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Analysis of Water Quality and Quality Status in Aceh Rivers Based on Environmental Pollution Index

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Abstract

The rapid development of industrialization and urbanization in the world impact increased water pollution. Human activities, such as dam constructions, excessive water consumption, severance of river flows, compaction of riverbanks, and excessive use of riverbed vegetation, disrupt river flow and alter the original hydrological cycle. In response to these conditions, this study aims to analyze water quality and river quality status to set up a watershed environmental management strategy in Aceh Province as a case study. River water quality was analyzed descriptively by comparing the results of laboratory tests with parameters, namely TSS, pH, BOD, COD, DO, total phosphate, nitrate, and fecal coli. These parameters were then transformed into the environmental index (Water Quality Index and Pollution Index). It was found that Water Quality Index (WQI) results are shown from 50 to 70. WQI with the Good category is at Kr. Weh which is in the Central Aceh city. The medium-less type was found in 10 watersheds. The water quality with the category of Less was found at 3 points, namely Kr. Aceh, Kr. Doy, and Kr. Daroy. The quality of the river water in the Aceh region, from upstream to downstream, has decreased in quality with a lightly polluted status based on the Minister of Environment and Forestry of the Republic of Indonesia No. 27 of 2021 for class II. Therefore the impact of this research to find out the water quality status of the watershed, the contaminants found in the water, and the Government Could plan and create a proper sustainable clean water supply system related to the provision of clean water and sanitation for various underdeveloped areas in the Aceh region.

Keywords: Aceh watershed, river pollution, water quality Index, water quality status

1. Introduction

Human activities, such as dam construction, excessive water consumption, severance of river flows, compaction of riverbanks, and excessive use of riverbed vegetation, disrupt river flow, alter the original hydrological cycle, and finally impact the water quality (Pearson, R. G., et al., 2021). The overuse of agricultural chemicals and poor sanitary conditions in agricultural areas predisposes water sources to be chemical and biological contamination, which in turn poses a high risk of disease outbreaks for the local population (Egbueri et al., 2020). People have adopted environmental management strategies for watersheds in response to this unfortunate event. These positive and negative human interventions affect river quality (Zhao et al., 2019)

Aceh has many rivers that run along the Province. In some locations, the river bank is used as a recreational location. Recreation is fishing or gathering at the many cafes set up on the banks of the river. The river also serves as a place to collect rainwater so humans can reuse it (Gadeng et al., 2020). Polluted rivers are caused by unpredictable natural activities, such as changing climates which can damage the river morphology (Poikane et al., 2021). In addition to the above factors, domestic pollutants will also worsen water quality, making it unsafe for human consumption (Suriadikusumah et al., 2021). As the population increases every year, it will increase domestic activities that affect water quality (Ngasala, T. M et al., 2019). Furthermore, the need for hygienic drinking water for domestic and irrigation water for agriculture and industry is substantial. The disposal of contaminants of organic matter, nutrients, and heavy metals into rivers, therefore, will be anthropogenic (Suwatanti et al., 2022), affecting community stability, changing ecosystem productivity, affecting the organic matter reshuffle cycle, food

chains, and aquatic ecological integrity (Zeleňáková et al., 2021).

The purpose of watershed management is to use natural resources sustainably so that it does not endanger the local or even global environment (Gadeng et al., 2020). Several researchers have used several studies on applying the pollution index (PI) or water quality index (WQI) to assess the level of pollution in rivers (Suriadikusumah et al., 2021).

From previous studies such as (Ondara et al., 2022)(Tian et al., 2019), and (Tanjung et al., 2019) using the PI method only to determine watershed pollution, this study adds an advanced method or conversion of PI to WQI. Therefore, PI and WQI can be useful Government can plan and create a proper sustainable clean water supply system.

2. Methodology

2.1. The Study Areas

Data collection in this study was carried out in the year 2021 by Watershed Management Center. In every river, it takes stations at every stage at every sample point. Considering the important role of rivers for local communities, the quality of monitoring points must be controlled for sustainable uses. A sampling of each monitoring point studied was carried out in two or three periods. Station sampling locations are presented in Figure 1.

2.2. Data Sampling

Based on the study area presented in Figure 1, the details of the sampling points in the year 2021 in several watersheds. The sampling of each monitoring point is presented in Table 1.

