/l. The concentration of TSS for marine tourism of the three zones have values above the quality standard value of The Ministry of Environment Regulation No.115 of 2003, while for mangrove ecosystems are still below the quality standard.

Temperature is one of the important physical factors for the life of organisms in the ocean. Every change in the ambient temperature of the water will affect the chemical processes that occur simultaneously in plant tissues and biota. The temperature based on Minister of Environment Decree No. 51 of 2004 [10] for marine tourism is +/-3 and mangrove ecosystem 28-32°C. The results of temperature measurements for marine tourism January - March 2018 in zone I, II, III have a minimum value of 25.6°C, 26.2°C and 26.7°C, the average temperature is 30.7°C, 31°C, 30.2°C, maximum temperature 28.4°C, 28.4°C, 29.1°C still in accordance with environmental quality standards but slightly above the quality standards for mangrove ecosystems.

Turbidity is a physical parameter that measures water quality. Turbidity has a positive correlation with TSS. Environmental quality standard based on The Ministry of Environment Regulation No. 115 of 2003 [11] for marine tourism and mangrove ecosystems for marine tourism was 5 ntu and for mangrove ecosystem <5 ntu. The measurement results of turbidity for marine tourism and mangrove ecosystem from January - March 2018 in the zone I, II, III have turbidity on minimum 0 ntu, on average 9.6 ntu, 12.22 ntu, and maximum 20.8 ntu, 41.7 ntu, 33.9 ntu. Turbidity for marine tourism and mangrove ecosystems above environmental quality standards.

Analysis storet for water quality physical parameters (TSS, temperature, and turbidity) for marine tourism showed the condition of light polluted waters (class B) in the zone I with index -10 and polluted moderately (class C) in zones II and III with index values -16. Analysis of storet water quality for marine biota (mangrove ecosystems) showed light polluted waters conditions (class B) in zones I and II with index -10 values and medium polluted (class C) in zone III with index -12 value.

3.2. Storet analysis to the chemical parameter

Nitrate as an indicator of aquatic fertility. Natural water nitrate levels are almost never more than 0.1 mg/l. Nitrate concentration of more than 5 mg/l illustrates anthropogenic pollution from human and fecal activities of animals [11]. The level of environmental quality standards for nitrates based on the Ministry of Environment Regulation No. 115 of 2003 for marine tourism and mangrove ecosystems not more than 0.008 mg/l. Nitrate measurement results from January to March 2018 in the zone I, II, III have minimum 0.14 mg/l, 0 mg/l, and 0 mg/l, respectively. The maximum values in zone I, II, III are 0.39 mg/l, 0.14 mg/l, 0.24 mg/l. The average value is 0.28 mg/l in the zone I, II and 0.07 mg/l in zone III. From Table 4.a and Table 4.b seen in zone I nitrate content is within the range of environmental quality standards, both for marine tourism and mangrove ecosystems, this shows in zone I is indicating high input of organic material from the incoming land activity to the river because zone I is a zone close to residential and livestock areas. River flow is one of the flowing aquatic ecosystems that contribute to bringing waste from land activities that affect and change the condition of the aquatic environment.

Sources of ammonia are from agricultural, residential and industrial wastes. The source of ammonia in the water is the result of the breakdown of organic nitrogen (protein from urea) and inorganic nitrogen contained in water. Ammonia is the final product of nitrogen which is toxic, therefore the presence of ammonia in the environment can affect the condition of the waters, especially the biota in it. Environmental quality standards based on The Ministry of Environment Regulation No. 115 of 2003 [11] ammonia concentration for marine tourism and mangrove
ecosystems each not more than 0 mg/l and 0.3 mg/l. Ammonia measurement results from January to March 2018 in zone I, II, III have a minimum value of 0.04 mg/l, 0.02 mg/l, 0.07 mg/l, a maximum value of 0.08 mg/l, 0.2 mg/l, 0.15 mg/l and an average value of 0.06 mg/l, 0.09 mg/l, 0.12 mg/l. Ammonia concentration values in the zone I, II, III are above the threshold of environmental quality standards for marine tourism (Table 4.a), while the value of ammonia concentration for mangrove biota is still within the range of environmental quality standards (Table 4.b).

