Indonesian Journal of Applied Research IJAR

CANAL WATER QUALITY STATUS IN SETTLEMENT AND TRADE AREA

Volume 3 Issue 2
(August 2022)
e-ISSN 2722-6395
doi: 10.30997/ijar.v3i2.214

Weli Zuandi[1] , Rizki Putranto[1] , Sigit Normagiat[2]
[1]Environmental Engineering, University of Nahdlatul Ulama West Kalimantan, Indonesia
[2]Agrotechnology, University of Nahdlatul Ulama West Kalimantan, Indonesia

ARTICLE INFO

Article history:
Received: 29-07-2022
Revised version received: 03-08-2022
Accepted: 25-08-2022
Available online: 31-08-2022

Keywords:
Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), pollution, shelter.

How to Cite:
Zuandi, W., Putranto, R., & Normagiat, S. (2022). CANAL WATER QUALITY STATUS IN SETTLEMENT AND TRADE AREA. *Indonesian Journal of Applied Research (IJAR)*, *3*(2), 103-114.
https://doi.org/10.30997/ijar.v3i2.214

Corresponding Author:
Weli Zuandi
welfarizi@gmail.com

ABSTRACT

Decreasing canal water quality due to densely populated settlements and trade is a common problem in urban areas. This study aims to assess the current water quality standards of the Sei Jawi canal so that appropriate management steps can take. Water sampling was divided into seven stations based on the difference in distance from the canal estuary. The parameters measured were Dissolved Oxygen (DO), pH, temperature, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Biological Oxygen Demand (BOD), and Chemical Oxygen Demand (COD). The results of the research on the water quality of the Sei Jawi channel revealed that the parameters of temperature, pH, TDS, and TSS were not below the threshold of the quality standard, while the DO level was in the category III quality standard, but the COD and BOD levels were higher than those outlined in PP No. 22 the year 2021 about the Implementation of Environmental Protection and Management

1. INTRODUCTION

Pontianak is known as the "kota seribu kanal" (city of a thousand canals). This is because many canals cross the city of Pontianak. The existing canal has been built since the Dutch colonial era. Originally the channel served as a water transportation route to transport crops and a plantation irrigation system (Nurcahyani et al., 1999). One of the canals whose existence is essential in the city of Pontianak is the Sei Jawi canal, also the name of the Kelurahan in the West Pontianak region. Sei Jawi Canal has a length of 6,600 meters which empties into the Kapuas River. Sei Jawi is the center of settlement and trade in the district of West Pontianak. According to BPS data for 2021, West Pontianak has a population of 146,700 people with a density of 9033 people/km2 (22.27%), the densest compared to 4 other sub-districts in Pontianak (BPS, 2021). Currently, the Sei Jawi canal is used as urban drainage. In addition, residents use it for bathing and washing purposes. Even residents use this canal for recreational areas, including swimming, relaxing, canoeing, and fishing.

The rapid development of cities affects the quantity and quality of water if it is not managed correctly (Pambudi, 2021). The density of people living along the canal causes water pollution problems that tend to increase and makes the surrounding location slums (Chen et al., 2022). Water is said to be polluted when it contains microorganisms of human or animal origin, toxic chemicals, industrial or domestic waste, agricultural chemicals, and organic and inorganic substances (Article, 2020). Even though a temporary garbage disposal site has been provided, residents still intentionally throw their domestic waste into the waters so that it pollutes the canal water (Cheng et al., 2022). Pollutants from residential and commercial centers can also enter the canal through surface runoff by accident (Müller et al., 2020).

A study on the water quality of the Jawi River Canal was conducted in 2014 using the periphytic microalgae community structure as an indicator of water pollution. The study concluded that the Sei Jawi canal at that time still had a low level of contamination (Andriansyah et al., 2014). Two years later, the water quality in the Sei Jawi canal was re-examined, which showed that the water in the canal was no longer suitable for drinking and clean water (Apriyanti et al., 2016). Polluted water is the leading cause of several diseases, such as cholera, typhoid, and other infectious bacterial diseases (Perveen & Zaidi, 2018). It was recorded that in 2016 around the Sei Jawi canal, there had been an increase in the incidence of diarrheal disease (Syafitri et al., 2017).

The condition of the Sei Jawi canal waters is currently under pressure from the urban population density level (Sarker et al., 2021). Moreover, consider that the level of canal water pollution can also change with time or seasons (Yang et al., 2021). These two things encourage the need for periodic assessments of water quality in canals in urban areas, especially in the Sei Jawi Canal. Information on the current state of water quality is essential for regional development and public health.

