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Study of Babak River water quality using physical and chemical parameters in Kebon Kongok landfill (Lombok, Indonesia)

Lalu Ahmad Didik Meiliyadi[1,2], Muhammad Zainur Rahman[2], Zahida Aliatu Zain[3]
[1]Department of Physics Education, Faculty of Tarbiya and Teacher Training, Universitas Islam Negeri Mataram, Mataram, Indonesia
[2]Advance Science and Integration Research Group, Universitas Islam Negeri Mataram, Mataram, Indonesia
[3]Department of Physics Education, Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris, Perak, Malaysia

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ABSTRACT

The study has been conducted on the water quality level of the Babak River around Kebon Kongok landfill, Lombok. This research was conducted considering that water has many benefits in the daily lives of people. This research uses an experimental method by analyzing physical parameters (temperature, conductivity, pH, and total dissolved solids (TDS)), and chemical parameters in the form of heavy metal content lead (Pb), iron (Fe), manganese (Mn), and copper (Cu)). Analysis results were compared with quality standards based on Ministry of Health Regulation No. 32 of 2017 concerning water quality. Based on the study, it was found that the farther the distance of water measured from the source of pollution, the value of the physical and chemical parameters of water will be smaller. Most of the physical parameter test results show the Babak River water quality is still at the safe threshold limit but there is 1 point of river water that is polluted due to the distance that is too close to the active zone. Chemical parameters show the results of heavy metal content below the threshold limit. Analysis of the water quality shows that the water is still in good condition, which is below the threshold set by the Indonesian government.

Corresponding Author:

Lalu Ahmad Didik Meiliyadi
Department of Physics Education, Faculty of Tarbiya and Teacher Training, Universitas Islam Negeri Mataram
Gajah Mada Street 100, Jempong Baru, Mataram, Indonesia
Email: laludidik@uinmataram.ac.id

1. INTRODUCTION

Indonesia has many rivers that have an essential role in people's lives. One of the roles of rivers is as a source of clean water for the community [1]. River water is widely used for bathing and washing; sometimes, river water is even used as a source of drinking water for residents. But nowadays, pollution disrupts the continuity of the river as a clean source for residents.

Water pollution is a phenomenon that often appears in society [2]. One of the most dangerous forms of pollution is water pollution. High levels of water pollution can cause a lot of damage to both humans and the surrounding environment [3]–[5]. Water is a source of life utilized by the community to meet their daily needs. Water pollution is caused by entering unwanted materials into the water, affecting water quality, and public health [6].

The majority of water the community uses in daily activities is river water. One of the rivers that may experience pollution is the Babak River. This is because the Babak River is located around the Kebon Kongok landfill, which can be a source of pollution due to leachate. Leachate is said to be a pollutant because of the various waste types, causing pollution to river water, which is very dangerous [7]. Remnants from metal processing will accumulate into waste [8]–[11]. Leachate is very high in heavy metals [12]. With leachate as a pollutant that contaminates Babak River water, the water quality of Babak River must be considered. Among the requirements for water of Babak River quality are physical, chemical radioactivity, and microbiological parameters adjusted to Ministry of Health Regulation RI No. 32 of 2017 concerning needs and water quality supervision.

In general, river water pollution can be reviewed through two parameters, namely physical parameters and chemical parameters [13]–[15]. Water pollution based on physical parameters is reviewed based on conductivity, total dissolved solids (TDS), temperature, and pH levels [2]. Meanwhile, based on chemical parameters, good water does not contain toxic chemicals and heavy metal content that exceeds clean water quality standards [16]. If water contains heavy metals that exceed the threshold limit, it will cause pollution and harm the community. Heavy metals often found in leachate include iron, arsenic, creosote, cadmium, zinc, mercury, copper, nickel, and lead. Natural factors and human activities influence the presence of heavy metals in waters [17]. Biological factors are in the form of erosion of mineral stones around the seas. At the same time, human activity can be in the form of industrial and domestic waste disposal and excessive use of fertilizers. The maximum limit of pollution levels based on physical and chemical parameters is shown in Table 1.

Several previous studies have measured water quality using physical and chemical parameters. Nurhidayati *et al*. [19] measured seawater quality based on physical parameters using a TDS meter and chemical parameters using atomic absorption spectrometry (AAS) [19]. Syuzita *et al*. [18] have measured the shallow water of the Babak River quality around the Kebon Kongok landfill [18]. However, no research has been found that examines in depth the leachate pollution of Babak River water around the Kebon Kongok landfill using physical and chemical parameter measurements.