2.2. Data Analysis

The water quality of the Aceh Region River was analyzed by comparing the results of laboratory tests with the water Quality parameter standard art based on Indonesian Minister of Environment and Forestry Regulations about Environmental Quality Index. WQI can show information on water conditions by comparing it with national quality standards (Saraswati et al., 2019)

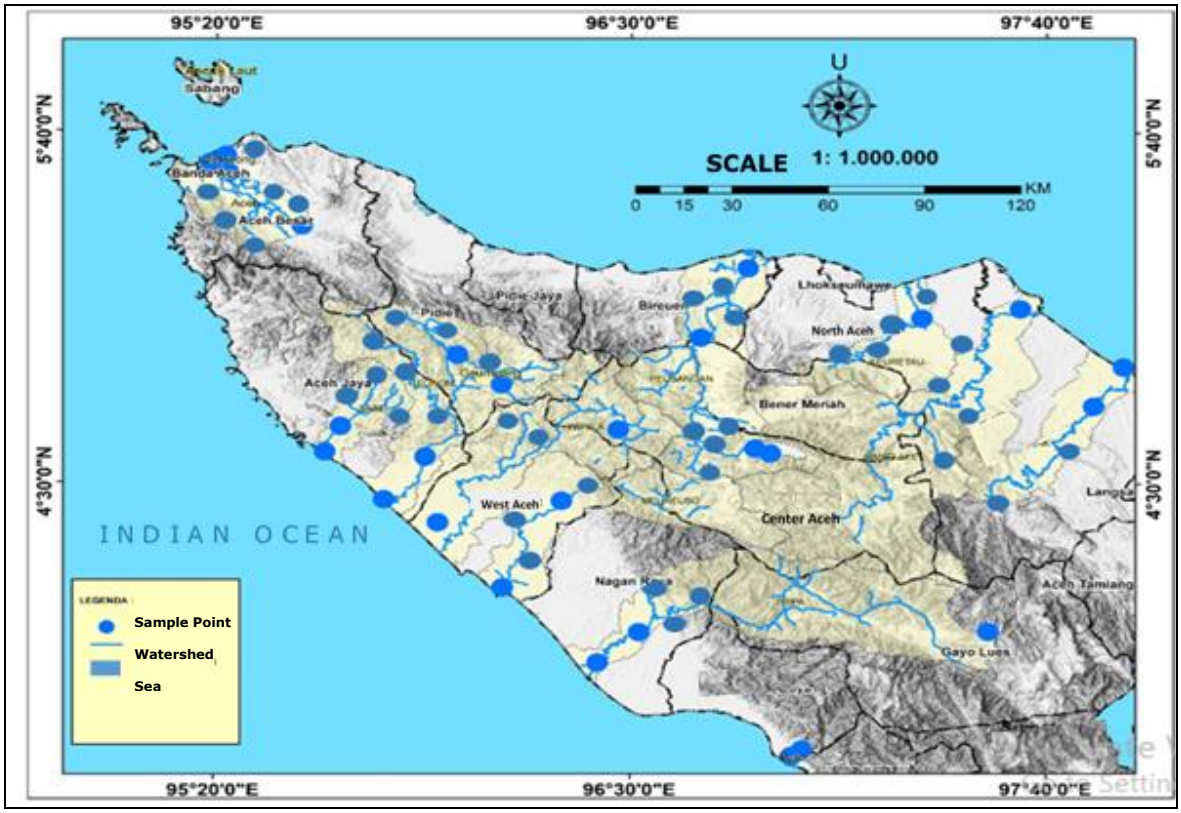

Figure 1. Aceh Rivers Area Map.

Table 1. Point of stations in every steps.