2. METHODS

This research was conducted on 3 – 9 April 2022 in the Jawi River canal, Pontianak City, West Kalimantan. Water samples were taken at seven observation stations with a distance between observation stations of 1 km. Station placement is in the upstream, downstream, and estuary areas. Each of the two observation stations represents a different characteristic of the environment around the canal. More clearly, the placement of the observation stations can be seen in table 1.

Table 1 Positioning of observation stations based on environmental characteristics around the canal

Position	Location Characteristics	Station
Hulu	Settlement	1.2
Middle	Settlement, trade	3.4
Downstream	Residential, trade, and public services	5.6
estuary	Kapuas river	7

Residential areas dominate the upstream of the canal. The middle area is a residential location and trade center. At the same time, the downstream is a residential location, trade, and public service center marked by the presence of schools, hospitals, and ports. The placement of observation stations is presented in Figure 1.

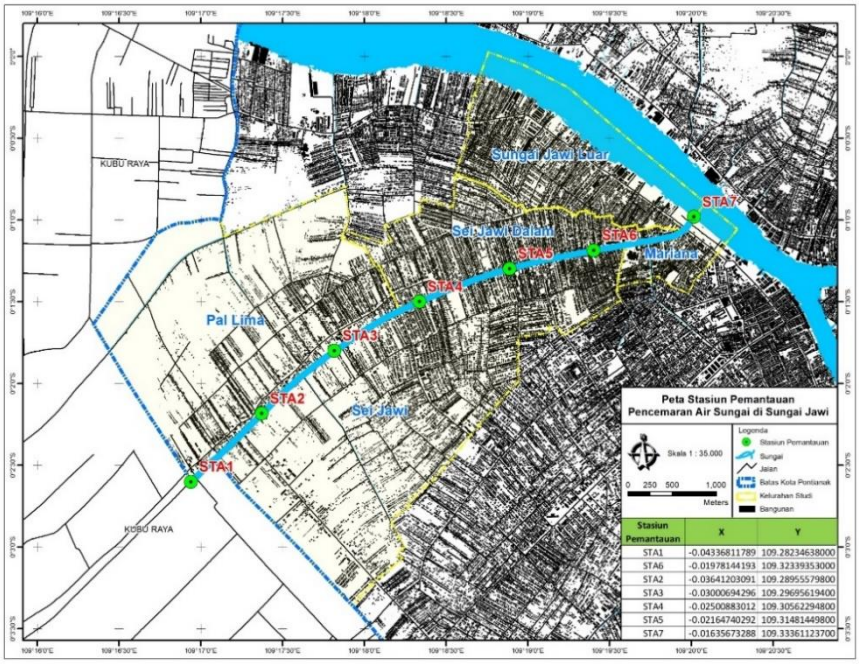

Figure 1 With the placement of the water quality observation station in the Sei Jawi canal,

This study measured the physical and chemical parameters of composite water samples taken from the edge and center of the canal, as much as 200 ml at each station. Water quality parameters consisting of dissolved oxygen (DO), pH, temperature, and total dissolved solids (TDS) were measured directly in the field using a water quality monitor. Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) parameters were measured using a Smart sensor AF107 water analyzer. While measuring total suspended solids (TSS), the water sample is brought to the laboratory for gravimetric analysis (Omer, 2012). The measurement results of each parameter obtained from this research are then compared with the water quality standards set out in PP No. 22 of 2021 so that it can be concluded from each parameter that it can still be seen in table 2. The following:

Table 2 River water quality standards based on the attachment of Government Regulation no. 22 Year 2021regarding the Implementation of Environmental Protection and Management

PARAMETER	Quality standards			
	I	II	III	IV
DO (mg/L)	6	4	3	1
Temperature (°C)	Dev 3	Dev 3	Dev 3	Dev 3
pH	6 – 9	6 – 9	6 – 9	6 – 9
TDS (mg/L)	1,000	1,000	1,000	2,000
TSS (mg/L)	40	50	100	400
COD (mg/L)	10	25	40	80
BOD (mg/L)	2	3	6	12

Figure 2 The process of measuring pH, temperature, DO, and TDS using water quality testing.

