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Effectiveness of Screening Models in Improving the Quality of Cenrana River Water as a Drinking Water

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***Abstract*—The objective of this study is to assess the quality of the Cenrana River water as a potential drinking water source for a community in the Cenrana watershed Wajo, as well as to evaluate the effectiveness of a basic water purification system in improving its condition. Cenrana River is located in the Maros Regency and Bone Regency, South Sulawesi Province, Indonesia. The study was conducted at the Laboratory of Material Testing, Faculty of Engineering Universitas Negeri Makassar, and the Makassar Health Laboratory Center. Water samples are taken in the Walanae River located in Bone Regency and tested in the abovementioned laboratory. This type of research is experimental, which involves assembling a simple clarification tool in the material testing laboratory, and then raw water is purified with the device. Water samples, both raw water and purified water, are tested at the Makassar Health Laboratory Center. The data analysis used is qualitative descriptive, which compares the results of laboratory tests of raw water that have not been clarified and the results of laboratory tests of water that have been purified with the parameters of clean water standard criteria based on the regulation by the Ministry of Health of the Republic of Indonesia. The results showed that although the water had been cleaned through two filters, several parameters tended to increase from the previous year's test results with one filter, such as the *No2* content from 0.017 to 0.034, *No3* from 0.01 to 0.39, dissolved solids from 152 to 156, *Fe* from 0.01 to 0.17, *Mn* from 0.01 to 0.15, *SO4* from 14.39 to 15, 54, and *Ammonia* from 0.05 to 0.29 even though it still meets the standards of the Ministry of Health of the Republic of Indonesia. In addition, the raw water *coliform* content also increased from an average of 6,600/100 ml in 2016 to 20,050/100 ml in 2019. This means that there is a tendency for Cenrana River water pollution may increase every year.**

***Keywords*—Raw water; purified water; Cenrana river; drinking water.**

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I. INTRODUCTION

Clean water fulfills the necessary standards for consumption, culinary purposes, personal hygiene, and energy usage. Water, one of the essential factors for life, is needed in the criteria for clean water [1]–[4]. Water is a natural wealth that God has given as an essential means of life and involves many people's lives. Water composition on earth's surface is 70% in the sea and 30% in land and air [5]. Furthermore, water is a vital chemical molecule for living organisms on Earth [6]–[16]. Water can exist in three different states: solid, in the form of ice; liquid, as water; and gas, as water vapor. Water is the sole substance that is naturally present on the earth's surface in all three states. Water is a chemical compound represented by the chemical formula H_2O. A water molecule consists of two hydrogen atoms bonded to one oxygen atom through covalent bonds. Water is colorless, tasteless, and odorless. Furthermore, raw water begins a process in the supply and treatment of clean water [17]–[22].

This study is grounded on the regulatory framework established by the Minister of Health of the Republic of Indonesia concerning drinking water quality requirements [23]. In article 1: 1, it is explained that: "Drinking water is water that is processed or without processing that meets health requirements and can be drunk directly." Furthermore, in Article 3: 1, it is explained that consuming water is considered safe for one's well-being if it adheres to the compulsory criteria and supplementary criteria regarding physical, microbiological, chemical, and radioactive aspects.

Water quality must adhere to health standards encompassing microbiological, physical, chemical, and radioactive criteria [24]–[30]. In the regional regulation, It is imperative to specify the water quality as defined in the regulations set by the Minister of Health. The number of parameters must be checked by the available capabilities and facilities in the regional laboratory. Inspection of water quality needs to be done in stages and continue to be improved so that the examination carried out by the provisions. Parameters cannot be checked in a laboratory if it is higher in ability as needed.

Anggraini [31] reported that good water quality must meet the following conditions: 1) Clear, odorless, and tasteless. The quality of healthy drinking water should not taste or tasteless. If it tastes, it means that the drinking water contains organic or bacterial substances. 2) Meet chemical requirements. Water that is good quality must have a normal pH level. It also does not contain toxic chemicals or organic matter, is free of salt or other metals, and 3) is free of bacteria. To be fit for consumption, drinking water should not contain disease-causing bacteria in the digestive tract, such as *E.coli*, *Salmonella typhi*, and *Vibrio cholera* bacteria.