City	Rivers	length	Stations
West Aceh	Kr. Woyla	125 Km	- Sarah Peureulak Tutut, Kec. Sungai Mas
			- Pasie Lunak Kuala Bhee Kec. Woyla
			- Kec. Woyla
			- Arongan Lambalek bridge , Peuribu village
			- Lhok Malee Village Bridge
			- Ranto Panyang Village Bridge
			- Kuala Bhee Village Bridge
			- Tutut Village, Tutut Bridge
West Aceh	Kr. Meurebo	188 Km	- Meunasah Rayeuk Village
			- Sawang Teube Village
			- Pasie Pinang Village
			- Pasie Pinang Village Bridge
			- Near Embankment Pasie Aceh Tunong Village
			- Intake PDAM Desa Gunong Beurghang
			- Sawang Teubee Village Bridge
			- Ketambang Village Bridge
Southwest Aceh	Kr. Baru		- Guru Ceh Breh Street, Alu Trienggadeng Village
			- Meunasah Tengah Village, Lembah Sabil districts
Aceh Besar	Kr. Aceh	145 Km	- Ingin Jaya
			- Suka Tani Village
			- Indrapuri Village
			- Peunaloy Village, Seulimum districts, Aceh Besar regency
Banda	Kr. Aceh	145 Km	- Sp. Surabaya Banda Aceh Bridge
Aceh City			- Pango Banda Aceh Bridge
			- Peunayong Banda Aceh Bridge
			- Sp. Surabaya Desa Suka Damai Bridge
Aceh Jaya	Kr. Sabee	30 Km	- Intake PDAM Ranto Panyang Village
			- Panggong Village, Aceh Jaya regency
	Kr. Teunom	42 Km	- (downstream) Teunom district
			- (Median) Teunom district
			- (upstream) Pasie Raya district
Central	Kr. Weh		- Weh Rawe River, Rawe village
Aceh			- Weh River Toweren Village Toweren
			- Weh Kenawat Kala Pedemun River
East Aceh	Kr. Peureulak	130 Km	- Near Matang Aron Village Water Pump
			- Beusa Merano Village Steel Frame Bridge
			- Peureulak Market Bridge, Tanjong Tualang Village
			- Near Teumpeun Village Community Housing
			- Kliet Village Asamera Bridge
Bireuen	Kr. peusangan	75 Km	- Kutablang bridge, Tingkeum Manyang village
			- Kubu village bridge, Peusangan district
			- intake PDAM desa Beunyot, Juli
			- Simpang Jaya Village Bridge, Juli District
Nagan	Kr. Tripa		- Tripa river Lueng Kebeu Jagat Village
Raya			- Tripa river Lamie Village

Table 1. Point of stations in every steps (continued).

City	Rivers	length	Stations
Banda Aceh City	Kr. Doy		- Teuku Umar Banda Aceh Bridge - RRI Banda Aceh Bridge - Lampaseh Ujong Banda Aceh Bridge
Banda Aceh City	Kr. Daroy		- Keutapang Banda Aceh Bridge - Putroe Phang Banda Aceh Bridge - POM Banda Aceh Bridge
Banda Aceh City	Kr. Lung Panga		- Soekarno Hatta Banda Aceh Bridge - AMD Banda Aceh Bridge - Pak Sen Sp. Surabaya Banda Aceh Bridge

2.3. Determination of Pollution Index (PI)

PI information can be seen as pollutant sources, environmental management, and water quality maintained (Ondara et al., 2022). The PI value was obtained by using parameters information based on the Minister of Environment and Forestry of the Republic of Indonesia No. 27 of 2021 concerning the Environmental Quality Index. The PI value limits used can determine the quality status with good categories ($0 \leq IPj \leq 1.0$), light polluted ($1.0 \leq IPj \leq 5.0$), moderately polluted ($5.0 \leq IPj \leq 10.0$), and heavily polluted ($IPj \geq 10.0$).

The calculation used to determine the status of river water quality was the Pollution Index (PI) method which is shown as follows:

$$PIj = \sqrt{\left(\frac{(Ci/Lij)^2M+(Ci/Lij)^2R)}{2}\right)} \quad (1)$$

Remark:
PIj = Pollution Index (j)
Ci = concentration of water quality parameter i
Lij = Standart Quality
M = Maximum Value
R = Average Value

For DO parameter, it is necessary to determine the theoretical DO value or the maximum value of Cim (which is saturated DO = 7). Then the Ci/Lij value of the measurement results is replaced by the calculated Ci/Lij value following Eq. 2 and If all the value (Ci/Lij) result is more than 1, new (Ci/Lij) will follows Eq. 3. (Purnamasari, D. E., 2017).

$$Ci/Lij = \frac{Cim - Ci}{Cim - Lij} \quad (2)$$

$$Ci/Lij = 1 + P.\,Log\,(Ci/Lij) \quad (3)$$

Remark:
Cim = Ci Maximum, which is saturated DO = 7
P = a constant, which value is 5

2.4. Water Quality Index

According to the Minister of Environment and Forestry of the Republic of Indonesia Indonesia No. 27 of 2021, the Pij value each stations was converted to WQI by multiplying the index value Renault with the percentage of quality standards. WQI Qualification river value could be classified as water quality from "Very Good", "good", "Medium Less", "Not Enough", and "Very Less" categories as given in Table 3.

Table 3. Water Quality Qualification.