Table 1. Water quality level thresholds [18]

Parameters	Threshold limits	Source
Physics parameters		
TDS	1000 ppm	Ministry of Health
Conductivity	200–1500 μS/cm	Regulation Number 32
pH	6.5–8.5	year 2017
Temperatures	Natural	
Chemical parameters		
Fe	0.3 ppm	
Cu	0.05 ppm	
Pb	0.05 ppm	
Mn	0.01 ppm	

2. RESEARCH METHOD

This research uses an experimental method with river water samples around the Kebon Kongok final disposal site. The sampling location is shown in Figure 1. Sampling considers the distance between the river and the landfill (pollutant source)-selection using 600 ml bottles that have been sterilized. The water samples taken from 5 points are shown in Figure 1.

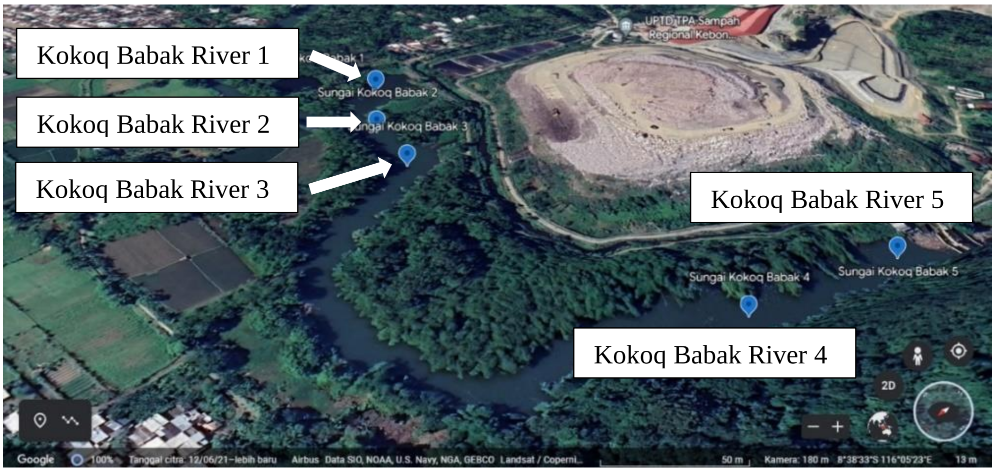

Figure 1. Research sampling location

Physical parameters were measured using a water quality tester (model number: COM-600) to determine the river water quality directly. Physical parameter variables include temperature, conductivity, pH, and TDS. After measuring the physical parameters, the shallow water of Babak River samples was taken to the BPTP Narmada Laboratory, West Lombok, to test the heavy metal content using the AA-7000 AAS. The rich metal content tested includes lead (Pb), iron (Fe), manganese (Mn), and copper (Cu). The samples of river water around Kebon Kongok landfill are shown in Figure 2.

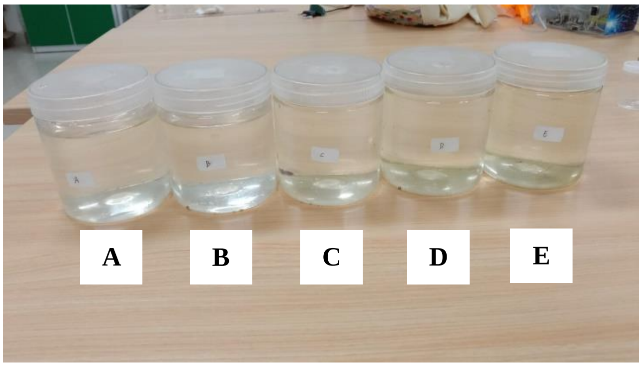

Figure 2. Water samples from the round river around the Kebon Kongok landfill site

3. RESULTS AND DISCUSSION

3.1. Analysis of physical parameters

Measurements of physical parameters taken from 8 shallow water Babak River sample points show the results after analysis, which can be seen in Table 1. Based on the table, the average and standard deviation of temperature, conductivity, pH, and TDS parameters can be seen. The measurement results based on physical parameters are shown in Table 2.