pH affects the water quality (good and bad). The pH of an aquatic can be used as an indicator of the balance of chemical elements. pH can affect the availability of chemical elements and nutrients which are very beneficial for aquatic biota life. pH environmental quality standards based on The Ministry of Environment Regulation No. 115 of 2003 [11] ranges from 7-8.5. pH minimum on January-March 2018 in the zone I, II, III each have 7.78, 7.91, 8.05. pH maximum have each values 8.19, 8.50, 8.55 and an average each value of 8.04, 8.17, 8.29. The pH value in the zone I, II is within the range of environmental quality standards, whereas in zone III is slightly above the environmental quality standard for both marine tourism and mangrove ecosystems.

Phosphate is one indicator to evaluate the quality and level of aquatic fertility. However, if the concentration of nitrate and phosphate is too large and exceeds the threshold, then eutrophication (nutrient enrichment) occurs which is indicated by the occurrence of phytoplankton bloom which usually causes death in biota. Classification of waters with a phosphate concentration of more than 0.1 mg/l is eutrophic waters where these waters often occur phytoplankton blooms. Phosphate plays an important role in determining the amount of phytoplankton. The source of phosphate in the water is the result decomposition of plants and the remains of dead organisms as well as input from the land through river flows in the form of industrial and household waste containing organic compounds. According to UNESCO/WHO/UNEP, 1992 [11] states that phosphorus levels in natural waters are in the range of 0.005-0.02 mg/l in phosphate form. Phosphate concentration based on environmental quality standards of the Ministry of Environment Regulation No. 51 of 2004 for marine tourism and mangrove ecosystems is 0.015 mg/l. The concentration phosphate January-March 2018 in zone I, II, III have a minimum value of 0.02 mg/l in three zones, a maximum value of 0.06 mg/l, 0.13 mg/l, 0.09 mg/l and an average value of 0.04 mg/l, 0.05 mg/l, 0.05 mg/l. Phosphate concentration values in the zone I, II, III are above the threshold of environmental quality standards for marine tourism and mangrove ecosystems.

Biological oxygen demand (BOD) is the need for oxygen by micro-organisms in the waters to degrade simple elements to complex compounds originating from domestic waste that is disposed of or chemically found in the waters. BOD concentration is based on environmental quality standards of the Ministry of Ministry of Environment Regulation No. 51 of 2004 [10] for marine tourism and mangrove ecosystems of 10 mg/l and 20 mg/l, respectively. BOD measurement results from January to March 2018 in zone I, II, III have a minimum value of 0.78 mg/l, 0.37 mg/l, 0.51 mg/l, maximum 6.99 mg/l, 1.19 mg/l, 1.19 mg/l and average 3.88 mg/l, 1.19 mg/l, 0.85 mg/l. BOD concentration values in the zone I, II, III are still within the range of environmental quality standards for both marine tourism and mangrove ecosystems.

Salinity is the concentration of all salt solutions obtained in seawater which are expressed in permill units. Salinity describes total solids in water. Salinity in the fresh water is 0.5‰ - 30‰ and sea waters are 30‰ - 40‰. Salinity diversity in seawater will affect aquatic life bodies based on the ability to control specific gravity and the diversity of osmotic pressure. Salinity values based on environmental quality standards of the Ministry of Environment Regulation No. 51 of 2004 [10] for marine tourism are natural salinity, while for mangrove ecosystems up to 34‰. Salinity measurement results from January to March 2018 in the zone I, II, III are still within the range of environmental quality standards for both marine tourism and mangrove ecosystems.