3. RESULTS AND DISCUSSION

3.1. Results

The measurement results obtained from each station are shown in the following graph:

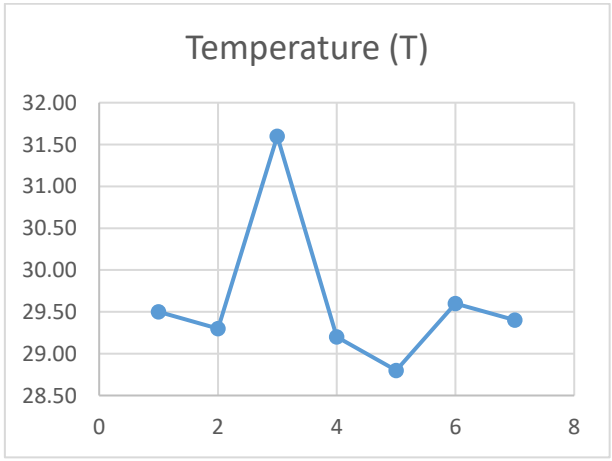

Figure 3 The difference in water temperature at each observation station

The measurement results show that the average temperature of the waters of Sei Jawi is 29.63°C. This value is higher than the average air temperature of Pontianak city of 27.6°(BPS, 2020). Compared with the river water quality standards in PP No. 22 of 2021, the water temperature is still in the good quality category, indicated by the deviation value of water and air temperatures of less than 3 (< Dev 3). The surface water temperature in urban areas easily fluctuates even at hourly intervals (Briciu et al., 2020). Morphometry can influence temperature conditions (surface area, depth, volume), including Hydrological Processes (tidal, flow velocity) (Post et al., 2018). Also, air temperature and other factors such as the water's clarity level (Ptak et al., 2018). Temperature plays a role in the life of organisms and the ongoing chemical processes in waters. Increasing the temperature to a specific limit will improve the biological productivity of the waters, and the existing chemical processes will take place more quickly (Akiya & Savage, 2002). The appropriate temperature for the activity of microorganisms can help the decomposition of organic waste in the water better (Yibo Liu et al., 2022).

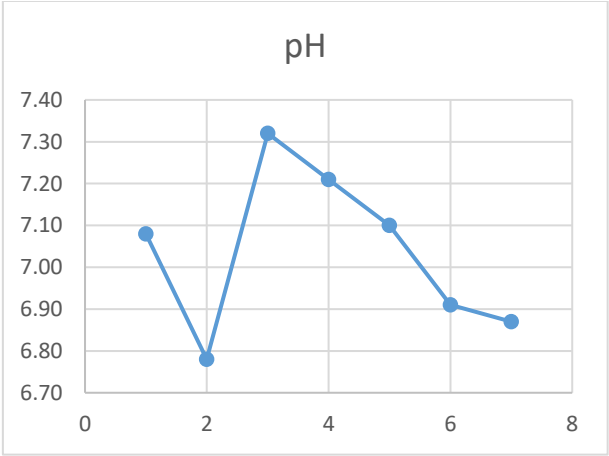

Figure 4 The degree of pH at each observation station

The pH conditions at the research site ranged from 6.78 to 7.33, which means that the pH in the waters of the Sei Jawi canal was in the neutral pH range. pH can affect aquatic biota, especially for the breeding of aquatic biota. A pH value that is too acidic can cause failure in hatching eggs and increase mortality in fish larvae (Nyanti et al., 2018). On the other hand, a neutral pH value increases the chances of survival of fish larvae (Marimuthu et al., 2019). Neutral pH conditions indicate that the waters in the Sei Jawi canal are not polluted by heavy metals (Zhang et al., 2018).

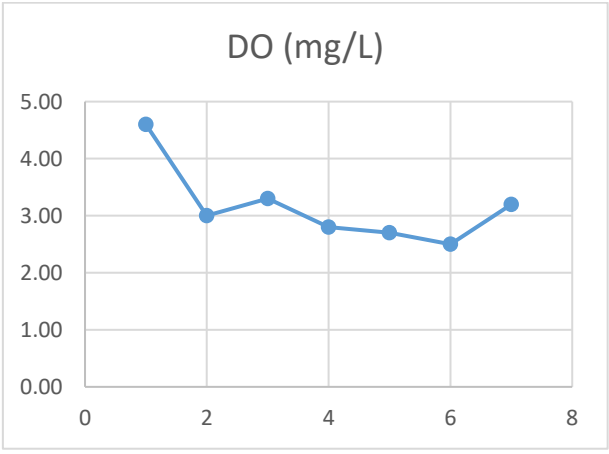

Figure 5 DO value at each observation station.