According to [23], high-quality water can be described as water that is devoid of any taste, smell, or color, and does not pose any harm to one's well-being. This entails taking into account variables such as pH acidity level, odor, taste, color, turbidity, temperature, and the concentration of dissolved particles. To prevent the dissolving of heavy metals and corrosion of water distribution networks, it is important for the pH of water to be neither acidic nor alkaline, but rather neutral. The optimal pH range for pure water is 6.5-8.5. Pure water typically lacks aesthetic appeal and may not be favored by the community. The odor of water might provide an indication of its quality. Taste: Clean water typically lacks any discernible flavor and is free from the presence of potentially harmful compounds that could pose a risk to one's health. For aesthetic purposes and to avoid potential poisoning from various chemicals and colored microbes, it is desirable for both color and water to be devoid of color.

The anticipated threshold for clean water standards is 50 TCU dyes, whereas the highest allowable limit for drinking water standards is 15 TCU dyes. Turbidity refers to the presence of a high concentration of suspended particles in water, resulting in a muddy and unclean color or appearance. The water's turbidity level can be measured by conducting laboratory tests utilizing the Turbidimeter technique. The permissible turbidity levels for clean water standards are 25 and 5 NTU for drinking water requirements. The water temperature should be maintained at a range of 10-25°C (cool) to prevent the occurrence of chemical dissolution in the ducts or pipelines, which could pose a risk to health. The "Total Dissolved Solids" (TDS) typically consist of organic compounds, inorganic salts, and dissolved gases. An increase in (TDS) will result in a corresponding rise in water hardness. Moreover, the impact of TDS or water hardness on health is contingent upon the specific chemicals responsible for the issue [23]. In total, the requirements for drinking water quality are shown in Table 1.

TABLE I

DRINKING WATER QUALITY REQUIREMENTS REQUIRE PARAMETER

No.	Types of Parameters	Maximum Levels Allowed
1.	**Parameters directly related to health.**	
	a. Microbiological parameters (ml)	
	1) E-Coli	0
	2) Total *coliform* bacteria	0
	b. Inorganic chemistry (Mg/l	
	1) *Arsenic* (As)	0.01
	2) *Fluoride* (F)	1.5
	3) *Chromium* (Cr)	0.05
	4) *Cadmium* (Cd)	0.003
	5) *Nitrite* (as No2)	3
	6) *Nitrate* (as No3)	50
	7) *Cyanide* (CN)	0.07
	8) *Selenium* (Se)	0.01
2.	**Parameters that are not directly related to health:**	
	a. Physical Parameters	
	1) Odors	Odorless TCU
	2) Color	15 Mg/l
	3) Dissolved Solid	500NTU
	4) Turbidity	Tasteless
	5) Taste	5
	6) Temperature	± 3 °C
	b. Chemical Parameters (Mg/l))	
	1) *Aluminum* (Al)	0.2
	2) *Iron* (Fe)	0.3
	3) Hardness (CaCo3)	500
	4) *Chloride* (Cl)	250
	5) *Manganese* (Mn)	0.4
	6) pH	6.5 – 8.5
	7) *Zinc* (Zn)	3
	8) *Sulfate* (SO4)	250
	9) Copper (Cu)	2
	10) *Ammonia* as N	1.5

Table 1 above shows the several types of simple water purification tools. Of the several ways of treating water as drinking water, the simplest way is to use physical treatment. Physical treatment that meets the physical standards of water as raw material for drinking water includes odor, taste, level of water clarity, the number of dissolved substances, temperature, and color. Physical water treatment is carried out through several stages: filtering, sedimentation, absorption, and adsorbs. 1) Filtering or filtration is separating solids dissolved in water. In this process, the filter has the role of separating water from solid particles. Solids filtered to be separated from water include wood, leaves, sand, and mud; 2) Precipitation aims to separate water and solid particles by utilizing the force of gravity. Objects or solids whose density is more significant than water will settle to the bottom of the settling tank; 3) Absorption is the event of absorption of certain substances dissolved in water. The material used to absorb is called absorbent. This absorbent will be used as a filter. Generally, the absorbent used is activated carbon. Example: coconut shell charcoal and coal; 4) Adsorption is the process of capturing ions contained in water. The ion-catching substance is called an adsorbent. The adsorbent used in the adsorption process is zeolite and resin. This study aims to determine the initial condition of the Cenrana River water as a source of drinking water for the community in the Cenrana watershed, Wajo Regency, and the water condition after a simple purification device.