Dissolved oxygen (DO) is an important chemical element for the life of marine biota because DO is needed by all bodies of life for breathing, the process of metabolism and the exchange of substances which then produce energy for growth and breeding. O2 is needed for the oxidation of organic and inorganic ingredients in the aerobic process. The main source of oxygen in a water comes from a diffusion process from free air and photosynthetic results of organisms that live in the waters. DO base on environmental regulations of the Minister of Environment No.51 of 2004 [10] for
marine tourism and mangrove ecosystems are > 5 mg/l. DO from January to March 2018 in the zone I, II, III were minimum 5.16 mg/l, 3.62 mg/l, 3.91 mg/l, maximum 8.42 mg/l, 5.51 mg/l, 5.59 mg/l and flat, respectively. - 5.82 mg/l, 4.55 mg/l, 4.63 mg/l. The results of DO measurements from January to March 2018 in the zone I are still within the range of environmental quality standards, while in zone II, III above the threshold of environmental quality standards for both marine tourism and mangrove ecosystems.

Based on the analysis of store water quality, chemical parameters (nitrate, ammonia, pH, phosphate, BOD, salinity and DO) for marine tourism shows the condition of heavily polluted waters (class D) in the zone I, II, III with an index value of -60, -80, -80. Likewise, the results of the analysis of store water quality for mangrove ecosystems show the condition of heavily polluted waters (class D) in the zone I, II, III with index values of -40, -52 and -56, respectively. nitrate, ammonia, and phosphate give the largest contribution for the polluted index in Perancak Estuary. There is a strong and significant relation between ammonia, nitrate, nitrite concentration and the index score, indicating that they make a remarkable contribution to water quality index [12,13].

3.3. Storet analysis to biology parameter
Plankton has a very important role in the water, apart from being the basis of the food chain, it is also a parameter of the level of aquatic fertility. Water quality can be measured from biological parameters using aquatic biota plankton as bioindicator. Plankton concentration based on environmental regulations of the Ministry of Environment No. 51 of 2004 [10] for marine tourism and mangrove ecosystems <15 mg/l. Plankton measurement results from January to March 2018 in zone I, II, III with a minimum of 0 mg/l, 0.6 mg/l, 1.2 mg/l, maximum 8.1 mg/l, 17.1 mg/l, 15.3 mg/l and an average of 3.15 mg/l, 6.6 mg/l, 5.9 mg/l.

The results of the analysis of plankton concentrations in the three zones (I, II, III) are still below the range of environmental quality standards, although there is 1 station (PRC7, PRC10) in zone III slightly above the environmental quality standard. Based on the analysis of storet biological quality water parameters (plankton) for marine tourism and mangrove ecosystems, it shows that it is still in accordance with the quality standards (class A) in the zone I with index value 0. While zones II and III are slightly above the standard quality threshold or experience mild contamination (class B) with index values of 6 and -6. Analysis storet of water quality from physical parameters (TSS, temperature and turbidity), chemistry parameter (nitrate, ammonia, pH, phosphate, BOD, salinity and DO), biology (plankton) shows above the heavily polluted (class D) in all zones (I, II, III) with index values at -70, -102, -102 for marine tourism and -50, -56, -60.
4. Conclusion
Storing analysis based on storet index for marine ecotourism zone I, II, III Perancak Estuary showed lightly contaminated to polluted moderately (-10 until -16) for physical parameters, heavily polluted (-60 until -80) for chemical parameter and biology parameters is still in accordance with quality standards until lightly contaminated (0 until -6). Stored index for marine biota (mangrove) in the zone I, II, III showed lightly contaminated (-10) for physical parameters, heavily polluted (-40 until -44) for chemical parameter and biology parameters is still in accordance with quality standards until lightly contaminated (0 until -6). Chemical parameters (nitrate, phosphate, ammonia) contribute the most to the level of pollution. Based on the value of the pollution index shows the status of Perancak estuary in January-March is classified as bad/severe pollution both for marine tourism and the mangrove ecosystem.

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