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Assessment of Water Quality in Jambi Coastal Areas Through Pollution Index Analysis

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Abstract

This study focuses on assessing the coastal conditions in Jambi Province both physicochemical and biological parameters. This combination of assessments previously still had limited understanding. Retrieval of physical parameter data using a multi-parameter water quality analyzer, chemical data using the APHA method and spectrophotometer, and chlorophyll-a data using the Copernicus Marine Environment Monitoring Service (CMEMS). The results, with adjustments to national quality standards and pollution index measurements, showed that the five research stations on the east coast of Jambi experienced light to moderate pollution with a score range of 1.252-5.831. Pollution is in the form of nutrients, especially nitrate. However, the trophic index of the coast is classified as oligotrophic, which ranges between 0.689278 - 0.7599 mg/m^3. Otherwise, the high nutrient values are TOM and TN, which have a significant correlation, besides the correlation with DO and pH. Measurements of TN and TP in the water column and sediment have also been carried out, where the water column TN concentration is about 5 times higher than the sediment TN and the water column TP concentration is 7 times lower than the sediment TP. The results of this study will contribute to a better understanding of coastal ecosystem health and its significance for the management of the coastal environment in Jambi as a fisheries catchment area.

Keywords: Coastal water quality, Jambi Province, Oligotrophic, Pollution indeks.

1. Introduction

Jambi is a province located on the eastern coast of the island of Sumatra in Indonesia (Rustiadi *et al.*, 2018). Jambi has a coastline stretches 221 km from West Tanjung Jabung to East Tanjung Jabung (Achmad *et al.*, 2020). This area is the estuary of the Batanghari River, one of the longest rivers on Sumatra Island. Its length is 1,740 km (Febrianti *et al.*, 2023). Coastal wetlands are aquatic ecosystems where freshwater and marine environments meet (Hopkinson *et al.*, 2019). They support high biodiversity and trophic-level productivity and also provide important ecosystem services (Navarro *et al.*, 2021; Whitfield *et al.*, 2022). The coastal wetlands of Jambi are unique in their biodiversity, productivity, and endemism.

However, the combined effects of booming population growth, economic development, and technological advancement have exacerbated the need for water resources in the surrounding coastal areas (Cetin, 2016; Chen, *et al.*, 2022). On the other hand, those imply changes in land use that cause major threats such as erosion and sedimentation (Umar *et al.*, 2015) are no exception to the condition of the Jambi coast. These anthropogenic pressures cause pollution such as nutrient enrichment, habitat destruction such as discoloration and abrasion, and resource depletion characterized by declining catches, which collectively affect the health of coastal ecosystems (Hiwasaki *et al.*, 2014; Oelsner and Stets, 2019; Williams *et al.*, 2018; DiBattista *et al.*, 2020; Sigsgaard *et al.*, 2017; Nie *et al.*, 2018; Chen *et al.*, 2022). Similarly, along the Jambi coast, land use change in the Batanghari catchment for residential and agricultural areas is projected to increase by 3.8% and 64.8% respectively, while sediment loads are projected to reach 72.8 t/ha by 2040 (Ridwansyah *et al.*, 2023). This is further exacerbated by deforestation of mangroves for agriculture in coastal areas (Wijaya *et al.*, 2015; Cahyaningsih *et al.*, 2022; Tharieq *et al.*, 2023).

The current research related to the assessment of water quality dynamics in the Jambi coastal area is limited. The purpose of this study is to assess the coastal water quality conditions in Jambi through a physicochemical and biological parameters approach.

1. Methods

2.1 Sampling site

Sampling was carried out in August 2023 at 5 stations along the east coast of Jambi, which is a fishing area, a detailed description of each station can be seen in the table1. Catches in the Jambi coastal area include in **Table 2**. The fishing gear used by the fishers is traditional, such as gill nets, longlines, togoks, and sondongs.

Table 1. Description of sampling location (**Figure 1 and Figure 2**)

No.	Station	Position	Description areas
1.	ST 1	1º 1' 48.85" LS - 104º 16' 14.99" BT	Nipah Panjang district: Nypa areas, Batanghari river estuary, there is a port area with ships operating mostly measuring 10 GT, agriculture area
2.	ST 2	0º 59' 49.21" LS - 104º 3' 5.88" BT	Sabak Timur district: Sabak Timur estuary, agriculture area, and human settlement
3.	ST 3	1º 0' 33.55" LS - 103º 49' 10.16" BT	Kampung Laut District: Batanghari river estuary, agriculture area, there is also a small port with vessels operating between 2-3 GT
4.	ST 4	0º 56' 18.00" LS - 103º 41' 26.38" BT	Mendahara Ilir district: Mendahara Ilir estuary, agriculture area
5.	ST 5	0º 48' 9.03" N - 103º 29' 15.77" BT	Kuala Tungkal District: Kuala Tungkal estuary, human settlement, and agriculture area