No	WQI Skor	Qualification
1.	$90 \leq WQI \leq 100$	Very good
2.	$70 \leq WQI < 90$	Good
3.	$50 \leq WQI < 70$	Medium Less
4.	$25 \leq WQI < 50$	Not enough
5.	$0 \leq WQI < 25$	Very less

3. Results and Discussion

3.1. Pollution Index (PI)

River water samples in Table 5 can be seen that each point in the sampling monitoring area is shown. Activities in watershed areas such as settlements, livestock, and agriculture will affected with river water quality (Ewaid et al., 2020);(Algifari & Adiansyah, 2021) and (Rodríguez-Merchan et al., 2021). The value of the quality status of the pollution index per point is in the range of 0.75 to 7.93. The quality of river water from upstream to downstream has decreased from good quality to lightly polluted. This can be seen from the value of Pij (pollutant index). Kr. weh which is in the central aceh city has good water quality.

This is probably because the land around the watershed still has a lot of forests, so there has not been a high. An example of (Rahmatillah et al., 2021) previous study showns PI values that was compared with this Study.

Table 4 . comparison of previous studies.

Author	Watershed	PI	WQI
Rahmatillah	Meureubo	2.41	-
Dicky	Meureubo	2.682	54.21

Table 5. Result of PI each Stations.

Rivers	Stations	Sampling Date	Pij	Status
Kr. Woyla	- (Upstream)Sarah Peureulak Tutut	08 September 2021	2.649	lightly polluted
	- (Central) Pasie Lunak Kuala Bhee	09 September 2021	2.426	lightly polluted
	- (Downstream) Woyla	08 September 2021	2.852	lightly polluted
	- (Upstream)Sarah Peureulak Tutut	04 June 2021	1.894	lightly polluted
	- (Downstream) Woyla	03 June 2021	1.705	lightly polluted
	- (Central) Pasie Lunak Kuala Bhee	03 June 2021	2.018	lightly polluted
	- (Downstream) Woyla	03 March 2021	0.781	Good quality
	- (Upstream)Sarah Peureulak Tutut	04 March 2021	2.165	lightly polluted
	- (Central) Pasie Lunak Kuala Bhee	03 March 2021	1.945	lightly polluted
	- Arongan Lambalek Bridge Peuribu	27 October 2021	1.201	lightly polluted
	- Lhok Malee Village Bridge	27 October 2021	1.845	lightly polluted
	- Steel Frame Bridge Ds. Ranto Panyang West Woyla	27 October 2021	1.621	lightly polluted
	- Talent Bridge Ds. Kuala Bhee District Woyla	27 October 2021	1.318	lightly polluted
	- Tutut Bridge Tutut Village	27 October 2021	1.837	lightly polluted
	- Arongan Lambalek Bridge Peuribu	15 April 2021	0.897	Good quality
	- Lhok Malee Village Suspension Bridge, West Woyla District	15 April 2021	1.078	lightly polluted
	- Steel Frame Bridge Ranto Panyang Village West Woyla	15 April 2021	0.882	Good quality
	- Bakat Bridge Kuala Bhee Village	15 April 2021	0.960	Good quality
	- Tutut Bridge Tutut Village	15 April 2021	0.959	Good quality
Kr. Meurebo	- (Middle) Phase III Meunasah Rayeuk Village	09 September 2021	1.584	lightly polluted
	- (Upstream) Phase III Sawang Teube Village, Kaway XVI	08 September 2021	0.880	Good quality
	- (Downstream) Phase III Pasie Pinang Village	08 September 2021	1.092	lightly polluted
	- (Upstream) Phase III Sawang Teube Village Kaway XVI	03 June 2021	1.529	lightly polluted
	- (Center) Phase II Meunasah Rayeuk Village	04 June 2021	1.659	lightly polluted
	- (Downstream) Phase II Pasie Pinang Village	03 June 2021	1.598	lightly polluted
	- (Upstream) Phase III Sawang Teube Village, Kaway XVI	03 March 2021	2.037	lightly polluted
	- (Middle) Phase I of Meunasah Rayeuk Village	04 March 2021	0.801	Good quality
	- (Downstream) Phase I Pasie Pinang Village	04 March 2021	2.682	lightly polluted
	- Iron Bridge Pasie Pinang Village	08 September 2021	0.948	Good quality
	- Near the Embankment of Pasie Aceh Tunong Village	08 September 2021	0.988	Good quality
	- Intake of PDAM Gunong Beurghang Village, Kaway XVI	08 September 2021	1.509	lightly polluted
	- Steel Frame Bridge Sawang Teubee Village, Kaway XVI	08 September 2021	1,445	lightly polluted
	- Suspension Bridge in Ketambang Village, Pante Ceureumen	08 September 2021	1.377	lightly polluted
	- Iron Bridge Pasie Pinang Village	01 April 2021	1.639	lightly polluted
	- Near the Embankment of Pasie	01 April 2021	1.210	lightly polluted

Table 5. Result of PI each Stations (continued).