II. MATERIALS AND METHOD

A. Materials

The study was conducted at the Laboratory of Material Testing Laboratory, Universitas Negeri Makassar, and the Makassar Health Laboratory Center. Water samples are taken in the Walanae River and tested in the laboratory. This type of research is experimental research, assembling a simple clarification tool in the Faculty of Engineering, Universitas Negeri Makassar (UNM) material testing laboratory and then purifying raw water with the device. Water samples, both raw water and purified water, are tested at the Makassar Health Laboratory Center.

B. Method

The data analysis technique used is qualitative descriptive. A descriptive research design utilizes several research instruments to investigate one or more variables through the process of observation and measurement [32]. We compared the results of laboratory tests of raw water that have not been clarified and the results of laboratory tests of water that have been purified with the parameters of clean water standard criteria based on the regulation by the Ministry of Health of the Republic of Indonesia [23]. Then, we compared it to the South Sulawesi Governor Regulation concerning water quality standards (river water), namely *MPN Coliform* and *MPN E.Coli* [33]. Analysis of the comparison results is a basis for concluding this study.

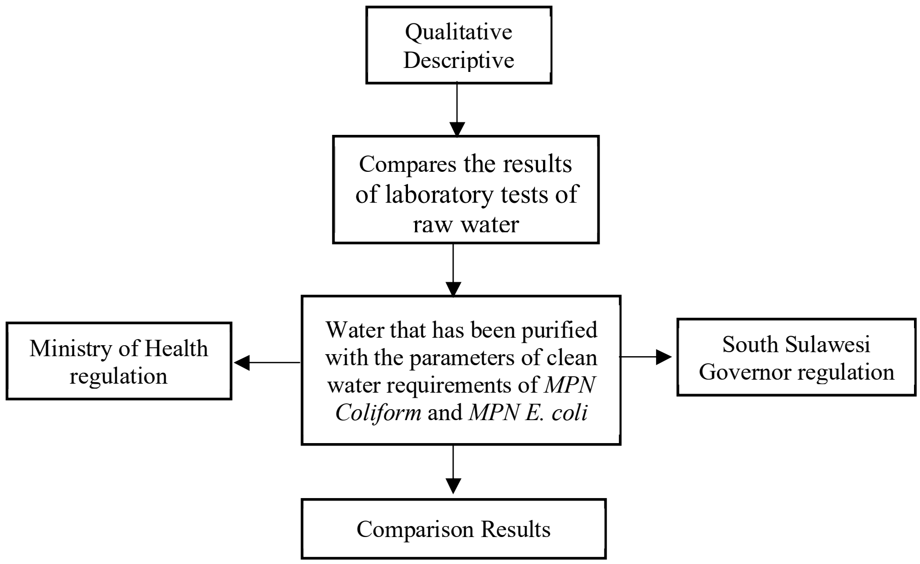

Fig. 1 Comparison results analysis

III. RESULTS AND DISCUSSION

A. Results

1) Raw Water Sample Testing Results: Raw water samples are native water directly taken in the Cenrana River. Some of this water is directly tested in the laboratory as sample 1, and the other part is made into a sample to be purified with a simple purifier that has been modified. The results of sample 1 testing conducted at the Makassar Health Laboratory Center can be presented as follows:

TABLE II
EST RESULTS FOR SAMPLE 1 (UNREFINED RAW WATER) REQUIRED PARAMETER

No.	Types of parameters	Allowed maximum levels	Laboratory test results
1.	**Parameters directly related to health:**		
	a. Microbiological parameters (ml):		
	1) E-Coli	0	420
	2) Total coliform bacteria	0	20.050
	b. Inorganic chemistry (Mg/l):		
	1) Arsenic (As)	0.01	<0.01
	2) Fluoride (F)	1.5	0.7
	3) Chromium (Cr)	0.05	0.01
	4) Cadmium (Cd)	0.003	<0.003
	5) Nitrite (No_2)	3	0.226
	6) Nitrate (No_3)	50	1.16
	7) Cyanide (CN)	0.07	<0.01
	8) Selenium (Se)	0.01	<0.01
2	**Parameters that are not directly related to health**		
	a. Physical Parameters:		
	1) Odors	Odorless	Odorless
	2) Color	15 TCU	25 TCU
	3) Dissolved Solid	500 Mg/l	220 Mg/l
	4) Turbidity	5 NTU	174 NTU
	5) Taste	Tasteless	Tasteless
	6) Temperature	± 3 °C	2 °C