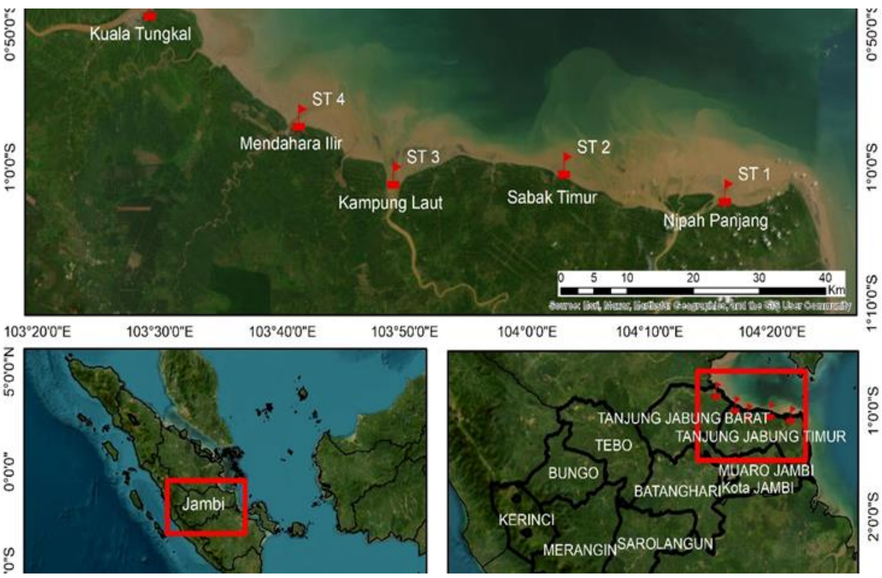

Figure 1. Map of sampling locations on the East coast of Jambi, consisting of 5 stations (Google Earth)

Table 2. Various types of fish caught by fishermen on the east coast of Jambi (Katarina *et al.*, 2019; Pratama *et al.*, 2021; Mauliddin *et al.*, 2022)

No.	Species	Local Name	Common name	Information
1.	*Acetes japonicas*	Rebon shrimp	Glass/fry shrimp	Crustacea
2.	*Portunus pelagicus*	Crab	Blue swimming crab	Crustacea
3.	*Muraenesox cinerus*	Sembilang/lola fish	Conger eel	Pisces
4.	*Trichiurus lepturus*	Layur fish	Slipmouth/ribbon fish	Pisces
5.	*Thryssa hamiltonii*	Selar/tambak fish	Hamilton’s thryssa	Pisces
6.	*Argyrosomus japonicas*	Duri/sebaguna fish	Japanese meagre	Pisces
7.	*Muraenesox cinerus*	Eel fish	Grey/cinerous moray	Pisces
8.	*Gobiidae* spp	Gobi fish	Gopies	Pisces
9.	*Panaeus merguienesis*	Galah/peci/putih shrimp	Banana shrimp	Crustacea
10.	*Panaeus monodon*	Windu/tiger shrimp	Black tiger shrimp	Crustacea
11.	*Litopenaeus vannamei*	Vaname shrimp	Whiteleg/ Pacific white shrimp	Crustacea
12.	*Metapenaeus lysianassa*	King/Yellow shrimp	Indian white shrimp	Crustacea
13.	*Metapenaesus affinis*	Swallow shrimp	Indian shrimp	Crustacea
14.	*Metapenaesus dobsoni*	“kapur” shrimp	Penaeid/dodge shrimp	Crustacea
15.	*Metapenaesus ensis*	“dogol” shrimp	Asian white shrimp	Crustacea
16.	*Metapenaesus brevicornis*	“brek” shrimp	Short-horned shrimp	Crustacea
17.	*Penaeus indicus*	White shrimp	Indian tiger shrimp	Crustacea
18.	*Metapenaeus tenuipes*	King shrimp	Slender shrimp	Crustacea
19.	*Parapenaeopsis sculptilis*	“batu” shrimp	Sculptured penaeid shrimp	Crustacea
20.	*Harpiosquilla raphidea*	“raja merah” shrimp	Red mantis shrimp	Crustacea
21.	*Mystacoleucus padangenesis*	Bilis fish	Palang sumatransky	Pisces
22.	*Coilia dussumieri*	“bulu ayam” fish	Belanak fish	Pisces
23.	*Pseudocenna amovensis*	Beder fish	Amoven's catfish	Pisces
24.	*Harpodon nehereus*	Lomek fish	Bombay duck	Pisces
25.	*Tetraodon lunaris*	Buntal fish	Moonfish/spotted pufferfish	Pisces
26.	*Cynoglossus lingua*	“lidah” fish	Tongue sole	Pisces
27.	*Trichiurus lepturus*	Layur fish	Silver pomfret atau hairtail	Pisces
28.	*Parastromateus niger*	Kakap hitam/gedang fish	African croaker	Pisces
29.	*Dussumeirea hasreltii*	Tamban fish	Wolf herring	Pisces
30.	*Nematolosa come*	Selangat fish	Indian oil sardine	Pisces
31.	*Opisthopterus tardoore*	“bulat mata” fish	Ladder-finned herring	Pisces
32.	*Mugil dussumieri*	Belanak fish	Dussumier’s mullet	Pisces
33.	*Muraenosox bagio*	Malung fish	Barracuda eel	Pisces
34.	*Chrocentrus dorab*	Parang fish	Royal Mackerel	Pisces
35.	*Dasyatis akajei*	Pari fish	Japanese stingray	Pisces
36.	*Chilosyllium arabium*	“hiu cicak” fish	Arabian carpet shark	Pisces
37.	*Atropus atropus*	“bulan” fish	Black-naped Tern	Pisces

