Assessment of pollution load on surface water in the down-lower part of the Tapung Kiri river, Kampar regency, Riau

Yuliati Yuliati[1]*, *Eni* Sumiarsih[1], *Eko* Purwanto[1], *Adriman* Adriman[1], *Isma* Mulyani [1] *Nurfathihayati* Nurfathihayati[2], and *Kie* Roger Nasution[3]

[1]Lecturer in the Department of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, Universitas Riau, Pekanbaru, Indonesia
[2]Lecturer in the Department of Chemical Engineering, Faculty of Engineering, Riau University, Pekanbaru, Indonesia
[3] Undergraduate students from the Department of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, Universitas Riau, Pekanbaru, Indonesia

Abstract. The Tapung Kiri River is experiencing degradation especially due to the increase in the oil palm plantation industry and sand mining activities. The research was conducted from June to August 2024 to determine the pollution load of the Tapung Kiri River in down-lower by analyzing physical, chemical, and biological water quality samples. Water samples were taken triple, including TSS, BOD, COD, Nitrate, Phosphate, and E.Coli parameters. The quality of the Tapung River is compared to the quality standards according to The Regulation of Government of the Republic of Indonesia (RGRI) Number 22/2021 Class III. The results of the analysis of the pollution load were 472.5 kg/day (TSS), 15.75 kg/day (BOD), 94.5 kg/day (COD), 34.44 kg/day (nitrate), and 0.37 kg/day total phosphate. The actual pollution load in the Tapung Kiri River is lower than the maximum pollution load.

1 Introduction

KLHK 2022[1] states that rivers in Indonesia are currently experiencing degradation with conditions ranging from mild to severe pollution. In fact, rivers are one of the freshwater resources that play an important role in providing water for agriculture, food production, manufacturing, human consumption, fish habitats, navigation, transportation, recreation, electricity production, and aquatic ecosystems [2-4]. River pollution in Indonesia is mainly caused by the entry of domestic, industrial, and agricultural waste. One of the rivers in Riau Province that is also experiencing degradation is the Tapung Kiri River in Kampar Regency. The Tapung Kiri River is the upstream part of the Siak River. This river is one of the vital water sources for domestic, agricultural, and industrial needs. In addition, this river is used by the community to catch fish. However, with increasing

* Corresponding author: yuliati@lecturer.unri.ac.id

community activities such as plantations, settlements, and industry, the quality of this river water is increasingly threatened by pollution. As reported, the condition of the Tapung Kiri River is currently experiencing degradation due to the entry of waste from the palm oil factory industry and the rampant excavation of river sand. These activities will have an impact on the destruction of the aquatic ecosystem, decreasing water quality, and loss of river biodiversity due to river pollution [5]. Because the Tapung Kiri River is upstream of the Siak River, water pollution in the Tapung Kiri River will certainly also have an impact on the Siak River. Therefore, it is necessary to calculate the pollution load of the Tapung Kiri River in Kampar Regency in an effort to control water pollution so that the amount of pollution load that must be reduced is obtained. Until now, research related to water quality in the Tapung Kiri River is still limited to calculating its water discharge [6–8]. The availability of data on the estimation of river pollution load is needed in water quality management and pollution load control.

2 Materials and methods of research

2.1 Sampling Methods

We conducted this research in the downstream section (i.e., the confluence of the Tapung Kiri River and the Siak River in July-August 2024. Water samples were taken compositely on the edge and middle of the river using a one-liter water sampler. Water samples were put into sample bottles (500 ml), then stored in a coolbox and then analyzed in the laboratory. Water quality parameters measured to calculate pollution load consist of TSS, BOD, COD, nitrate, and phosphate. Water quality analysis procedure refers to APHA [9] and SNI (Tabel 1).

Table 1. Measured water quality parameters

Parameters	Method	Unit
TSS	SNI 6989.3:2019	Mg/l
BOD	SNI 06-2503-1991	Mg/l
COD	SNI 06-6989.31-2005	Mg/l
Nitrate	APHA-2012	Mg/l
Phosphate	Mg/l	

In addition, river depth measurements were also carried out using a fish finder and current velocity was measured using a current meter. Water sampling was carried out at two stations, namely in Pantai Cermin Village (Station 1), with the characteristics of a palm oil factory waste disposal channel and the Tapung Kiri River estuary, where it meets the Siak

River (Station 2) (Figure 1). The Tapung Kiri River watershed is generally dominated by oil palm plantations.