No.	Types of parameters	Allowed maximum levels	Laboratory test results
	b. Chemical Parameters (Mg/l):		
	1) Aluminum (Al)	0.2	<0.05
	2) Iron (Fe)	0.3	<0.01
	3) Hardness ($CaCo_3$)	500	144
	4) Chloride (Cl)	250	18.10
	5) Manganese (Mn)	0.4	<0.01
	6) pH	6.5 – 8.5	7.5
	7) Zinc (Zn)	3	<0.01
	8) Sulfate (SO_4)	250	15.51
	9) Copper (Cu)	2	<0.01
	10) Ammonia as N	1.5	0.18

Based on the results of testing in the laboratory of raw water at the study site, namely, water taken directly into the river without going through treatment, it is evident that four indicators do not qualify as drinkable water, namely: 1) E-Coli which should be = 0/100 ml, the test results prove the content = 420/100 ml this content is very high. 2) total coliform bacteria should be 0/100 ml. Test results = 2050/100 ml (very high). 3) Color, standard <15 TCU, test results = 25 TCU. 4) Turbidity, standard <5 NTU, test results = 174 NTU. The laboratory test results prove that the Walanae River's raw water is unsuitable for drinking before purification. Therefore, it is highly recommended that the surrounding communities who rely on the Walanae River water as a basis of consumption water should only be careful and thoroughly clean this water prior to its utilization as drinking water.

2) Test results for purified water samples: Modification of water purifier assembled in the Faculty of Engineering, UNM material testing laboratory. After the device is complete, the water samples taken in the Cenrana River below to the faculty of Engineering, UNM material test laboratory are filtered with a modified water purifier. Then, the results are brought to the Makassar Medical Laboratory Center as sample 2. The results of sample 2 testing can be presented as follows:

TABLE III
TEST RESULTS OF SAMPLE 2 (PURIFIED WATER) REQUIRED PARAMETER

No.	Types of parameters	Allowed Maximum Concerns	Laboratory test results
1	**Parameters directly related to health:**		
	a. Microbiological parameters (ml):		
	1) E-Coli	0	0
	2) Total coliform bacteria	0	201
	b. Inorganic chemistry (Mg/l):		
	1) Arsenic (As)	0.01	<0.01
	2) Fluoride (F)	1.5	<0.05
	3) Chromium (Cr)	0.05	<0.01
	4) Cadmium (Cd)	0.003	<0.003
	5) Nitrite (No_2)	3	0.034
	6) Nitrate (No_3)	50	0.39
	7) Cyanide (CN)	0.07	<0.02
	8) Selenium (Se)	0.01	<0.01
2	**Parameters that are not directly related to health**:		
	a. Physical Parameters:		
	1) Odors	Odorless	Odorless
	2) Color	15 TCU	10 TCU
	3) Dissolved Solid	500 Mg/l	156 Mg/l
	4) Turbidity	5 NTU	3.23 NTU
	5) Taste	Tasteless	Tasteless
	6) Temperature	± 3 °C	2 °C
	b. Chemical Parameters (Mg/l):		
	1) Aluminum (Al)	0.2	<0.05
	2) Iron (Fe)	0.3	<0.17
	3) Hardness ($CaCo_3$)	500	123.48
	4) Chloride (Cl)	250	1.19
	5) Manganese (Mn)	0.4	0.15
	6) pH	6.5 – 8.5	6.8
	7) Zinc (Zn)	3	<0.01
	8) Sulfate (SO_4)	250	15.541
	9) Copper (Cu)	2	<0.01
	10) Ammonia as N	1.5	0.291

After there is treatment, that is, making simple and affordable water purification equipment for the surrounding community, especially low-income people, the water that has been cleaned is tested in a laboratory. The results meet almost all indicators of clean water requirements, and only one indicator has not been fulfilled, namely the content of *E-Coli* which should be = 0/100 ml, the test results prove the content = 201/100 ml. This has not met the standards of the Ministry of Health of the Republic of Indonesia [23]. But it has fulfilled the South Sulawesi governor's Regulation concerning water quality standards (river water), namely: *MPN Coliform*/100 ml <10,000/100 ml (Maximum) and *MPN E.coli*/100 ml <2000/100 ml (Maximum) [33]. The laboratory test results = *MPN* 201/100 ml <2000/100 ml so the purified water is safe for drinking water but must be cooked until it boils with a minimum temperature of 100 C. The results of this test can be compared with the tests conducted by Lullulangi and Armiwaty [34]), as presented in Table 4.