38.	*Caranx Boobp*	Selar fish	Bigeye trevally	Pisces
39.	*Paratomateus niger*	"bawal hitam" fish	Black-banded pipefish	Pisces
40.	*Lates calcalifer*	"kakap laut" fish	Barramundi	Pisces
41.	*Lutjanus argentimaculatus*	"kakap merah" fish	Spotted snapper	Pisces
42.	*Atrobucca nibe*	Selampai fish	Nibe croaker	Pisces
43.	*Otolithoides microdon*	"Gulama batu" fish	Indian flathead	Pisces
44.	*Eleutheronema tetradactylum*	Senangin fish	four-finger threadfin	Pisces
45.	*Rachyncentron canadum*	"gabus laut" fish	Olusfish/ threadfin bream	Pisces
46.	*Rastrolliger brachysoma*	"kembung lelaki" fish	Short mackerel	Pisces
47.	*Rastrolliger kanagurta*	"kembung perempuan" fish	Indian/bigmouth mackerel	Pisces
48.	*Scomberomorus commerson*	Tenggiri fish	Barred spanish mackerel	Pisces
49.	*Epinephelus bleekeri*	Kerapu fish	Duskytail grouper	Pisces
50.	*Pampus argenteus*	"bawal putih" fish	Butterflyfish	Pisces
51.	*Trichiurus savala*	Layur fish	Small-head hairtail	Pisces
52.	*Chynoglosus arel*	"sebelah" fish	Largescale tonguesole	Pisces
53.	*Thylosurus strongylurus*	Todak fish	Hound needlefish	Pisces
54.	*Hexanematichyhys sagor*	"duri putih" fish	Marine/sagor catfish	Pisces
55.	*Arius venosus*	"duri kuning" fish	Veined catfish	Pisces
56.	*Mystus nemurus*	"baung laut" fish	Asian red-tail catfish	Pisces
57.	*Plotosus canius*	Sembilang fish	Gray eel catfsh	Pisces
58.	*Grammoplites scaber*	Baji fish	Rough flathead	Pisces

Figure 2. Conditions around the research location (Google Earth)

2.3 Collecting Data

2.3.1 Measurement of physical and biological parameters

Physical parameters observed included sea surface temperature, pH, and DO using a multi-parameter water quality analyzer (AZ-86031, Taiwan), while biological parameters included chlorophyll-a data. Data for these two parameters were obtained from the Copernicus Marine Environment Monitoring Service (CMEMS), available on the website https://marine.copernicus.eu/ (Le Traon *et al.*, 2019; Lellouche *et al.*, 2018; von Schuckmann *et al.*, 2016). These data are the result of a re-analysis of in situ observations, remote sensing, and atmospheric data. The data used have a spatial resolution of 1/12º or 9.25 km with a daily period on 29 August 2023. Sea surface temperature, salinity, and chlorophyll-a data have been spatially visualized using Arc Gis 10.8 software.

2.3.2 Chemical parameters

Sampling for the measurement of chemical parameters was carried out in the water column in depth 2 meters and sediment column. Parameters measured in the water column included TN, TP, nitrate, nitrite, ammonia, orthophosphate, and TOM. Parameters measured in the sediment included TN, TP, and TOC.

Water samples were collected using a Vandorn vertical water sampler and then filled into a 1000 ml sterile polyethylene bottle. Sediment was collected using an Ekman grab and placed in a sterile polyethylene bag. Then, all samples were placed in a cooler box to reduce the sample degradation process (Ustaoğlu and Tepe, 2019) while en route to the Basic and Integrated Laboratory, Jambi University. Upon arrival at the laboratory, the water sample was immediately placed in the refrigerator at 4°C, while the sediment sample was transferred to a 500 ml sterile polyethylene bottle and stored in the refrigerator at 4°C. It will then be analyzed at the ProLing (Productive Environment) Laboratory, IPB University, Bogor, Indonesia in September 2023.

2.4 Data Analysis

The condition of the Jambi coast is analyzed by comparing the results of physical and chemical water quality measurements with the coastal environmental quality standards established in Indonesia, namely the Minister of Environment (KepmenLH) Regulation No. 51 of 2004 on seawater quality standards, which are intended for the life of coastal biota of various species of fish, crabs, crustaceans, shellfish, and mangroves. The condition of the east coast of Jambi is assessed using the Pollution Index (PIj), where the formulation refers to the Minister of Environment (KepmenLH) Regulation No. 115 of 2003 on Guidelines for Determining Water Quality Status. The following is the formula for the Pollution Index (PIj):

$$PI_j = \sqrt{\frac{(C_i/L_{ij})_M^2 + (C_i/L_{ij})_R^2}{2}}$$

Where PIj is the pollution index for the designation, Lij is the concentration of the water quality parameters listed in the water quality standards, Ci is the concentration of the water quality parameter (i) obtained from the measurement results, (Ci/Lij)R is the mean Ci/Lij value, and (Ci/Lij)M is the maximum Ci/Lij value. Seven physicochemical parameters are used in this calculation, namely ammonia, nitrate, orthophosphate, DO, temperature, salinity, and pH. The range of scores and water quality status based on the Pollution Index can be seen in **Table 3** as follows:

Table 3. Evaluation of the PI value (Minister of Environment (KepmenLH) Regulation No. 115 of 2003)

PI score	Status
$0 \leq Pij \leq 1.0$	Good condition/meets quality standards
$1.0 \leq Pij \leq 5.0$	light pollution
$5.0 \leq Pij \leq 10$	moderately polluted
$Pij > 10$	severely polluted

Chlorophyll measurements were used to assess the trophic level on the east coast of Jambi by comparing the results of satellite remote sensing chlorophyll measurements with the chlorophyll values from Hakanson and Bryann (2008).

Coastal conditions were then enhanced by analysis using the R application to determine clustering of stations with similar site characteristics and water quality parameters (KMEANS), Principal Component Analysis (PCA) to determine water quality parameters that influence each research station, and correlation (90% confidence interval) between quality parameters in the water column, sediment, and between the water column and sediment.

The formula for getting the correlation coefficient is as follows:

$$r_{xy} = \frac{n\sum_{i=1}^{n} x_i y_i - (\sum_{i=1}^{n} x_i)(\sum_{i=1}^{n} y_1)}{\sqrt{\{n\sum_{i=1}^{n} x_1^2 - (\sum_{i=1}^{n} x_i)^2\}\{n\sum_{i=1}^{n} y_1^2 - (\sum_{i=1}^{n} y_i)^2\}}}$$

The test statistics are:

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

Where,
r= Pearson correlation coefficient
n = Sample size
The form of the hypothesis in correlation is as follows:

$H_0: \rho = 0$There is no linear relationship between the two variables

$H_1: \rho \neq 0$There is a linear relationship between two variables

Reject if or$H_0 t < -t_{\left(\frac{\alpha}{2},\ n-2\right)} t > t_{\left(\frac{\alpha}{2},\ n-2\right)}$orReject if$H_0 p - value < \alpha$

The results of this water quality analysis will be used to predict the community structure of trophic-level organisms in the Jambi coastal area by reviewing relevant journals.

2. Result and Discussion

3.2 Condition of Jambi East Coast Waters

Water quality parameters in coastal areas are largely influenced by various inputs from the surrounding environment, such as the influence of river flow (Alizadeh *et al.*, 2018). Table 4 presents in situ water quality measurement data for the Jambi coast, while Table 3 presents ex-situ water quality measurement data.

Table 4. In situ measurement of water quality parameters in the water column of the East coast of Jambi

Water quality parameters	ST 1	ST 2	ST 3	ST 4	ST 5	Minister of Environment Decree 51 of 2004 Seawater Quality Standards for Biota
Temperature (ºC)	28.6 ± 0.1	29.2 ± 0.17	29.17 ± 0.12	29.67 ± 0.12	29.4 ± 0.1	28-32 (for mangroves)
pH	6.39 ± 0.18	7.84 ± 0.20	7.78 ± 0.16	7.64 ± 0.11	7.73 ± 0.05	7-8.5
DO (mg/L)	3.33 ± 0.49	5.6 ± 0.6	5.83 ± 0.61	5.77 ± 0.31	5.83 ± 0.35	>5

Table 5. Results of measuring ex-situ water quality parameters in the Jambi Coastal water column

Water quality parameters	ST.1	ST.2	ST.3	ST.4	ST.5	Minister of Environment Decree 51 of 2004 Seawater Quality Standards for Biota
TP (mg/L)	0.168	0.277	0.1	0.096	0.178	-
TN (mg/L)	18.5	22.5	20.1	22.1	22.4	-
Ammonia (mg/L)	0.147	0.069	0.081	0.112	0.054	0.3
Nitrate (mg/L)	0.204	0.061	0.138	0.072	0.063	0.008
Nitrite (mg/L)	0.005	0.003	0.005	0.029	0.028	-
Orthophosphate (mg/L)	0.004	0.004	0.002	0.003	0.012	0.015
TOM (mg/L)	155.05	189.05	169.08	185.61	188.43	-
Salinity (PSU) (CMEMS)	31.26	31.3	30.97	30.82	30.3	until 34‰(for mangroves)
Chlorophyll a (mg/m^3) (CMEMS)	0.689278	0.7454	0.7599	0.737	0.70566	-

Table 6. Pollution status on the East coast of Jambi based on the Pollution Index (PIj) value

Stations	Pollution index score (PIj)	Status
ST 1	$5.0 \leq$ **5.83** ≤ 10	moderately polluted
ST 2	$1.0 \leq$ **1.25** ≤ 5.0	lightly polluted
ST 3	$5.0 \leq$ **5.16** ≤ 10	moderately polluted
ST 4	$1.0 \leq$ **1.86** ≤ 5.0	lightly polluted
ST 5	$1.0 \leq$ **3.96** ≤ 5.0	lightly polluted

Table 7. The trophic level of the East Jambi coast is based on chlorophyll values

Stations	**Score of fertility rate (mg/m3)**	**Evaluation (Hakanson and Bryann, 2008)**	**status**
ST 1	0.689	< 2.0 mg/m3 (oligotrophy) 2.0 - 6.0 mg/m3 (mesotrophic) 6.0 - 20 mg/m3 (eutrophic) > 20 mg/m3 (hypereutrophic)	Oligotrophy
ST 2	0.745		
ST 3	0.760		
ST 4	0.737		
ST 5	0.706		

The results of temperature measurements at all stations show average values varying between 28.6ºC 29.67ºC. pH measurements at all stations have an average range of 6.39 - 7.84. The temperature value is still within the National Quality Standard range that can be tolerated for mangrove habitats and other coastal biota (see **Table 4**).