		Aceh Tunong Village		
	-	Intake of PDAM Gunong Beurghang Village, Kaway XVI	01 April 2021	1.289	lightly polluted
	-	Steel Frame Bridge Sawang Teubee Village, Kaway XVI	01 April 2021	1.179	lightly polluted
	-	Suspension Bridge in Ketambang Village, Pante Ceureumen	01 April 2021	1.362	lightly polluted
Kr. Baru	-	Jln Guru Ceh Breh Alu Village Trienggadeng District Sabil Valley	29 October 2021	1.483	lightly polluted
	-	Middle Meunasah Village, Sabil Valley District (Downstream)	29 October 2021	3.362	lightly polluted
	-	Middle Meunasah Village, Sabil Valley District (Downstream)	26 July 2021	5.674	moderately polluted
	-	Jln Guru Ceh Breh Alu Village Trienggadeng District Sabil Valley	26 July 2021	1.589	lightly polluted
	-	Middle Meunasah Village, Sabil Valley District (Downstream)	11 June 2021	5.051	moderately polluted
	-	Jln Guru Ceh Breh Alu Village Trienggadeng District Sabil Valley	11 June 2021	2.124	lightly polluted
Kr. Aceh Aceh Besar	-	Kr. Aceh (Downstream) Phase III Ingin Jaya Suka Tani Desa Village	16 September 2021	3.507	lightly polluted
	-	Kr. Aceh (Central) Phase III Indrapuri Village	16 September 2021	1.558	lightly polluted
	-	Kr. Aceh (Upstream)Phase II Suka Tani Village	14 June 2021	1.919	lightly polluted
	-	(Downstream) Phase II Ingin Jaya	14 June 2021	4.316	lightly polluted
	-	(Middle) Phase II Indrapuri Village	14 June 2021	2.116	lightly polluted
	-	(Middle) Phase I Indrapuri Village	14 March 2021	0.919	Good quality
	-	(Downstream) Phase I Ingin Jaya	14 March 2021	1.372	lightly polluted
	-	(Upstream) Phase I Suka Tani Village	14 March 2021	1.374	lightly polluted
	-	Peunaloy Village, Seulimum District, Aceh Besar District (Upstream)	27 October 2021	0.832	Good quality
	-	Peunaloy Village, Seulimum District, Aceh Besar District (Upstream)	24 July 2021	0.874	Good quality
	-	Peunaloy Village, Seulimum District, (Upstream)	10 June 2021	0.861	Good quality
Kr. Sabee	-	Intake of PDAM Ranto Panyang Village	29 October 2021	0.776	Good quality
	-	Panggong Village District (Upstream)	29 October 2021	0.747	Good quality
	-	Intake of PDAM Ranto Panyang Village	25 July 2021	1.595	lightly polluted
	-	Panggong Village District (Upstream)	25 July 2021	0.752	Good quality
	-	Intake of PDAM Ranto Panyang Village	11 June 2021	0.953	Good quality
	-	Panggong Village (Upstream)	11 June 2021	0.718	Good quality
Kr. Teunom	-	Kr. Teunom (Downstream)	25 October 2021	4.425	lightly polluted
	-	Kr. Teunom (Median) Teunom	25 October 2021	4.153	lightly polluted
	-	(Upstream)Pasie Raya	25 October 2021	3.979	lightly polluted
Kr. Weh	-	Weh Rawe River Kp. Rawe	29 November 2021	0.811	Good quality
	-	Sungai Weh Toweren	29 November 2021	0.786	Good quality

Table 5. Result of PI each Stations (continued).