TABLE IV
TEST RESULTS FOR WATER SAMPLES IN 2018 AND 2019 (PURIFIED WATER)

No.	Types of parameters	Allowed Maximum Concerns	Laboratory test results	
			2018	2019
1	**Parameters directly related to health:**			
	a. Microbiological parameters (ml):			
	1) E-Coli	0	10	0
	2) Total coliform bacteria	0	5794	201
	b. Inorganic chemistry (Mg/l):			
	1) Arsenic (As)	0.01	<0.01	<0.01
	2) Fluoride (F)	1.5	<0.23	<0.05
	3) Chromium (Cr)	0.05	<0.01	<0.01
	4) Cadmium (Cd)	0.003	<0.003	<0.003
	5) Nitrite (No2)	3	0.017	0.034
	6) Nitrate (No3)	50	0.01	0.39
	7) Cyanide (CN)	0.07	<0.01	<0.02
	8) Selenium (Se)	0.01	<0.01	<0.01
	Parameters that are not directly related to health:			
	a. Physical Parameters			
	1) Odors	Odorless	Odorless	Odorless
	2) Color	15	10	10 TCU
	3) Dissolved Solid)	500 Mg/l	152 Mg/l	156 Mg/l
	4) Turbidity	5 NTU	5.67 NTU	3.23 NTU
	5) Rasa / Taste	Tasteless	Tasteless	Tasteless
	6) Temperature	± 3 °C	2 °C	2 °C
	b. Chemical Parameters (Mg/l):			
	1) Aluminum (Al)	0.2	<0.05	<0.05
	2) Iron (Fe)	0.3	<0.01	<0.17
	3) Hardness (CaCo3)	500	122	123.48
	4) Chloride (Cl)	250	4.57	1.19
	5) Manganese (Mn)	0.4	0.01	0.15
	6) pH	6.5 – 8.5	7.46	6.8
	7) Zinc (Zn)	3	<0.01	<0.01
	8) Sulfate (SO4)	250	14.39	15.54
	9) Copper (Cu)	2	<0.01	<0.01
	10) Ammonia as N	1.5	0.05	0.29

Source: [34] and Research Results

The data presented in Table 4 are the results of 2018 laboratory tests conducted by researchers, juxtaposed with the results of 2019, as well as the maximum allowable levels based on required restrictions that must be met as a requirement for healthy drinking water.

B. Discussion

Several parameters tend to increase when comparing the results of laboratory tests in 2018 with 2019. However, the water filtration carried out in 2018 was only one time, compared with the results of testing in 2019, which went through two filters. Logically, testing in 2019 should be better because it went through filtering twice, but some parameters have gone up, even though it has not exceeded the maximum allowed level. Examples are No2 content from 0.017 to 0.034, No3 from 0.01 to 0.39, CN from 0.01 to 0.02, dissolved solids from 152 to 156, Fe from 0.01 to 0.17, $CaCo_3$ from 122 to 123.48, Mn from 0.01 to 0.15, SO_4 from 14.39 to 15.54, and Ammonia from 0.05 to 0.29. Increasing some of these parameters shows that raw water in the Cenrana River is increasingly polluted. In addition to comparing the results of tests conducted last year and this year's research, the results of this study can also be compared to Ranijintan et al. [35], specifically the coliform content in which the results of their research, the coliform content averaged 6600/100 ml in 5 years has increased to 20,050 / ml.