The Pollution Index (PIj) value shows that the research site is slightly to moderately polluted, with details of ST 1 and ST 3 being moderately polluted with scores of 5.83 and 5.16 respectively. Meanwhile, ST 2, ST 4, and ST 5 were slightly polluted with scores of 1.25, 1.86, and 3.96 respectively (see **Table 4**). ST 1 and ST 3 are the large estuaries of the Batanghari River and ST

2, ST 4, and ST 5 are the estuaries of small rivers (see **Figure 2**). Therefore, ST 1 and ST 3 are in the same cluster, while the other stations are in different clusters (see **Figure 5a**). The study sites were identified as being polluted with nutrients, particularly nitrate, as the nitrate levels at all stations exceeded the threshold for the national quality standard. The high levels of nutrient pollutants, particularly nitrogen in estuaries, are caused by human activities in the form of domestic wastewater discharges, in particular, the intensive use of synthetic detergents, industrial capacity, and run-off from agricultural activities using fertilizers (Liu *et al.*, 2003). In addition, ST 1 and ST 3 dock areas, with ST 1 having a large number of diesel-fuelled vessels of around 10 GT passing through and most of the area being overgrown with nypa. ST 3, on the other hand, is a densely populated area and a berth for fishing boats of 2-3 GT, also using diesel fuel. The degradation of hydrocarbons from marine fuel is a source of pollutants in seawater (Nazri and Sapawe, 2020), particularly ammonia and nitrate concentrations (Brooke *et al.*, 2001). This station also recorded the highest values for ammonia and nitrate, 0.147 mg/L and 0.204 mg/L respectively, but the ammonia value was still below the National Quality Standard (all stations), while the nitrate value was not. Coastal pollution causes a disturbance in the balance of the marine food web, which ultimately leads to a reduction in the final consumers in the water, which is fish.

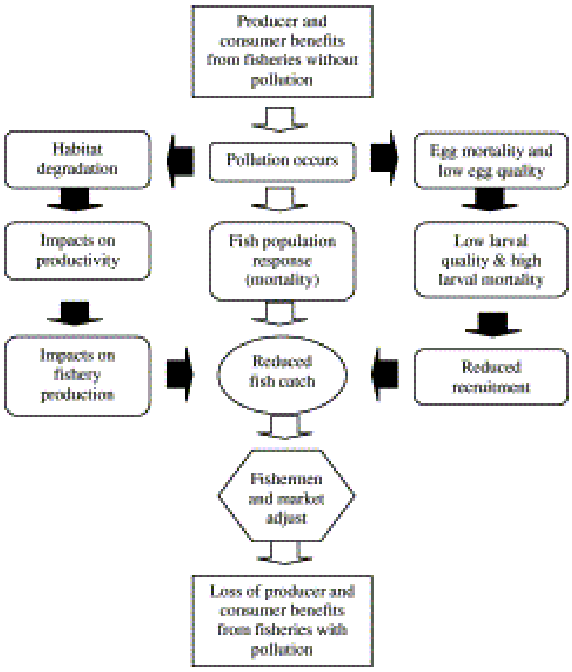

Figure 3. Flowchart of the impact of water pollution on fish populations and its impact on the economy (Islam and Tanaka, 2004)

Based on the data in Tables 4 and 5, pH and DO are the lowest in ST 1 with average values of 6.39 and 3.33 mg/L respectively (not by national quality standards). DO standards vary widely between countries, generally ranging from 2 mg/l (lowest limit) to 6.5 mg/l (highest limit), with the EPA itself setting the lowest limit for aquatic biota at 2.3 mg/l for adults. Juvenile survival and 4.8 mg/l for adult-juvenile-larval growth (EPA, 2000). The EPA also recommends a pH limit of 6.5 for coastal and/or estuarine areas (EPA, 1976). Fluctuations in pH can be influenced by fluctuations in ion concentrations of carbon dioxide, carbonate, and bicarbonate (Zang *et al.*, 2011). Therefore, pH values below those recommended by the EPA (1976) may hurt coastal biota, especially mussels. The low DO in ST 1 is a result of oxygen consumption for biochemical reactions that occur in the water itself or in the bodies of organisms (Wetzel and Likens, 2000; Ammon and Banner, 1996). According to research by Bilgin and Yonsel (2005), the fuel degradation process involving microbial activity uses a lot of dissolved oxygen to accelerate the rate of degradation. Moreover, the chlorophyll content at this station is the lowest (0.689278 mg/m^3), so the photosynthetic process produces less dissolved oxygen, especially when there are more heterotrophic organisms than autotrophs, so the competition for dissolved oxygen is greater for the process.Respiration (Kulkarni, 2016). Based on a comparison with (Hakanson and Bryann, 2008), the east coast of Jambi is still classified as oligotrophic (**Table 7**). Oligotrophic waters refer to waters with low nutrient supply (Dave *et al.*, 2015), so the abundance of autotrophic organisms is also low. The DO in ST 1, which is below 4.8 mg/l and approaching the limit of 2.3 mg/l, could be a warning that this condition is dangerous for the growth and survival of coastal biota. Zang et al. (2011) argue that pH, DO, temperature and chlorophyll have a close relationship, with carbon dioxide concentration also being influenced by algal photosynthesis, aquatic respiration, water temperature, and oxidative decomposition of organic matter. This is supported by the Pearson correlation results which show that there is a significant positive correlation between temperature and DO and pH and DO ($P < 0.1\%$), while temperature and chlorophyll a and temperature and pH do not show a significant correlation ($P > 0.1\%$) (Figure 6).