	Toweren Village			
	- Weh Kenawat River Kala Pedemun, Kp. Pedewan	29 November 2021	0.746	Good quality
	- Weh Rawe River Kp. Rawe	16 August 2021	0.722	Good quality
	- Sungai Weh Toweren	16 August 2021	0.733	Good quality
	- Weh Kenawat River Kala Pedemun, Kp. Pedewan	16 August 2021	0.820	Good quality
Kr. Peureulak	- Near Matang Village Water Pump Aron Peurelak	17 September 2021	1.292	lightly polluted
	- Under the Steel Frame Bridge Ds. Beusa Merano	17 September 2021	0.928	Good quality
	- Peureulak Market Bridge, Tanjong Tualang Village	17 September 2021	0.76	Good quality
	- Near Teumpeun Village Community Housing	17 September 2021	0.844	Good quality
	- Asamera Old Iron Bridge Kliet Village, Peureulak region	17 September 2021	1.338	lightly polluted
	- Near Matang Village Peureulak Aron Peurelak Beusa Merano	07 April 2021	1.928	lightly polluted
	- Peureulak Market Bridge, Tanjong Tualang Village	07 April 2021	2.592	lightly polluted
	- Near Teumpeun Village Community Housing	07 April 2021	1.200	lightly polluted
	- Asamera Old Iron Bridge Kliet Village, Peureulak region	07 April 2021	1.162	lightly polluted
	- point 5 iron bridge jl. Kutablang village Tingkeum Manyang	24 September 2021	1.114	lightly polluted
	- point 4 iron bridge in Kubu The village, Peusangan sub-district	24 September 2021	0.811	Good quality
	- point 3 dam/ PDAM intake in Beunyot village, Juli sub-district	24 September 2021	0.978	Good quality
	- point 2 iron bridge Simpang Jaya village, Juli district	24 September 2021	1.167	lightly pollutedthe
	- point 1 village likes farmers, sub-district Juli	24 September 2021	1.237	lightly polluted
	- point 5 iron bridgJljl. Kutablang village Tingkeum Manyang	07 April 2021	0.887	Good quality
	- point 4 iron bridge in Kubu village, Peusangan sub-district	07 April 2021	0.830	Good quathe lity
	- point 3 dam/ PDAM intake in Beunyot village, Juli sub-district	07 April 2021	1.453	lightly polluted
	- point 2 iron bridge Simpang Jaya village, Juli district	07 April 2021	0.938	Good qthe uality
	- point 1 village likes farmers, sub-district Juli	07 April 2021	0.892	Good quality
Kr. Tripa	- Kr. Tripa (Downstream) Phase III Lueng Kebeu Jagat . Village	12 September 2021	3.417	lightly polluted
	- Kr. Tripa (Central) Phase III Lamie Desa Village	10 September 2021	1.004	lightly polluted
	- Kr. Tripa (Downstream) Phase II Lueng Kebeu Jagat . Village	06 June 2021	1.885	lightly polluted
	- Kr. Tripa (Central) Phase II Lamie Desa Village	06 June 2021	1.658	lightly polluted
	- Kr. Tripa (Downstream) Phase I Lueng Kebeu Jagat. Village	06 March 2021	0.722	Good quality
	- Kr. Tripa (Central) Phase I Lamie Desa Village	06 March 2021	1.725	lightly polluted
Kr. Aceh	- (Point 2)- Sp. Surabaya Bridge.	27 October 2021	7.847	moderately polluted
Banda	- (Point 3)- Pango Bridge	27 October 2021	7.843	moderately polluted

Table 5. Result of PI each Stations (continued).

Aceh	-	(Point 1)- Peunayong Bridge	27 October 2021	7.872	moderately polluted
	-	(Point 3)- Pango Bridge	15 September 2021	1.682	lightly polluted
	-	(Point 2)- Sp. Surabaya Bridge.	15 September 2021	3.403	lightly polluted
	-	(Point 1)- Peunayong Bridge	15 September 2021	3.434	lightly polluted
	-	Surabaya Intersection Bridge, Suka Damai Village	25 July 2021	1.586	lightly polluted
	-	Surabaya Intersection Bridge, Suka Damai Village	10 June 2021	1.495	lightly polluted
	-	Surabaya Intersection Bridge, Suka Damai Village	27 October 2021	0.870	Good quality
Kr. Daroy	-	(Point 3)- Keutapang Bridge	27 October 2021	7.757	moderately polluted
	-	(Point 2)- Putroe Phang Bridge	27 October 2021	7.932	moderately polluted
	-	(Point 1)- Banda Aceh POM Bridge	27 October 2021	4.259	lightly polluted
	-	(Point 3)- Keutapang Bridge	15 September 2021	3.454	lightly polluted
	-	(Point 2)- Putroe Phang Bridge	15 September 2021	4.346	lightly polluted
Kr. Doy	-	(Point 3)- Teuku Umar Bridge	27 October 2021	7.768	moderately polluted
	-	(Point 2)- RRI Banda Aceh Bridge	27 October 2021	7.780	moderately polluted
	-	(Point 1)- Lampaseh Ujong Bridge	27 October 2021	4.305	lightly polluted
	-	(Point 3)- Teuku Umar Bridge	15 September 2021	4.280	lightly polluted
	-	(Point 2)- RRI Banda Aceh Bridge	15 September 2021	4.288	lightly polluted
	-	(Point 1)- Lampaseh Ujong Bridge	15 September 2021	4.386	lightly polluted
Kr. Lueng Paga	-	(Point 3)- Soekarno Hatta Bridge	27 October 2021	4.219	lightly polluted
	-	(Point 2)- AMD Bridge	27 October 2021	4.260	lightly polluted
	-	(Point 1)- Pak Sen Sp Surabaya Bridge	27 October 2021	3.996	lightly polluted
	-	(Point 3)- Soekarno Hatta Bridge	15 September 2021	4.285	lightly polluted
	-	(Point 2)- AMD Bridge	15 September 2021	4.010	lightly polluted
	-	(Point 1)- Pak Sen Sp Surabaya Bridge	15 September 2021	4.566	lightly polluted