Dissolved oxygen levels in the upstream area are higher than in the downstream areas but rise again at the estuary point. Dissolved oxygen (DO) levels in urban rivers tend to increase in developing countries, most of the increase in DO in upstream areas (Huang et al., 2017). All living organisms need oxygen for respiration and metabolic processes. In waters, oxygen plays a role in oxidation by reducing chemicals into simpler compounds as nutrients that aquatic organisms need (Salmin, 2005). The cause of a decrease in DO waters downstream of the river can be caused by the activity of decomposition of organic matter and the lack of aeration level (Tran et al., 2021). Meanwhile, high DO levels can be influenced by high rainfall (Yali Liu et al., 2020).

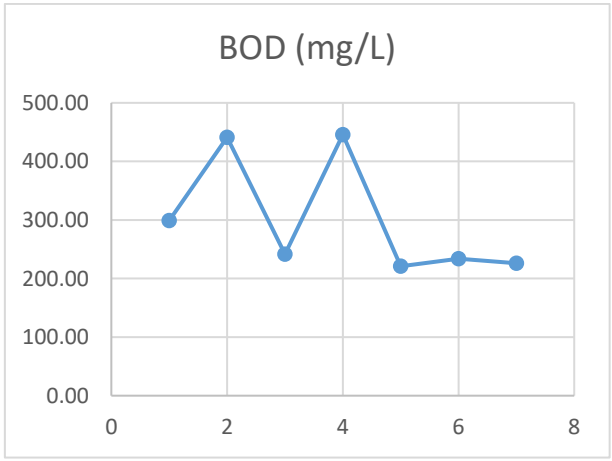

Figure 6 COD value at each observation station

BOD is the number of oxygen microorganisms needed to break down or degrade organic waste materials in water. The decomposition of organic waste through oxidation by microorganisms in water is a natural process that can easily occur when the water contains sufficient oxygen. Observation stations with a high BOD value are located at point two, a residential area, and point four, a traditional market area that sells many animal products. In urban areas, the level of BOD is influenced by household waste (Parabang, 2021). BOD values can be higher in waters around farms or markets selling animal products (Abdullahi et al., 2021).

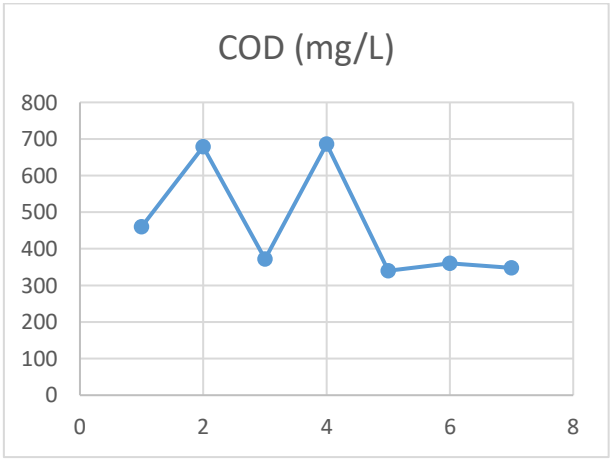

Figure 7 COD value at each observation station

COD measures water's capacity to consume oxygen during the decomposition of organic matter in water. In other words, it is the amount of oxygen required to oxidize the organic matter present in the amount of water (SciMed, 2022). Domestic wastewater from bathing, washing and public toilets contributes to increased BOD and COD concentrations (Prilly et

al., 2019). The high COD concentration in the Jawi River canal waters can be caused by the influx of tap water, which most residents use for clean water. Tap water already contains chlorine which can disrupt the stability of the COD concentration in the waters (Y. Zhao et al., 2021)

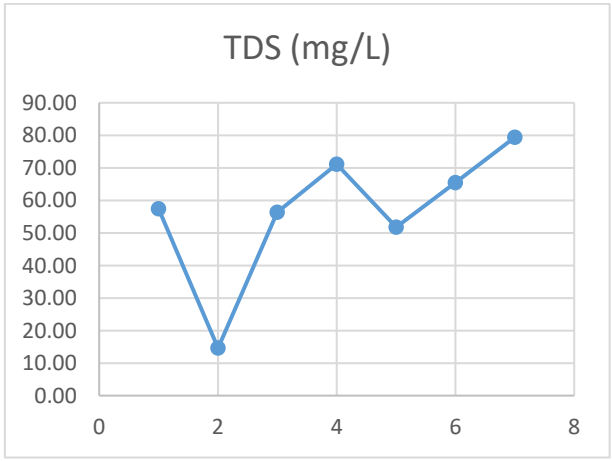

Figure 8 BOD value at each observation station

Total dissolved solids consist of inorganic salts (mainly calcium, magnesium, potassium, sodium, bicarbonate, chloride, and sulfate) and small amounts of organic matter dissolved in water. TDS is generally used as an indicator of the appearance characteristics of drinking water (Chavhan & Khan, 2020). It appears at observation station 2 that the TDS value is lower than at other observation stations. The low TDS value at station 2 is related to the cover of trees that grow around residential areas. The level of TDS in the waters can be influenced by the role of surrounding vegetation, reducing surface runoff that carries solid particles into the waters (Cadaret et al., 2016). The higher the vegetation cover around the river, the better the water quality (Mamulak & Semiun, 2021)