Organic matter (OM) in aquatic systems is derived from autochthonous and allochthonous as well as anthropogenic inputs and can occur in dissolved, particulate, or colloidal forms (Artifon *et al.*, 2019). The constituents of organic matter can be carbon (C), nitrogen (N), phosphorus (P), and sulfur (S) (Nelson and Sommers, 1996; Schnitzer, 1999; Elliott *et al.*, 2001). Total Organic Matter (TOM) on the east coast of Jambi (Sumatra Island, Indonesia) is a nutrient parameter with the highest value with a range of 155.05 mg/l - 189.05 mg/l, where ST 2 is the highest with a value of 189.05 mg/l. Meanwhile, TOM values on the coast of Banyuwangi (Java Island, Indonesia) range from 2,528 mg/l to 53,088 mg/l (Lestari *et al.*, 2024). This means that the TOM value on the east coast of Jambi is 6 times higher than on the Banyuwangi coast. TOM is a combination of dissolved organic matter and undissolved organic matter, and the location of TOM is shown in Figure 4.

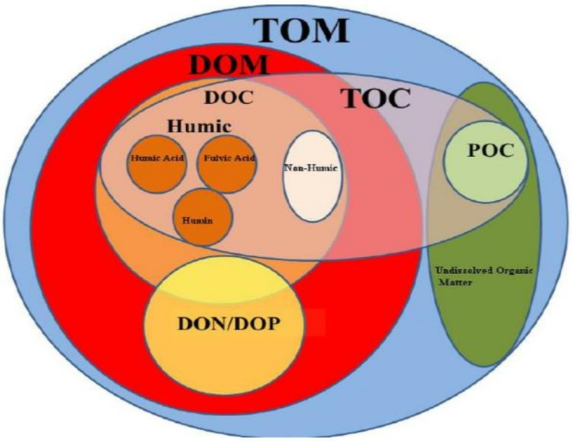

Figure 4. Venn diagram depicting forms of organic matter in nature adopted from (Pagano et al., (2014))

The biogeochemistry of organic matter, such as the release and aggregation of nutrient particles, is influenced by dissolved oxygen, pH, and temperature (Wu *et al.*, 2013; Seidel *et al.*, 2014). The Pearson correlation results show that TOM has a significant positive correlation with pH and DO, but no significant correlation with temperature. Based on **Figure 4** and **Table 5**, the TOM contents in order from highest to lowest are TN (18.5 mg/l - 22.5 (mg/l), highest ST 2), TP (0.096 mg/l - 0.277 mg/l, highest ST 2), nitrate (0.061 mg/l - 0. 204 mg/l, highest ST 1), ammonia (0.054 mg/l - 0.147 mg/l, highest ST 1), nitrite (0.003 mg/l - 0.029 mg/l, highest ST 4) and orthophosphate (0.002 mg/l - 0.012 mg/l, highest ST 5) (see also PCA, **Figures 5b**). These data were confirmed by Pearson correlation analysis, where TOM had a significant positive correlation with TN and a significant negative correlation with nitrate ($P < 0.1$). On the other hand, TOM showed no significant correlation with TP, ammonia, orthophosphate, and nitrite ($P > 0.1$). These data suggest that the content of undissolved nutrients in TOM is greater than the content of dissolved nutrients. Dissolved particles refer to their ability to pass through a 0.1 - 0.7 µm filter membrane, while nondissolved particles are those retained on the filter membrane (Mostofa *et al.*, 2013). The condition of the water along the east coast of Jambi is murky brown, caused by the conversion of forests to plantations and sand mining in the Batanghari River (Ramadhan *et al.*, 2017), resulting in high TOM levels. Uncontrolled mining intensity has an impact on ecosystem damage, especially the loss of fish biodiversity (Mensah *et al.*, 2015; Sonter *et al.*, 2018), as the increase in suspended solids from mining in water bodies can cause disease and even fish mortality (Dethier *et al.*, 2023).