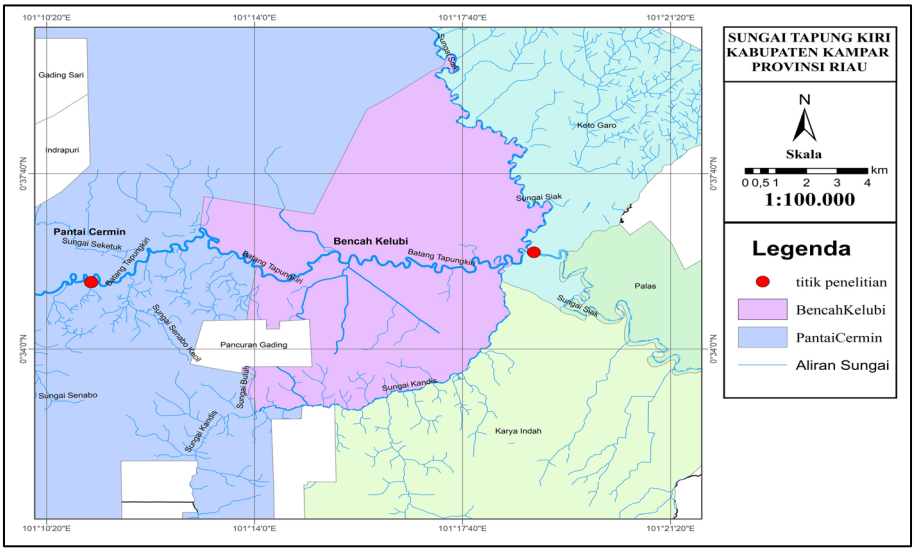

Fig. 1. Map of Tapung Kiri River

2.2 Analysis Data

The results of the water quality parameter analysis are then compared with the quality standards according to PP 22 of 2021 class II. The Tapung Kiri River is designated for tourism and water transportation, so the quality standards refer to class II. Pollution load examination was conducted using the methodology described in [10] to determine the load in the downstream part of the Tapung Kiri River. Pollution load (PL) was calculated using the following equation [10]:

$$PL\ (kg/day) = Q\,x\,C\ x\,Ti \quad (1)$$

C is the concentration of parameter I, expressed in mg/L, and Q is the water discharge, computed in m3/second. Ti stands for daily load. By calculating the river estuary's cross-sectional area and current velocity, the discharge from the Tapung Kiri River was determined.

$$Q = Fd\,.VD \quad (2)$$

Fd = Cross-sectional area (m^2), VD = river current velocity (m/seconds),

$$Fd = b.\frac{(c+d+e)}{3} \quad (3)$$

b = the river width (m), c,d,e = depth of river (m)

3 Results and Discussion

Observing Table 2, The TSS at Station 1 presented a higher concentration of 47 mg/l than station 2 (45 mg/l). However, the TSS concentration at both observation points has approached the threshold (50 mg/l). The presence of suspended particles is the cause of the high TSS concentration. In the Tapung Kiri River, suspended particles mainly come from riverbank erosion. The riverbank has lost its rivarian plants due to the conversion into oil palm plantations. The changes in land use will affect hydrology which will ultimately affect the non-point source pollution load entering the river [11].

In Table 2, the monitored BOD is presented at both stations. In station 1, it presented a value of 1.1 mg/l and 1.5 mg/l in station 2. The BOD value in the Tapung Kiri River is still very low and has not exceeded the specified limit. This shows that the Tapung Kiri River has not been polluted by organic materials. BOD concentrations are linked to elements like the quantity of organic matter, the presence of organic carbon, and the high nutrient concentration [12].

The concentrations of COD are presented, which were between 6 and 9 mg/l in station 1 and station 2, respectively. Higher concentrations were recorded at station 2, which is the confluence of the Tapung Kiri River and the Siak River. The difference in COD values indicates a difference in the presence of organic matter in the waters of the Tapung Kiri River. However, the COD levels in this study still do not exceed the quality standards according to PP 22/2023, class II. This means that the Tapung Kiri River has not been polluted by organic materials. COD concentrations in river water are usually high in locations with residential areas or receiving industrial waste [13][14]. Meanwhile, the Tapung Kiri River passes through rural areas where population growth is still low, and there are no industries that directly discharge waste into the river.