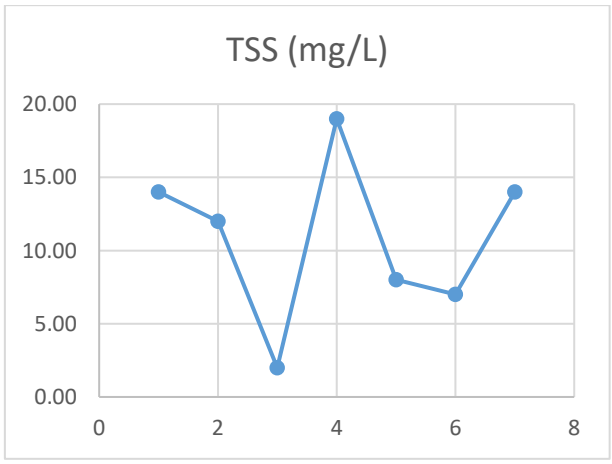

Figure 9 TSS value at each observation station

The TSS value at observation station 3 is lower than at other points. The highest value at station 4 can be related to the high activity of vehicles on the highway at that point. The study's results support that the amount of sediment and particle size on the road surface will also affect the high and low concentrations of TSS in canal waters (H. Zhao et al., 2022). The highest TSS value is along the canal's banks but will become lower towards the middle of the river. Meanwhile, the vertical distribution shows that the closer the water's bottom, the higher the TSS (Wirabumi et al., 2021). The measurement of each water quality parameter in the Sei

Jawi canal shows that the temperature, pH, TDS, and TSS are still below the quality standard threshold, while the DO level is in quality category III. standard, but the levels of COD and BOD exceed the quality standards set in PP No. 22 of 2021.

3.2. Discussion

The average water temperature in the Sei Jawi canal is 29.63°C, 2°C higher than the average air temperature in Pontianak City. The highest temperature was measured at station 3, where trees no longer shaded the right side. Other stations have many shade trees, which street vendors use to set up their food stands. The presence of this shade tree can maintain the water condition in the Sei Jawi canal so that the air temperature above it does not rise. The pH values measured on site ranged from 6.78 to 7.32. Station two has the lowest pH, and Station 3 has the highest. The pH levels for these two nearby sites are somewhat different. At station two, many residents still use their yards and road shoulders for ornamental and fruit cultivation activities. They use urea-type fertilizer to encourage plant growth. It is suspected that the urea they use is partially washed away by rainwater and flows into the canal, affecting the pH level at station 2, which tends to be lower than other stations. Excessive use of urea fertilizers in agriculture has been associated with poorer pH levels in soil and water (Kissel et al., 2020).

The high BOD and COD values found in the samples taken at stations two and four were caused by local activities at these locations. Around station two is a residential area. Meanwhile, around station 4 is a trading area as well as a residential area. There are many traditional markets and supermarkets at station 4. Besides that, there are also street vendors selling various foods and drinks along the canal. Various kinds of fish, meat, vegetables, and fruits are sold in traditional markets. Even though market hygiene and sanitation are under control, organic waste from market leachate continues to flow into the Sei Jawi canal, directly opposite it. The activities of street vendors sometimes still produce organic waste left over from their trade that enters the canal.

Figure 10 Aerial view of the Sei Jawi canal, which is bustling with trade and residential areas

The high levels of BOD and COD are caused by many sources of pollution, both from the community, traditional markets, and street vendors. In addition, the distance between the pollutant source and the channel can also affect the high levels of BOD and COD. Water quality that exceeds the quality standard has been recorded in the Mahap River, Sekadau Regency, West Kalimantan, with a BOD number of 16.19 – 29.71 mg/L and a COD number of 39.47 – 69.14 mg/L even though it is more than 40 meters source of pollution, namely the residential environment. This result is still much lower than the BOD and COD values of the Sei Jawi channel.