Other district watersheds, it has been lightly polluted, this is probably because the land use around the watershed is used as residential and agricultural areas which causes water pollution. Generally, upstream areas still have good conditions, further downstream the water has been lightly polluted like Aceh Besar although at some points in other districts it fluctuated. This increase in the pollutant index value certainly indicates the status of river water quality has decreased. This is likely due to the development of small community-owned industries in downstream areas such as the cowhide processing industry, tempe processing, the Acehnese cake industry, and brick factories around Aceh Besar District. Some of these industrial activities certainly contribute to domestic waste which is usually directly discharged into river bodies without being processed first.

This will certainly increase the concentration of BOD, COD, pH, phosphate, and total coliform in water (Ewaid et al., 2020). In addition, the increase in population from year to year also contributes to the amount of domestic waste entering the water, which certainly affects pollutant parameters (Ngasala, T. M., et al., 2019). Conditions in the upstream have better water quality than the downstream. This is due to the large number of indirect pollutants carried by rain activities that bring pollutants into the water flowing downstream (Wu et al., 2021). According to the Minister of Environment and Forestry of the Republic of Indonesia Indonesia No. 27 of 2021 the quality of river water from upstream, middle, and downstream changes from class 1 which can be used as drinking water to class 2 which is used for recreation, animal husbandry, plantations, and fish farming.

3.2. Water Quality

On Indonesian Minister of Environment and Forestry No: 27 of 2021, the calculation of WQI was transformed by using the Pij value index of each station's value. In the condition of Kr. Woyla has 19 monitoring points, 5 Good quality points, and 14 light polluting points. Pij to WQI conversion can be seen in the Table 6.

The data in Table 6 was calculated for 13 of each river. From the results of the WQI calculation. WQI results Aceh Rivers in 2021 can be seen in Table 7. Table 7 shows that there has been a decrease in water quality in several places. WQI Nasional Standart from the 2021 environment and forestry service report was at point 52,70. A good category was found in one River, namely Kr. Weh. At Kr. Woyla, Kr. Meureubo.

This shows that WQI is related to land use and surrounding rivers activities. Water quality in the Poor category is found at 3 points, namely Kr Aceh (Banda Aceh city), Kr. Doy, and Kr. Daroy. Thus, it is necessary to control efforts to prevent river water pollution by involving Krueng Baru, Kr. Aceh (Aceh Besar), Kr. Peureulak, Kr. Peusangan, Kr. Tripa, Kr. Lung Panga is categorized as medium less, while the remaining 3 rivers are the not enought qualification. At Table 7. explains the result of watershed sampling points resented in Figure 2. Stakeholders such as the government, the private sector, and the community.

Table 6. Example of Kr. Woyla WQI Calculation.

No	WQI Status	Number of monitoring points	Percentage of Water Quality	Qualification index	Index Value per Water Quality
1.	Good quality	5	26.3%	70	26.3 % x 70 = 18.42
2.	lightly polluted	14	73.7%	50	73.7 % x 50 = 36.85
3.	moderately polluted	0	0%	30	0
4.	heavily polluted	0	0%	10	0
5.	Total	19			WQI = 55.27

Table 7. The result of WQI measurements each river at Aceh province.