Several comparative indicators of laboratory test results that have been stated above give an unmistakable finding that pollution in the Walanae River is increasing yearly, making it increasingly unsafe to use as drinking water if not through the cleaning process first. This is supported by the opinion of Hartono [36], who said that the increase in surface water pollution has been very high compared to when the regional drinking water company (*Perusahaan Daerah Air*

Minum/PDAM) was built 30 or 40 years ago with the existing water quality conditions at that time. For this reason, socialization needs to be further improved so that the community and industry do not dispose of liquid waste or garbage into surface water. Based on the results of this study, the Wajo Regency Government should consider building a clean water purification plant for the needs of community members, especially those living along the Walanae River Basin.

The research findings indicate that raw water, which serves as a drinking water source, is becoming increasingly polluted each year [16], [37], [38]. It is observed that the raw water meets the drinking water standards set by the Ministry of Health of the Republic of Indonesia and the Governor of South Sulawesi Province. The South Sulawesi governor's Regulation pertains to the criteria for water quality standards (specifically river water) following the purification process using a basic water purification model, such as the prototype instrument analyzed in this study. Therefore, it is crucial to examine the adoption of basic water purification methods to enhance water quality and guarantee compliance with the necessary criteria for drinking water [39]–[44].

IV. Conclusion

The condition of raw water from the Walanae River as a source of drinking water for the Walanae Walanae watershed Wajo Regency is getting polluted year by year, meaning that environmental pollution is sound upstream and around Lake Tempe continue. Raw water from the Walanae river can meet drinking water constraints by the regulation of the Ministry of Health of the Republic of Indonesia and Governor of South Sulawesi province. The South Sulawesi governor's Regulation requirements concern water quality standards (river water) after being purified by a simple water purification model, such as the prototype instrument examined in this study.

The research implications of this study are that the Cenrana River, a potential source of drinking water for communities in the area, is becoming increasingly polluted. The study also found that a simple water purification model can effectively improve the river water quality to meet the drinking water requirements set by the Ministry of Health of the Republic of Indonesia and the Governor of South Sulawesi province. Therefore, the study suggests that communities relying on Cenrana River water for drinking purposes should consider implementing simple water purification models to improve the water quality and ensure that it meets the required standards for safe drinking water.

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References

[1] H. A. Hasan and M. H. Muhammad, "A review of biological drinking water treatment technologies for contaminants removal from polluted water resources," *J. Water Process Eng.*, vol. 33, p. 101035, 2020.

[2] M. A. Alim, A. Rahman, Z. Tao, B. Samali, M. M. Khan, and S. Shirin, "Suitability of roof harvested rainwater for potential potable water production: A scoping review," *J. Clean. Prod.*, vol. 248, p. 119226, 2020.

[3] T. Ladi, A. Mahmoudpour, and A. Sharifi, "Assessing impacts of the water poverty index components on the human development index in Iran," *Habitat Int.*, vol. 113, p. 102375, 2021.

[4] N. V. Suseno and M. Widyastuti, "Analisis Kualitas Air PDAM Tirta Manggar Kota Balikpapan," *J. Bumi Indones.*, vol. 6, no. 1, 2017.

[5] C. Asdak, *Hidrologi dan pengelolaan daerah aliran sungai*. UGM Press, 2023.

[6] M. Bilal, I. Ihsanullah, M. Younas, and M. U. H. Shah, "Recent advances in applications of low-cost adsorbents for the removal of heavy metals from water: A critical review," *Sep. Purif. Technol.*, vol. 278, p. 119510, 2021.

[7] R. Saxena, M. Saxena, and A. Lochab, "Recent progress in nanomaterials for adsorptive removal of organic contaminants from wastewater," *ChemistrySelect*, vol. 5, no. 1, pp. 335–353, 2020.

[8] H. Gusril, "Studi kualitas air minum PDAM di Kota Duri Riau," *J. Geogr.*, vol. 8, no. 2, pp. 190–196, 2016.

[9] A. A. Ansari, M. Naeem, S. S. Gill, and F. M. AlZuaibr, "Phytoremediation of contaminated waters: An eco-friendly technology based on aquatic macrophytes application," *Egypt. J. Aquat. Res.*, vol. 46, no. 4, pp. 371–376, 2020.

[10] M. A. Hassaan and A. El Nemr, "Pesticides pollution: Classifications, human health impact, extraction and treatment techniques," *Egypt. J. Aquat. Res.*, vol. 46, no. 3, pp. 207–220, 2020.