The high value of BOD and COD can be caused by the pollution source being too close to the channel. Residential density and high levels of community activity, especially at stations 2 and 4, which are only 5 – 20 meters from the canal, can encourage residents who are still secretly depositing household organic waste into the Sei Jawi canal. Cases of high water pollution are also found in the Winongo river in the city of Yogyakarta due to residents' unawareness of the importance of cleanliness (Yogafanny, 2015). People are tempted to throw organic waste into the canal because of the distance to the temporary waste disposal site (TPS). The volume of domestic waste flowing from the sewers of densely populated settlements is also suspected of contributing to the decline in water quality in the Sei Jawi canal. Domestic waste in densely populated areas has been studied to dominate the sources of river pollution, such as in the Cibeureum river and the city of Cimahi (Hermawan & Wardhani, 2021). BOD and COD values were recorded to decrease at observation stations 5, 6, and 7. increasingly towards the end of the canal, which empties into the Kapuas river.

The levels of BOD and COD are relatively lower than the observation stations located in the middle and upstream of the river. This is directly influenced by the tidal circulation around the canal's mouth. At low tide, the concentration of contaminants is rapidly released into the Kapuas River. At high tide, the volume of water entering the Kapuas River subsequently mixes in the channel so that pollution concentration decreases. In contrast to the levels of BOD and COD, the TDS value near the mouth of the canal was 79.40 mg/L, higher than at other observation locations. Convergence of currents from the canal and the Kapuas river results in increasingly large and irregular water movements at the mouth of the canal.(Purnaini, Sudarmadji and Purwono, 2018).

4. CONCLUSION

The results of the study of the water quality of the Sei Jawi canal show that the parameters of temperature, pH, TDS, and TSS are not below the quality standard threshold, while the DO level is in the category III quality standard. However, the COD and BOD levels exceed the quality standard. Quality standards are set out in PP no. 22 of 2021. regarding the Implementation of Environmental Protection and Management. Based on these findings, it can be concluded that the water in the Jawi River Canal is no longer suitable for use as a source of clean water. This canal is recommended for flood prevention and can be managed as a recreational area by adding to the attractiveness and aesthetic value of the area.

ACKNOWLEDGMENT

The authors would like to thank the Institute for Research and Community Service (LPPM) Nahdlatul Ulama University, West Kalimantan, for the support provided, Sungai Jawi Dalam Village, Pal Lima Village, and West Pontianak Village. Hopefully, the results of this research can be helpful from a theoretical point of view and contribute to better management of the Sei Jawi canal.

REFERENCES

Abdullahi, AB, Siregar, AR, Pakiding, W., & Mahyuddin. (2021). The analysis of BOD (Biological Oxygen Demand) and COD (Chemical Oxygen Demand) contents in the water of around laying chicken farm. IOP Conference Series: Earth and Environmental Science, 788(1), 012155. https://doi.org/10.1088/1755-1315/788/1/012155

Akiya, N., & Savage, PE (2002). Roles of water for chemical reactions in high-temperature

water. Chemical Reviews, 102(8), 2725–2750. https://doi.org/10.1021/cr000668w

Andriansyah, Setyawati, TR, & Lovadi, I. (2014). Water Quality of the Jawi River and Raya River Canals in Pontianak City in terms of structure. Protobiont, 3(1), 61–70.

Apriyanti, E., Ihwan, A., & Ishak, M. (2016). Analysis of Water Quality in the Great Ditch of the Jawi River, Pontianak City. Prism Physics, 4(03), 101–109.

Article, R. (2020). A review on water pollution: Causes, effects and treatment methods. International Journal of Pharmaceutical Sciences Review and Research, 60(2), 94–101. https://www.mendeley.com/catalogue/5a301616-ba65-3d80-9087-22d552d0011f/

BPS. (2020). The air temperature 2018-2020 Pontianak City. BPS Pontianak. https://pontianakkota.bps.go.id/indicator/151/48/1/suhu-air.html

BPS. (2021). Pontianak City in Numbers. CV Nine Nine.

Briciu, AE, Mihaila, D., Graur, A., Oprea, DI, Prisacariu, A., & Bistricean, PI (2020). Changes in the water temperature of rivers impacted by the urban heat island: Case study of Suceava city. Water (Switzerland), 12(5). https://doi.org/10.3390/W12051343

Cadaret, EM, Nouwakpo, SK, McGwire, KC, Weltz, MA, & Blank, RR (2016). Experimental investigation of the effect of vegetation on soil, sediment erosion, and salt transport processes in the Upper Colorado River Basin Mancos Shale formation, Price, Utah, USA. CATENA, 147, 650–662. https://doi.org/10.1016/J.CATENA.2016.08.024

Chavhan, S., & Khan, A. (2020). Analysis Of Total Dissolved Solid Of Arvi (Wardha) Region. International Journal of Scientific & Technology Research, 9(3), 156–159.