Table 2 shows that the water samples are still in good condition because they have physical parameter values below the threshold limit except for the pH value of the selection at point 5. The pH of the river water sample at point 5 is classified as acidic. In addition, point 5 also has good physical parameter values of TDS, conductivity, pH, and temperature. This is because point five is closest to the Kebon Kongok landfill. A comparison graph of TDS values at each point is shown in Figure 3.

Figure 3 shows the conductivity graph at each sampling point. Based on Figure 4, the TDS value will be inversely proportional to the distance between the water sample points in the Babak River and the Kebon Kongok landfill. The conductivity value of river water at a distance of 100 meters (point 2) is 325.7 ppm, while at the smallest space of 40 meters is 527.1 ppm. The TDS value at the five sampling points is still below the threshold limit of 1000 ppm as set by the government Ministry of Health Regulation No. 32 of 2017. A comparison graph of conductivity values at each point is shown in Figure 4.

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TDS and electrical conductivity are closely related [19] where if the conductivity value increases, the TDS value will also increase, the TDS value will also increase. The further away the shallow water of the Babak River is, the better. This is in line with research, where the relationship between electrical conductivity and TDS, namely in river water and lake water, will increase the conductivity value in line with the increase in TDS value. A comparison graph of water temperature values at each point is shown in Figure 5.

Figure 5 shows a comparison graph of water temperature at each sampling point. Based on Figure 6, it appears that the relative temperature is constant at each measurement point. The temperature value is determined naturally because of the surrounding environmental conditions. Several factors, including external disturbances such as the influence of wind, humidity conditions around the environment, and weather in the area, can cause an increase and decrease in temperature [20]. Based on the average value and standard deviation in temperature measurements, it shows that the shallow water of Babak River quality around the Kebon Kongok landfill leachate is still of usual quality, where the temperature obtained is still within the normal threshold limits that were determined.

Temperature is one of the water quality variables based on physical parameters that must be considered [21]. With temperature, the rate of solubility of Fe heavy metal can be known. The impact that occurs by temperature can affect the solubility of oxygen. Oxygen levels in water will decrease if the temperature shows a high degree. A comparison graph of pH values at each point is shown in Figure 6.

Figure 6 shows the pH measurement at each point. The pH measurement determines the water of Babak River samples' acidity or alkaline content. The quality standard for pH is 6-9. Other pH quality standards are 6.5-8.5. Based on Figure 3, there appears to be an increase in pH that is not too significant. However, the overall average value of shallow water of Babak River samples indicates that the water of Babak River quality is not polluted and is still within safe threshold limits.

The pH measurement results show that the pH tends to be acid-neutral. Several factors cause the pH of the water of Babak River to be acidic, one of which is soil characteristics. Alluvial soils with pH characteristics tend to be acidic at 4-6.7. The pH condition that tends to be acidic will affect the pH of the water of Babak River if water passes through the soil so that the degree of acidity is high.

Table 2. Measurement results of water quality of the Babak River around Kebon Kongok landfill using physical parameters

Point	Sampling distance (m)	TDS (ppm)	Conductivity (μS/cm)	pH	Temperature (°C)
1	60	426.2	457.50	6.95	31.7
2	100	325.7	237.10	7.13	31.5
3	80	424.7	300.05	6.84	31.4
4	80	425.2	324.30	6.77	31.1
5	40	527.1	687.12	5.41	31.9
	Thresholds	1000	200-1500	6.5-8.5	Natural