No	City	Rivers	Length	WQI	Qualification
1.	West Aceh	Kr. Woyla	125 Km	55.27	Medium Less
2.	West Aceh	Kr. Meurebo	188 km	54.21	Medium Less
3.	Southwest Aceh	Kr. Baru		63.33	Medium Less
4.	Aceh Besar	Kr. Aceh (Aceh Besar)	145 Km	56.67	Medium Less
5.	Banda Aceh City	Kr. Aceh (Banda Aceh)	145 Km	45.56	Not enough
6.	Aceh Jaya	Kr. Sabee	30 Km	66.67	Medium Less
7.	Aceh Jaya	Kr. Teunom	42 Km	50.00	Medium Less
8.	Central Aceh	Kr. Weh		70.00	Good
9.	East Aceh	Kr. Peureulak	130 Km	58.00	Medium Less
10.	Bireuen	Kr. Peusangan	75 Km	62.00	Medium Less
11.	Nagan Raya	Kr. Tripa		53.33	Medium Less
12.	Banda Aceh City	Kr. Daroy		43.33	Not enough
13.	Banda Aceh City	Kr. Doy		43.33	Not enough
14.	Banda Aceh City	Kr. Lung Panga		50.00	Medium Less

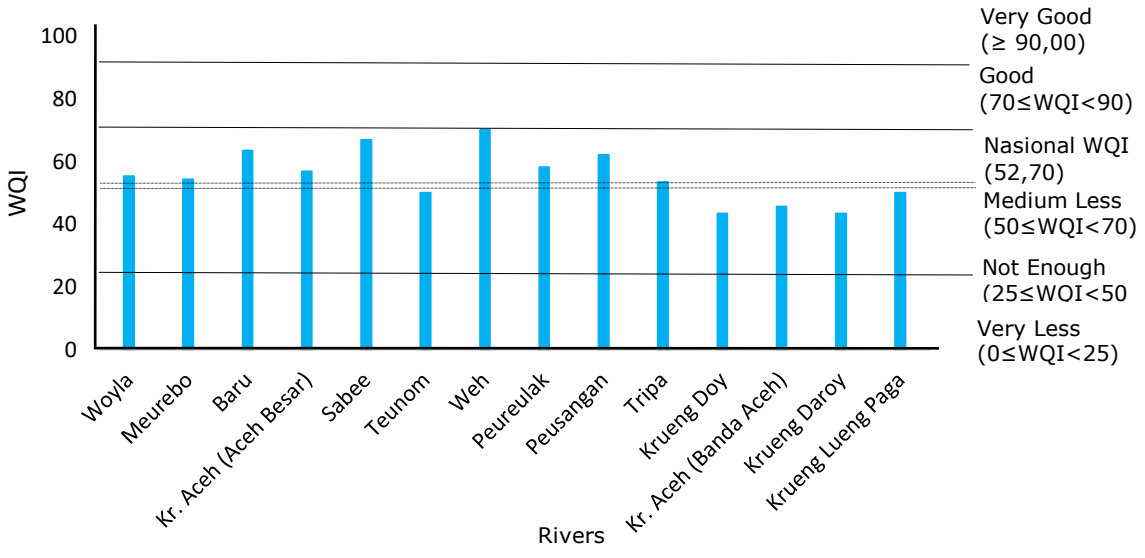

Figure 2. WQI Aceh Rivers

Some control efforts such as urging the community around the river to maintain the cleanliness of the river, make rules and punishments, and innovate. Generally, people throw domestic waste into rivers that can damage river ecosystems both physically and chemically and threaten clean water supplies (Tian et al., 2019). In addition, several other examples of activities around watersheds can contaminate water, such as heavy metal contamination of chromium (Sunarsih et al., 2018) lead (Hashim et al., 2018), and domestic waste (Adiansyah., 2020).

4. Conclusion

River water quality in the Aceh region seen from the physical and chemical parameters of water indicates that there has been a decline in quality. This can be seen from several water quality parameters that have exceeded the required quality standards and overall shows a declining Water Quality Index in both seasons. The quality of the river water in the Aceh region, from upstream to downstream, has decreased in quality with the status of being the lightest polluted based on the Minister of Environment and Forestry of the Republic of Indonesia NO. 27 of 2021 for class II. Therefore by knowing the water quality status of the watershed, the contaminants in the water, and the Government can plan and create a proper sustainable clean water supply system related to the provision of clean water and sanitation for various underdeveloped areas in the Aceh region.

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