Chen, SS, Kimirei, IA, Yu, C., Shen, Q., & Gao, Q. (2022). Assessment of urban river water pollution with urbanization in East Africa. Environmental Science and Pollution Research, 29(27), 40812–40825. https://doi.org/10.1007/S11356-021-18082-1

Cheng, K., Sheng, B., Zhao, Y., Guo, W., & Guo, J. (2022). An Urban Water Pollution Model for Wuhu City. Water (Switzerland), 14(3). https://doi.org/10.3390/W14030386

Hermawan, YI, & Wardhani, E. (2021). Analysis of Domestic Waste Impact on Water Quality of the Cibeureum River, Cimahi City. National Symposium on 21st Century Infrastructure Technology, 611–616.

Huang, J., Yin, H., Chapra, SC, & Zhou, Q. (2017). Modeling Dissolved Oxygen Depression in an Urban River in China. Water 2017, Vol. 9, Page 520, 9(7), 520. https://doi.org/10.3390/W9070520

Kissel, DE, Bock, BR, & Ogles, CZ (2020). Thoughts on acidification of soils by nitrogen and sulfur fertilizers. Agrosystems, Geosciences and Environment, 3(1), 1–10. https://doi.org/10.1002/agg2.20060

Liu, Yali, Du, J., Hu, P., Ma, M., & Hu, D. (2020). Microtopographic modification conserves urban wetland water quality by increasing the dissolved oxygen in the wet season. Journal of Environmental Sciences, 87, 71–81. https://doi.org/10.1016/J.JES.2019.06.03

Liu, Yibo, Zhang, B., Zhang, Y., Shen, Y., Cheng, C., Yuan, W., & Guo, P. (2022). Organic Matter Decomposition in River Ecosystems: Microbial Interactions Influenced by Total Nitrogen and Temperature in River Water. Microbial Ecology 2022, 1–17. https://doi.org/10.1007/S00248-022-02013-9

Mamulak, YI, & Semiun, CG (2021). CONTRIBUTION Of RIPARIAN VEGETATION TO

WATER QUALITY IN SPRING WATER ORAS. Indonesian Journal of Applied Research (IJAR), 2(1), 28–32. https://doi.org/10.30997/ijar.v2i1.95

Marimuthu, K., Marimuthu, K., Palaniandya, H., & Muchlisin, ZA (2019). Effect of different water pH on hatching and survival rates of African catfish Clarias gariepinus (Pisces: Clariidae). Aceh Journal of Animal Science, 4(2), 80–88. https://doi.org/10.13170/ajas.4.2.13574

Müller, A., sterlund, H., Marsalek, J., & V advertisingder, M. (2020). The pollution conveyed by urban runoff: A review of sources. Science of the Total Environment, 709. https://doi.org/10.1016/J.SCITOTENV.2019.136125/THE_POLLUTION_CONVEYED_BY_URBAN_RUNOFF_A_REVIEW_OF_SOURCES.PDF

Nurcahyani, L., Sulistyorini, P., & Hasanudin. (1999). PONTIANAK CITY AS A TRADE PORT ON THE SILK ROAD. DEPARTMENT OF EDUCATION AND CULTURE OF THE REPUBLIC OF INDONESIA.

Nyanti, L., Soo, C.-L., Danial-Nakhaie, M.-S., Ling, T.-Y., Sim, S.-F., Grinang, J., Ganyai, T., & Lee, K.-S.-P. (2018). Effects of water temperature and pH on total suspended solids tolerance of Malaysian native and exotic fish species. Aquaculture, Aquarium, Conservation & Legislation, 11(3), 565–575. http://www.bioflux.com.ro/aacl

Omer, NH (2012). Water Quality Parameters. In Water Quality - Science, Assessments and Policy (p. 13). http://dx.doi.org/10.1039/C7RA00172J%0Ahttps://www.intechopen.com/books/advanced-biometric-technologies/liveness-detection-in-biometrics%0Ahttp://dx.doi.org/10.1016/j.colsurfa.2011.12.014

Pambudi, USA (2021). Sustainable Lake/Situ Management. Indonesian Journal of Applied Research (IJAR), 2(2), 79–91. https://doi.org/10.30997/ijar.v2i2.108