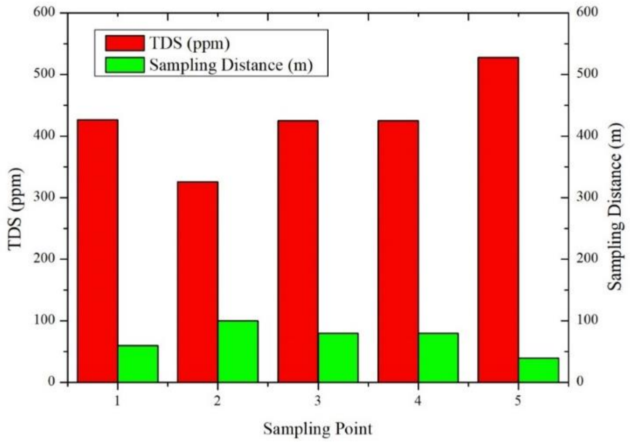

Figure 3. Comparison graph of TDS values at each point

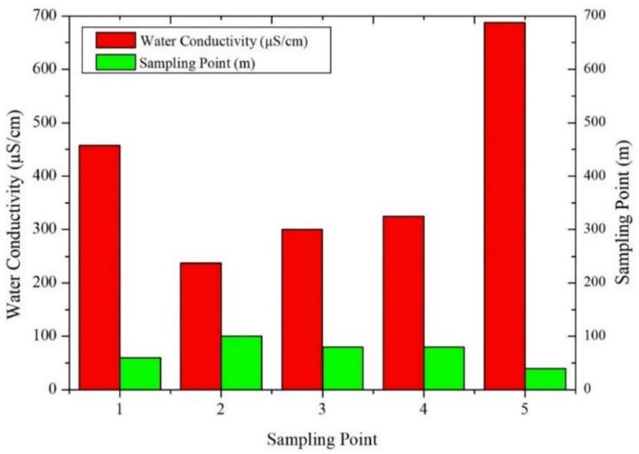

Figure 4. Comparison graph of conductivity values at each point

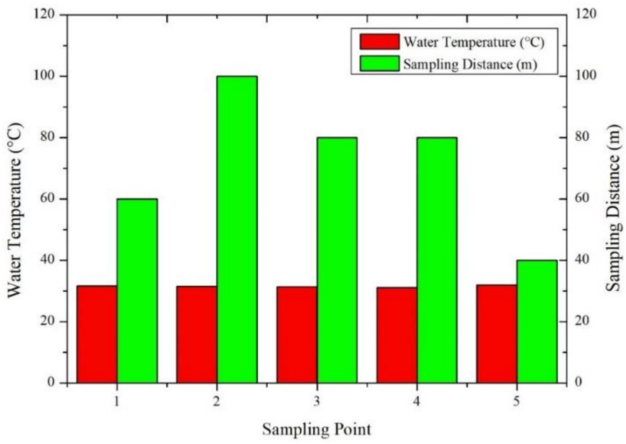

Figure 5. Comparison graph of water temperature values at each point

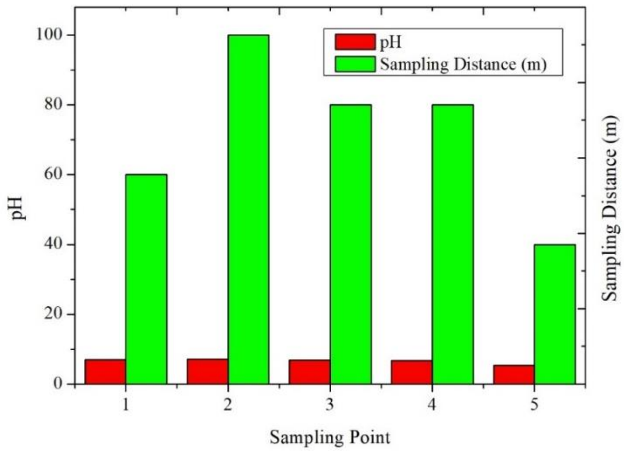

Figure 6. Comparison graph of pH values at each point

3.2. Chemical parameter analysis

The results of chemical parameter measurements taken from 8 shallow water Babak River sample points after analysis can be seen in Table 3. Among the heavy metal contents analyzed using the AAS test are (Pb), (Fe), (Mn), and (Cu). Concentrations of heavy metals in soil, surface water, and air significantly impact human health [3]. When the metal content in the soil accumulates to a certain level that exceeds the safe limit, metal pollution is considered to have occurred [4]. These four elements were analyzed because they are straightforward to find and include heavy metals that are often found in leachate [7], [8], [22]. Some of these compounds react quickly in water and can be a significant source of contamination in the shallow water of the Babak River. The result of the measurement of the water quality of the Babak River around the Kebon Kongok landfill using chemical parameters is shown in Table 3.