[11] R. R. Karri, G. Ravindran, and M. H. Dehghani, "Wastewater—sources, toxicity, and their consequences to human health," in *Soft computing techniques in solid waste and wastewater management*, Elsevier, 2021, pp. 3–33.

[12] B. S. Rathi, P. S. Kumar, and D.-V. N. Vo, "Critical review on hazardous pollutants in water environment: Occurrence, monitoring, fate, removal technologies and risk assessment," *Sci. Total Environ.*, vol. 797, p. 149134, 2021.

[13] N. Mushtaq, D. V. Singh, R. A. Bhat, M. A. Dervash, and O. bin Hameed, "Freshwater contamination: sources and hazards to aquatic biota," *Fresh water Pollut. Dyn. Remediat.*, pp. 27–50, 2020.

[14] P. Chowdhary, R. N. Bharagava, S. Mishra, and N. Khan, "Role of industries in water scarcity and its adverse effects on environment and human health," *Environ. Concerns Sustain. Dev. Vol. 1 Air, Water Energy Resour.*, pp. 235–256, 2020.

[15] S. Madhav *et al.*, "Water pollutants: sources and impact on the environment and human health," *Sensors water Pollut. Monit. Role Mater.*, pp. 43–62, 2020.

[16] J. Singh, P. Yadav, A. K. Pal, and V. Mishra, "Water pollutants: Origin and status," *Sensors water Pollut. Monit. Role Mater.*, pp. 5–20, 2020.

[17] F. R. Spellman, *The science of water: concepts and applications*. CRC press, 2020.

[18] L. Li, S. Rong, R. Wang, and S. Yu, "Recent advances in artificial intelligence and machine learning for nonlinear relationship analysis and process control in drinking water treatment: A review," *Chem. Eng. J.*, vol. 405, p. 126673, 2021.

[19] X. Xu *et al.*, "EEM–PARAFAC characterization of dissolved organic matter and its relationship with disinfection by-products formation potential in drinking water sources of northeastern China," *Sci. Total Environ.*, vol. 774, p. 145297, 2021.

[20] D. Wu, H. Wang, and R. Seidu, "Smart data driven quality prediction for urban water source management," *Futur. Gener. Comput. Syst.*, vol. 107, pp. 418–432, 2020.

[21] A. Perez-Vidal, J. C. Escobar-Rivera, and P. Torres-Lozada, "Development and implementation of a water-safety plan for drinking-water supply system of Cali, Colombia," *Int. J. Hyg. Environ. Health*, vol. 224, p. 113422, 2020.

[22] A. Gomiero, K. B. Øysæd, L. Palmas, and G. Skogerbø, "Application of GCMS-pyrolysis to estimate the levels of microplastics in a drinking water supply system," *J. Hazard. Mater.*, vol. 416, p. 125708, 2021.

[23] Permenkes RI, "Peraturan Menteri Kesehatan Republik Indonesia Nomor 492/Menkes/Per/IV/2010 Tentang Persyaratan Kualitas Air Minum," *Peraturan Mentri Kesehatan Republik Indonesia*. p. MENKES, 2010.

[24] M. J. Paul, S. D. LeDuc, M. G. Lassiter, L. C. Moorhead, P. D. Noyes, and S. G. Leibowitz, "Wildfire induces changes in receiving waters: A review with considerations for water quality management," *Water Resour. Res.*, vol. 58, no. 9, p. e2021WR030699, 2022.

[25] J. L. Banach and H. J. Van Der Fels-Klerx, "Microbiological reduction strategies of irrigation water for fresh produce," *J. Food Prot.*, vol. 83, no. 6, pp. 1072–1087, 2020.

[26] F. M. Schets, H. H. J. L. van den Berg, G. Lynch, S. de Rijk, A. M. de Roda Husman, and J. F. Schijven, "Evaluation of water quality guidelines for public swimming ponds," *Environ. Int.*, vol. 137, p. 105516, 2020.

[27] N. Gillings *et al.*, "Guideline on current good radiopharmacy practice (cGRPP) for the small-scale preparation of radiopharmaceuticals," *EJNMMI Radiopharm. Chem.*, vol. 6, no. 1, pp. 1–22, 2021.

[28] N. H. H. Hairom *et al.*, "A review of nanotechnological applications to detect and control surface water pollution," *Environ. Technol. Innov.*, vol. 24, p. 102032, 2021.