Parabang, S. (2021). Pollution Load Analysis of Biological Oxygen Demand from Household Sources. International Journal of Scientific and Research Publications (IJSRP), 11(4), 411–417. https://doi.org/10.29322/IJSRP.11.04.2021.P11254

Perveen, A., & Zaidi, S. (2018). Effects of Water Pollution on Human Health: A Review. World Journal of Pharmacy and Pharmaceutical Sciences, 7(1), 504. https://www.mendeley.com/catalogue/70a7808a-88cb-3194-a9b9-8b4b20e69004/

Post, CJ, Cope, MP, Gerard, PD, Masto, NM, Vine, JR, Stiglitz, RY, Hallstrom, JO, Newman, JC, & Mikhailova, EA (2018). Monitoring spatial and temporal variation of dissolved oxygen and water temperature in the Savannah River using a sensor network. Environmental Monitoring and Assessment, 190(5). https://doi.org/10.1007/S10661-018-6646-Y

Prilly, S., Arum, I., & Harisuseno, D. (2019). Domestic Wastewater Contribution to Water Quality of Brantas River at Dinoyo Urban Village, Malang City. J-Pai, 10(2), 84–91. https://doi.org/10.21776/ub.jpal.2019.010.02.02

Ptak, M., Sojka, M., Choiński, A., & Nowak, B. (2018). Effect of Environmental Conditions and Morphometric Parameters on Surface Water Temperature in Polish Lakes. Water, 10(5), 580. https://doi.org/10.3390/W10050580

Purnaini, R., Sudarmadji, S., & Purwono, S. (2018). The Effect of Tides on Salinity Distribution in the Kapuas Kecil River. Wetland Environmental Technology Journal, 6(2), 21. https://doi.org/10.26418/jtllb.v6i2.30239

Salmin. (2005). Dissolved Oxygen (DO) And Biological Oxygen Demand (BOD) As One Indicator To Determine Water Quality. Oceana, 30(3), 21–26.

Sarker, B., N. Keya, K., I. Mahir, F., M. Nahiun, K., Shahida, S., & A. Khan, R. (2021). Surface and Ground Water Pollution: Causes and Effects of Urbanization and Industrialization in South Asia. Scientific Review, 73, 32–41. https://doi.org/10.32861/SR.73.32.41

Syafitri, L., Rahmawati, & Fitria, L. (2017). Incidence of Diarrhea Based on Density of Coliform Bacteria in the Jawi River, Pontianak City. Wetlands Environmental Technology Journal, 5(1).

Tran, CN, Yossapol, C., Tantemsapya, N., Kosa, P., & Kongkhiaw, P. (2021). Water Quality Simulation and Dissolved Oxygen Change Scenarios in Lam Takhong River in Thailand. Undeournal of Sustainable Development of Energy, Water and Environment Systemsfined, 10(1). https://doi.org/10.13044/J.SDEWES.D9.0389

What is chemical oxygen demand (COD)? |. (2022). SciMed. https://www.scimed.co.uk/education/what-is-chemical-oxygen-demand-cod/

Wirabumi, P., Kamal, M., & Wicaksono, P. (2021). Determining effective water depth for total suspended solids (TSS) mapping using PlanetScope imagery. International Journal of Remote Sensing, 42(15), 5774–5800. https://doi.org/10.1080/01431161.2021.1931538

Yang, S., Liang, M., Qin, Z., Qian, Y., Li, M., & Cao, Y. (2021). A novel assessment considering spatial and temporal variations of water quality to identify pollution sources in urban rivers. Scientific Reports, 11(1). https://doi.org/10.1038/S41598-021-87671-4

Yogafanny, E. (2015). The influence of residents' activities on the river border on the water quality of the Winongo River. Journal of Environmental Science & Technology, 7(1), 41–50. https://journal.uii.ac.id/JSTL/article/view/3494

Zhang, Y., Zhang, H., Zhang, Z., Liu, C., Sun, C., Zhang, W., & Marhaba, T. (2018). PH Effect on Heavy Metal Release from a Polluted Sediment. Journal of Chemistry, 2018. https://doi.org/10.1155/2018/7597640

Zhao, H., Ma, Y., Fang, J., Hu, L., & Li, X. (2022). Particle size distribution and total suspended solid concentrations in urban surface runoff. Science of The Total Environment, 815. https://doi.org/10.1016/J.SCITOTENV.2021.152533

Zhao, Y., Tang, H., Ge, X., Li, Y., & Wang, S. (2021). the chloride ion to the chemical oxygen demand (COD) analysis of the influence of different analysis methods. E3S Web of Conference 236, 02034, 2020–2022.