Table 3. Results of measurement of water quality of the Babak River around Kebon Kongok landfill using chemical parameters

No	Sampling point (meter)	Heavy metal concentration (ppm)			
		Fe	Cu	Pb	Mn
1	60	0.2021	0.0033	0.0103	0.0105
2	100	0.1127	0.0012	0.0134	0.0092
3	80	0.1183	0.0041	0.0102	0.0097
4	80	0.1105	0.0037	0.0130	0.0086
5	40	0.2035	0.0043	0.0221	0.0181
	Thresholds	0.3	0.05	0.05	0.01

Based on Table 3 shows Pb is one of the metals used in the food and non-food industries that can cause poisoning. So that Pb, needs to be considered because it includes heavy metal conditions that are harmful to living things [23]. Pb contamination of shallow water of the Babak River can also be caused by mining wastes [6]. The threshold limit that has been set for Pb is 0.05 mg/l. From the measurement data, it was found that the heavy metal content of Pb was far below the predetermined threshold limit.

Fe has many positive impacts if Fe levels do not exceed the predetermined threshold. However, if the Fe level in the waters exceeds the predetermined threshold limit, the Fe compound will be toxic which will cause damage to free radicals. One of the factors that cause high Fe content is the weathering of bedrock. Quality standard for Fe of 1 mg/l.

Several factors cause heavy metal content to go undetected. Leachate is not always a contaminating factor in the shallow water of Babak River. However, soil material can also be used as a pollution factor. In addition to the soil material, the depth of the shallow water of the Babak River also affects it. Equally important is the ability of the soil to pass water through the pore space, called soil permeability.

Cu is one type of toxic metal that can be found in nature in a free and compound state [24]. Cu has many benefits in the electronic field. Cu in small amounts does not adversely affect the activities of living things, but Cu will be toxic if the amount is large so that it will interfere with the activities of living things such as algae, fungi, and bacteria [4], [25]. The threshold limit set for Cu for sanitary hygiene purposes is 0.02 ppm.

Mn is one of the compounds found in the surrounding environment. Mn can be found anywhere in soil, water, air, and the bodies of microorganisms. Excessive Mn concentration in water can cause poisoning and can attack the nerves. The threshold limit determined for Mn is 0.5 ppm. From the test results that have been carried out in Figure 3, the results for Mn are 1.457 mg/l at a distance of 50 m from the source of leachate pollution. It can be seen that the level of Mn detected exceeds the predetermined threshold limit. This is because the distance between the shallow water of the Babak River and the polluted source is very close so the opportunity for leachate water to absorb into the water of the Babak River is large. Mn contained in the shallow water of the Babak River indicates a lack of dissolved oxygen and the presence of high CO_2 content so the water of the Babak River should not be consumed or used for sanitary hygiene purposes [26], [27]. An increase in the metal content of river water will lead to an increase in water conductivity as shown in Figure 7.

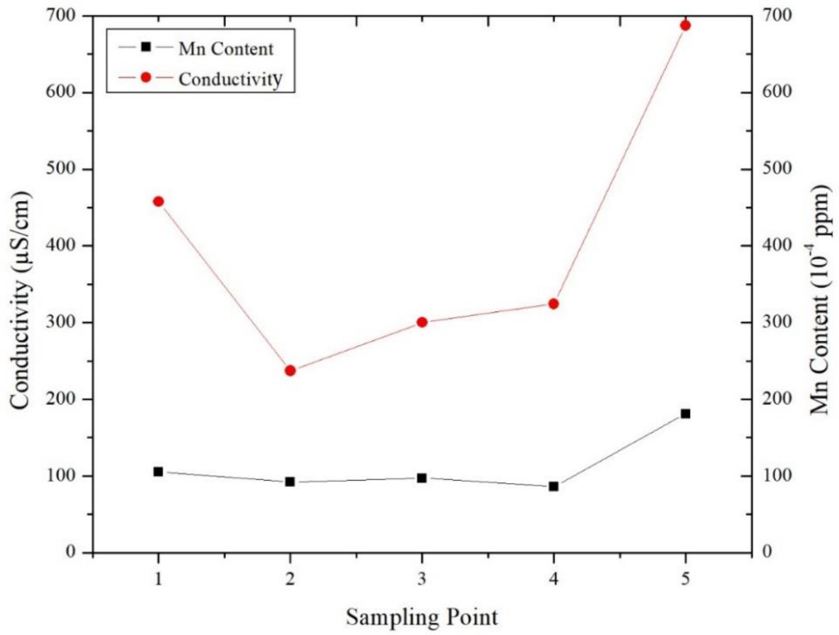

Figure 7. Comparison of Mn content with river water conductivity

Based on Figure 7, it appears that the mineral content has the same pattern as the conductivity of river water. This is because metals have a greater conductivity than water. Therefore, the conductivity of river water is much influenced by the metals contained therein [28]–[30].