Table 2. The Water quality of Tapung Kiri River

Parameters	Unit	Station 1	Station 2	Threshold Value (PP 21/2023, class II)
TSS	Mg/l	47	45	50
BOD	Mg/l	1.1	1.5	3
COD	Mg/l	6	9	25
Nitrate	Mg/l	3.42	3.28	20
Phosphate	Mg/l	0.012	0.027	0.1
Water discharge (Q)	m/seconds	8.5	10,5	-
Current speed	m^3/second	0.2	0.2	-

Phosphate showed relatively the same value at both observation stations, ranging from 3.28–3.42 mg/l. Elevated quantities are linked to heightened erosion brought on by sporadic, heavy rains, which pull phosphates into the body of water. P loading from Non Point Source originates from a number of sources, such as land usage, cattle, and runoff from

rural household waste. P inputs can enter neighboring streams directly by unhindered runoff or through stormwater discharges, and they are frequently closely coupled to soil particles [5].

The average nitrate value in this study ranged from 3.28–3.42 mg/l. This level indicates that nitrate has not exceeded the standard quality limit (PP 22/2021, class II). The Tapung Kiri River have not experienced excess nutrient disturbances that can cause overfertility. Nutrients are obtained by the application of nitrogenous fertilizers to the soil because runoff carries these nutrients to bodies of water. Nitrate in the Tapung Kiri River from the runoff of fertilizer residues from oil palm plantations. Nutrient buildup in aquatic systems can have detrimental effects on water quality, which can therefore have an influence on aquaculture [15] [16].

In Table 3, the pollution load in Sungai Tapung Kiri is presented. The results of the pollution load analysis of the Tapung Kiri River show that the actual pollution load is lower than the maximum pollution load for all parameters. However, the TSS Actual Pollution Loads (APL) show a value of 475,5 kg/day that almost exceeds the Maximum Pollution Load (MPL) (525 kg/day) that can be accommodated by the Tapung Kiri River. The source of suspended particle (TSS) pollution in the Tapung Kiri River is suspected to be from the dredging of river sand for building materials. In addition, it is also from erosion of the riverbank due to the loss of riverbank plants[17,18]. Furthermore, sand mining can increase water turbidity. Dregging increases turbidity, sedimentation, and the quantity of contaminants deposited in the water [5].

Table 3. The average pollution loads in the Tapung Kiri River

Parameters	**The Actual pollution loads (APL), Q = 10.5 m^3/seconds**	**The Maksimum Pollution loads (MPL) Q = 10.5 m^3/seconds**	**APL: MPL**
TSS (kg/day)	472,5	525	APL<MPL
BOD (kg/day)	15,75	31,5	APL<MPL
COD (kg/day)	94,5	262,5	APL<MPL
Nitrate (kg/day)	34,44	210	APL<MPL
Phosphate (kg/day)	0.12	1,05	APL<MPL

Phosphate is the lowest pollution load (0,12 kg/day) and is still far from the maximum load limit (1,05 kg/day) of the Tapung Kiri River. This load value is lower than the phosphate load in the Air Hitam River, Pekanbaru City, a tributary of the Siak River, namely 0.3 kg/day [12]. More than that, the Tapung Kiri River is still not polluted by phosphate. High phosphate levels cause the aquatic environment to become eutrophicated [15]. Phosphate loads in waters are distributed by agricultural activities [19]. One of the main causes of agricultural non-point source pollution is thought to be surface runoff [11,16]. In recent years, pollution from agricultural sources has become increasingly severe, causing widespread concern[20].

4. Conclusion

The actual load of all parameters is still lower than the maximum pollution load that can be accommodated by the Tapung Kiri River. The highest pollution load on the Tapung Kiri River is from TSS with a value of 472.5 kg/day.

Acknowledgment

We would like to thank the University of Riau's Research and Community Service Institute (LPPM UNRI) for providing funding for this research (No.999/UN19.5.1.3/AL04.2024), through the university's superior research scheme.

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