The results of the nutrient measurements in the sediment, TN ranged from 1.24 mg/l - 11.25 mg/l with the highest value in ST 2, TP ranged from 1.05 mg/l - 1.38 mg/l with the highest value in ST 3, and TOC ranged from 1.51 mg/l - 1.99 mg/l with the highest value in ST 4 (**Table 8**). When comparing the nutrient levels between the water column and the sediment, the TN concentration in the water column is about 5 times higher than the TN concentration in the sediment and the TP concentration in the water column is 7 times lower than the TP concentration in the sediment. Nutrient deposition in the sediment can be caused by the flocculation process of dissolved organic matter, which is influenced by the salinity or the valence of cations from the saline solution to suspended solids and the flocculation rate (Asmala *et al.*, 2014; Zhu *et al.*, 2018). For TP particles, the flocculation rate is faster to form larger flocs and eventually experience sedimentation. The opposite happens with TN, where the flocculation rate is slow, resulting in small flocs in the water column. The high nitrogen and carbon contents are caused by agricultural activities that use various fertilizers and accumulate in the soil when the land is irrigated or it rains, causing runoff into the water bodies (Shang *et al.*, 2015; Xia *et al.*, 2020). Pearson correlation results show that TN and TP contents in both water and sediment columns are not significantly related, $P > 0.1$ (**Figure 7**).

Table 8. Sediment nutrient measurements on the East Coast of Jambi

	ST.1	ST.2	ST.3	ST.4	ST.5
TN (mg/l)	1.24	11.25	4.14	4.34	2.48
TP (mg/l)	1.05	1.1	1.38	1,2	1.13
TOC (mg/l)	1.55	1.69	1.62	1.99	1.51

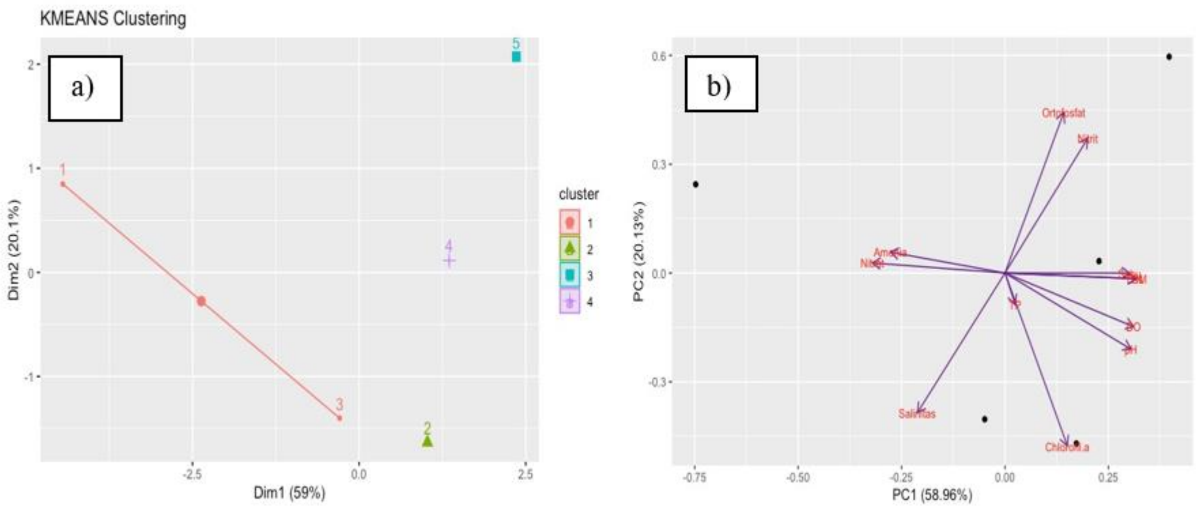

Figure 5. a) KMEANS Clustering between ST 1 and ST 3; b) PCA analysis to describe the relationship between water quality parameters in each station

Based on the results of water quality calculations both physically, chemically, and biologically as well as the PI value, it shows that ST 1 and ST 3 have similar characteristics (Figure 5a).

Meanwhile, based on Figure 5b, shows that the biological parameter (*chlorophyll-a*) is the most influential at ST 2 and TOM is influential at ST 4.