Water quality in both river and seawater in West Lombok district is still mostly in good condition. We also need to compare the water quality of both river water, shallow groundwater, and seawater around the Kebon Kongok landfill. This is shown by the results of other studies that examine water quality in West Lombok as in Table 4. Based on Table 4, it appears that the river water quality around the Kebon Kongok landfill is still in good condition. The heavy metal content usually consists of Cu and Mn, both of these heavy metals come from laundry waste.

Table 4. Comparison of water quality of several places around Kebon Kongok landfill

Place of research	Research parameters	Water quality	Reference
Babak River around Kebon Kongok landfill	Physical and chemical parameters	Water quality is good, but only at a distance of 40 meters from Kebon Kongok landfill has Mn content above the threshold	This research
Groundwater around Kebon Kongok landfill	Physical and chemical parameters	Water quality is good based on physical parameters but chemical parameters indicate that the content of heavy metals is mostly well below the quality standard, except Cu metal is detected at 0.029 mg/l and Mn metal at 1,457 mg/l at a distance of 50 m	[18]
Jangkok River	Biological parameters	Water quality is good based on the diversity of microalgae	[31]
Lembar Port	Physical and chemical parameters	Water quality is good	[19]

4. CONCLUSION

Based on the results of the study, it was found that the farther the distance of water intake measured from the source of pollution, the value of the physical and chemical parameters of water will be smaller. In general, the condition of river water in the Babak River around Kebon Kongok landfill is still relatively good. This is indicated by the value of physical and chemical parameters still below the standard set by the Government of the Republic of Indonesia through the Ministry of Health Regulation RI Number 32 of 2017. However, the exception occurs at point 5, which is 40 meters from the Kebon Kongok landfill, which has an Mn content that exceeds the threshold.

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REFERENCE

[1] Z. Ezzeddine, B. Solh, and H. Hamad, "Heavy metals removal by thiol modified oak charcoal: adsorption efficiency and selectivity," *International Journal of Advances in Applied Sciences*, vol. 10, no. 3, pp. 227-235, Sep. 2021, doi: 10.11591/ijaas.v10.i3.pp227-235.

[2] M. K. Hasan, A. Shahriar, and K. U. Jim, "Water pollution in Bangladesh and its impact on public health," *Heliyon*, vol. 5, no. 8, Aug. 2019, doi: 10.1016/j.heliyon.2019.e02145.

[3] Y. Cui, L. Bai, C. Li, Z. He, and X. Liu, "Assessment of heavy metal contamination levels and health risks in environmental media in the northeast region," *Sustainable Cities and Society*, vol. 80, 2022, doi: 10.1016/j.scs.2022.103796.

[4] S. Cui, K. Zhou, R. Ding, J. Wang, Y. Cheng, and G. Jiang, "Monitoring the soil copper pollution degree based on the reflectance spectrum of an arid desert plant," *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*, vol. 263, 2021, doi: 10.1016/j.saa.2021.120186.

[5] N. Hardyanti, H. Susanto, F. Kusuma, and M. Budihardjo, "A bibliometric review of adsorption treatment with an adsorbent for wastewater," *Polish Journal of Environmental Studies*, vol. 32, no. 2, pp. 981–989, Feb. 2023, doi: 10.15244/pjoes/156472.

[6] K. Toyoda *et al.*, "Geochemical identification of particulate lead pollution in shallow groundwater in inhabited areas in Kabwe, Zambia," *Applied Geochemistry*, vol. 139, Apr. 2022, doi: 10.1016/j.apgeochem.2022.105215.

[7] K. S. Rajoo, D. S. Karam, A. Ismail, and A. Arifin, "Evaluating the leachate contamination impact of landfills and open dumpsites from developing countries using the proposed leachate pollution index for developing countries (LPIDC)," *Environmental Nanotechnology, Monitoring and Management*, vol. 14, 2020, doi: 10.1016/j.enmm.2020.100372.

[8] A. M. Stefanowicz, M. Stanek, and M. W. Woch, "High concentrations of heavy metals in beech forest understory plants growing on waste heaps left by Zn-Pb ore mining," *Journal of Geochemical Exploration*, vol. 169, pp. 157–162, 2016, doi: 10.1016/j.gexplo.2016.07.026.