[29] W. H. Organization, *Guidelines for drinking-water quality: incorporating the first and second addenda*. World Health Organization, 2022.

[30] O. Bozorg-Haddad, M. Delpasand, and H. A. Loáiciga, "Water quality, hygiene, and health," in *Economical, Political, and Social Issues in Water Resources*, Elsevier, 2021, pp. 217–257.

[31] D. N. Anggraini, "3 Kriteria Air Minum yang Sehat," PT Medika Komunika Teknologi. [Online]. Available: https://www.klikdokter.com/gaya-hidup/diet-nutrisi/3-kriteria-air-minum-yang-sehat

[32] S. McCombes, "Descriptive Research: Definition, Types, Methods & Examples." Accessed: Feb. 04, 2024. [Online]. Available: https://www.scribbr.com/methodology/descriptive-research/

[33] Gubernur Sulawesi Selatan, "Peraturan Gubernur Sulawesi Selatan Nomor 6 Tahun 2016 tentang Penetapan Kelas Air Sungai Segeri di Provinsi Sulawesi Selatan," *Analisis Nilai Moral Dalam Cerita Pendek Pada Majalah Bobo Edisi Januari Sampai Desember 2015*. 2016.

[34] M. Lullulangi and A. Armiwaty, "Upaya peningkatan kesehatan diri dan lingkungan pada masyarakat pinggiran Sungai Cenrana," 2018.

[35] R. P. Ranijintan, A. M. F. Hayat, and S. Raodhah, "Kualitas Air Sungai Walannae di Dusun Kampiri Desa Pallawarukka Kecamatan Pammana Kabupaten Wajo," *Hig. J. Kesehat. Lingkung.*, vol. 2, no. 1, pp. 15–20, 2016.

[36] D. M. Hartono, "Sistem Penyediaan Air Minum dan Permasalahannya," in *Co Creation World Water Day*, 2014. [Online]. Available: https://www.researchgate.net/publication/280082419_Sistem_Air_Minum_dan_Permasalahannya

[37] A. Hojjati-Najafabadi, M. Mansoorianfar, T. Liang, K. Shahin, and H. Karimi-Maleh, "A review on magnetic sensors for monitoring of hazardous pollutants in water resources," *Sci. Total Environ.*, vol. 824, p. 153844, 2022.

[38] E. Craswell, "Fertilizers and nitrate pollution of surface and ground water: an increasingly pervasive global problem," *SN Appl. Sci.*, vol. 3, no. 4, p. 518, 2021.

[39] V. Rodriguez-Merchan, C. Ulloa-Tesser, C. Baeza, and Y. Casas-Ledón, "Evaluation of the Water–Energy nexus in the treatment of urban drinking water in Chile through exergy and environmental indicators," *J. Clean. Prod.*, vol. 317, p. 128494, 2021.

[40] P. Jarvis and J. Fawell, "Lead in drinking water–an ongoing public health concern?," *Curr. Opin. Environ. Sci. Heal.*, vol. 20, p. 100239, 2021.

[41] J. Favere, R. G. Barbosa, T. Sleutels, W. Verstraete, B. De Gusseme, and N. Boon, "Safeguarding the microbial water quality from source to tap," *NPJ Clean Water*, vol. 4, no. 1, p. 28, 2021.

[42] K. N. Palansooriya *et al.*, "Occurrence of contaminants in drinking water sources and the potential of biochar for water quality improvement: A review," *Crit. Rev. Environ. Sci. Technol.*, vol. 50, no. 6, pp. 549–611, 2020.

[43] V. R. Moreira, Y. A. R. Lebron, L. V. de Souza Santos, and M. C. S. Amaral, "Dead-end ultrafiltration as a cost-effective strategy for improving arsenic removal from high turbidity waters in conventional drinking water facilities," *Chem. Eng. J.*, vol. 417, p. 128132, 2021.

[44] J. Lugo-Arias, J. Burgos-Vergara, E. Lugo-Arias, A. Gould, and D. Ovallos-Gazabon, "Evaluation of low-cost alternatives for water purification in the stilt house villages of Santa Marta's Ciénaga Grande," *Heliyon*, vol. 6, no. 1, 2020.