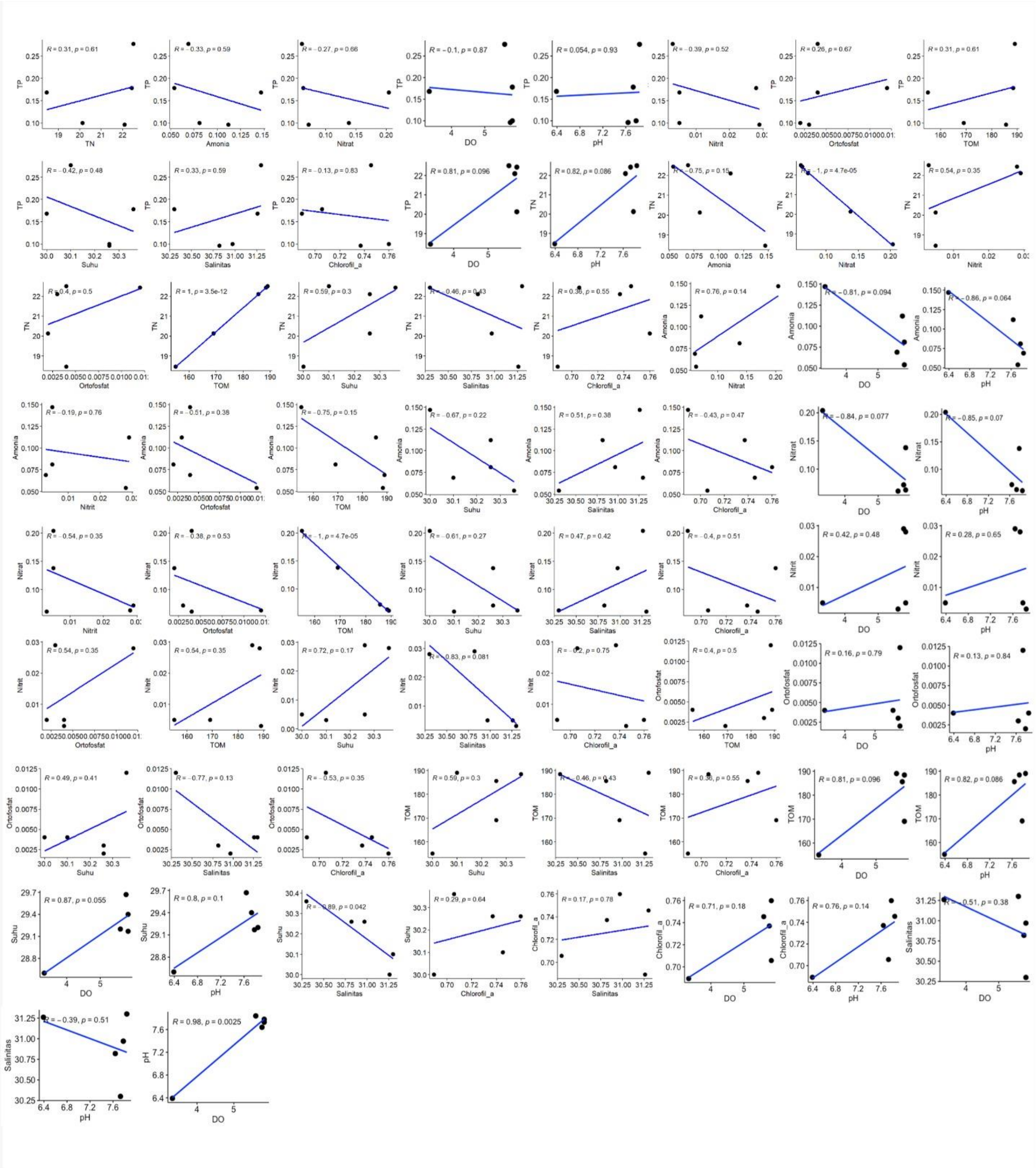

Figure 6. Correlation between water quality parameters in the East Jambi coastal water column with a 90% confidence interval

Another significant positive correlation ($P < 0.1$) shown in **Figure 6** is TN with nitrate. This shows the degradation of total nitrogen in the waters to nitrate. N-containing products are mainly degraded into nitrate and ammonium (Yang *et al.*, 2018). On the east coast of Jambi, chemical reactions mainly involve TN, ammonia, nitrate, and nitrite. This can be seen from the Pearson correlation results between these nutrients and the environmental parameters pH, DO, and salinity. A significant positive correlation was found between TN and DO and pH, while a significant negative correlation was found between ammonia and nitrate and DO and pH, and a significant negative correlation was found between nitrite and salinity. In the cyclical N degradation process by microbes, both nitrification, and denitrification, there is an interplay between environmental factors such as temperature, pH, DO, and salinity (Stres *et al.*, 2007). These environmental conditions are more closely related to influencing the ability of microbes to maintain stability and their function to decompose nutrients in the ecosystem (Li *et al.*, 2021).

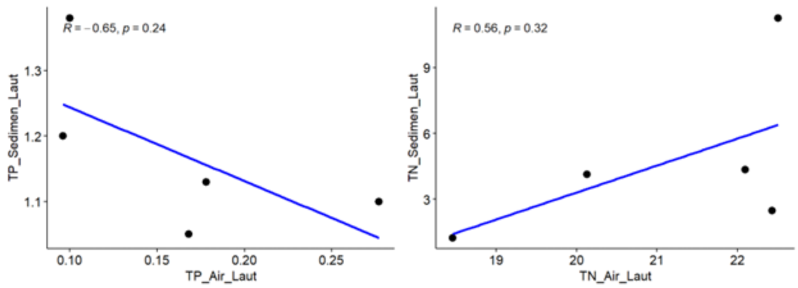

Figure 7. Correlation between water quality in column and sediment at East Coast of Jambi with a confidence interval of 90%

3. Conclusion

This research concludes that the coastal waters of Jambi are classified as oligotrophic based on the trophic level of the waters, and as light to moderately polluted based on the pollution index, mainly due to nutrient pollution. These conditions form the basis for predicting community structure using the eDNA approach. Results from several references show that the dominant organisms are microbial, particularly nutrient degraders such as bacteria and archaea, while phytoplankton are predicted to be dominated by eukaryotic groups.

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