[9] E. K. Nti *et al.*, "Water pollution control and revitalization using advanced technologies: Uncovering artificial intelligence options towards environmental health protection, sustainability and water security," *Heliyon*, vol. 9, no. 7, Jul. 2023, doi: 10.1016/j.heliyon.2023.e18170.

[10] L. Zhu, Z. J. B. M. Husny, N. A. Samsudin, H. Xu, and C. Han, "Deep learning method for minimizing water pollution and air pollution in urban environment," *Urban Climate*, vol. 49, p. 101486, 2023, doi: 10.1016/j.uclim.2023.101486.

[11] S. C. S. M. Hemachandra and B. G. N. Sewwandi, "Application of water pollution and heavy metal pollution indices to evaluate the water quality in St. Sebastian Canal, Colombo, Sri Lanka," *Environmental Nanotechnology, Monitoring and Management*, vol. 20, 2023, doi: 10.1016/j.enmm.2023.100790.

[12] G. S. Ingle, “Study of soil properties affected by leachate – a case study at Urali-Devachi, Pune, India,” *Materials Today: Proceedings*, vol. 60, pp. 588–594, 2022, doi: 10.1016/j.matpr.2022.02.118.

[13] S. Bakri and P. Yushananta, “Water pollution and water quality assessment of the way Kuripan River in Bandar Lampung City (Sumatera, Indonesia),” *Polish Journal of Environmental Studies*, vol. 32, no. 2, pp. 1061–1070, Feb. 2023, doi: 10.15244/pjoes/153432.

[14] L. Ho *et al.*, “Impact of salinity gradient, water pollution and land use types on greenhouse gas emissions from an urbanized estuary,” *Environmental Pollution*, vol. 336, p. 122500, Nov. 2023, doi: 10.1016/j.envpol.2023.122500.

[15] L. Yang *et al.*, “Water quality improvement project for initial rainwater pollution and its performance evaluation,” *Environmental Research*, vol. 237, Nov. 2023, doi: 10.1016/j.envres.2023.116987.

[16] I. Khalik, A. Sapei, S. Hariyadi, E. Anggraeni, W. Hekmuseta, and M. Mardiana, “Study of water quality status of Dendam Tak Sudah Lake in Bengkulu City, Indonesia: using CCME index,” *Polish Journal of Environmental Studies*, vol. 32, no. 2, pp. 1633–1643, Mar. 2023, doi: 10.15244/pjoes/156580.

[17] M. S. Islam and M. G. Mostafa, “Groundwater suitability for irrigated agriculture in alluvial Bengal delta plain: a review,” *International Journal of Advances in Applied Sciences*, vol. 10, no. 2, pp. 156-170, Jun. 2021, doi: 10.11591/ijaas.v10.i2.pp156-170.

[18] A. Syuzita, L. A. D. Meiliyadi, and B. Bahtiar, “Level of leachate pollution in shallow groundwater around Kebon Kongok landfill using physical and chemical parameters (in Indonesian),” *Jurnal Fisika Flux: Jurnal Ilmiah Fisika FMIPA Universitas Lambung Mangkurat*, vol. 19, no. 2, p. 126, Jun. 2022, doi: 10.20527/flux.v19i2.13030.

[19] N. Nurhidayati, L. A. Didik, and A. Zohdi, “Identification of heavy metal pollution around sheet harbor using physical and chemical parameter analysis (in Indonesian),” *Jurnal Fisika Flux: Jurnal Ilmiah Fisika FMIPA Universitas Lambung Mangkurat*, vol. 18, no. 2, p. 139, Aug. 2021, doi: 10.20527/flux.v18i2.9873.

[20] R. D. C. Adi, W. Wilopo, and H. Setiawan, “Groundwater recharge estimation using chloride mass balance method on the southern slope of Merapi Volcano, Indonesia,” *International Journal of Advances in Applied Sciences*, vol. 12, no. 3, p. 265, Sep. 2023, doi: 10.11591/ijaas.v12.i3.pp265-273.

[21] J. G. Herrera-Pérez, F. Legorreta-García, M. Reyes-Pérez, V. E. Reyes-Cruz, E. A. Chávez-Urbiola, and L. E. Trujillo-Villanueva, “Analysis of the effect of magnetic separation processing parameters for the treatment of mining waste,” *Polish Journal of Environmental Studies*, Dec. 2023, doi: 10.15244/pjoes/173113.

[22] M. N. Ossai, B. S. Ojoajogwu, and J. A. Yakubu, “Integrated resistivity study on the effect of dumpsite leachate on groundwater at Ezeani-Obimo, Nsukka, Enugu state Nigeria,” *International Journal of Advances in Applied Sciences*, vol. 11, no. 1, pp. 65-75, Mar. 2022, doi: 10.11591/ijaas.v11.i1.pp65-75.

[23] R. Zhang and H. Yi, “Optimization of Pb biosorption from aqueous solution using genetically engineered saccharomyces cerevisiae by response surface methodology,” *Polish Journal of Environmental Studies*, vol. 33, no. 2, pp. 1467–1476, Jan. 2024, doi: 10.15244/pjoes/172838.

[24] J. Khan, S. Lin, J. C. Nizeyimana, Y. Wu, Q. Wang, and X. Liu, “Removal of copper ions from wastewater via adsorption on modified hematite ($α$-Fe2O3) iron oxide coated sand,” *Journal of Cleaner Production*, vol. 319, 2021, doi: 10.1016/j.jclepro.2021.128687.

[25] E. C. Emenike, K. O. Iwuozor, and S. U. Anidiobi, “Heavy metal pollution in aquaculture: Sources, impacts and mitigation techniques,” *Biological Trace Element Research*, vol. 200, no. 10, pp. 4476–4492, Oct. 2022, doi: 10.1007/s12011-021-03037-x.

[26] C. L. Goi, “The river water quality before and during the movement control order (MCO) in Malaysia,” *Case Studies in Chemical and Environmental Engineering*, vol. 2, Sep. 2020, doi: 10.1016/j.cscee.2020.100027.

[27] Y. Wang, X. Ding, Y. Chen, W. Zeng, and Y. Zhao, “Pollution source identification and abatement for water quality sections in Huangshui River basin, China,” *Journal of Environmental Management*, vol. 344, 2023, doi: 10.1016/j.jenvman.2023.118326.

[28] L. A. D. Meiliyadi, M. Wahyudi, I. Damayanti, and A. Fudholi, “Morphological characteristics and electrical properties analysis of silica based on river and coastal iron sand,” *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, vol. 11, no. 1, pp. 129–140, Apr. 2022, doi: 10.24042/jipfalbiruni.v11i1.12390.

[29] Q. Chen *et al.*, “Remediation of soil contaminated by heavy metals using biochar: strategies and future prospects,” *Polish Journal of Environmental Studies*, vol. 32, no. 1, pp. 27–40, 2022, doi: 10.15244/pjoes/153912.

[30] M. M. M. Syeed, M. S. Hossain, M. R. Karim, M. F. Uddin, M. Hasan, and R. H. Khan, “Surface water quality profiling using the water quality index, pollution index and statistical methods: a critical review,” *Environmental and Sustainability Indicators*, vol. 18, Jun. 2023, doi: 10.1016/j.indic.2023.100247.

[31] N. Purwati, E. T. Jayanti, and M. Jannah, “Community structure of fresh water microalgae in Jangkok River, Lombok Indonesia,” *Jurnal Penelitian Pendidikan IPA*, vol. 8, no. 4, pp. 2043–2047, 2022, doi: 10.29303/jppipa.v8i4.1761.

BIOGRAPHIES OF AUTHORS

Lalu Ahmad Didik Meiliyadi is an experienced lecturer with a demonstrated history of working in the Department of Physics. His research interests include material physics, nanomaterials, environmental physics, and renewable energy. He can be contacted at email: laludidik@uinmataram.ac.id.

Muhammad Zainur Rahman is a lecturer at the Department of Social Education Universitas Islam Negeri Mataram. His research interest is in social science and environmental management. He can be contacted at email: muhzainurrahaman@uinmataram.ac.id.

Zahida Aliatu Zain is an Education Graduate who is studying for a Master of Education in Physics at Sultan Idris Education University (UPSI). Her academic journey was marked by her contribution to the field of education, especially the field of physics. Her research interests are specifically in physics education. She can be contacted at email: m20221000495@siswa.upsi.edu.my.