Pol. J. Environ. Stud. Vol. XX, No. X (XXXX), 1-10
DOI: 10.15244/pjoes/192043 ONLINE PUBLICATION DATE:

Original Research

Clean Water Utilization and Threat to the Availability of Quality Well Water in Slum Areas

Edi Rusdiyanto[1]*, Abdillah Munawir[2]

[1]Universitas Terbuka, Indonesia, Street Cabe Raya, Pondok Cabe, South Tangerang, Banten Province, Indonesia
[2]Institut of Technology Bandung, West Java, Indonesia

Received: 10 October 2023
Accepted: 5 August 2024

Abstract

Based on the many studies related to the importance of clean water needs, the condition of clean water is increasingly becoming a serious problem and management needs to be minimized, especially in guaranteeing the lives of the population and for the sake of sustainable use of clean water. This study aims to analyze the quality of physics and organic-inorganic chemistry, and analyze the number of total coliform bacteria and Escherichia coli in well water in the densely populated slum residential. The research data was obtained by observing and conducting laboratory analysis in three slums in the city of Bandung, namely Kampong Pelangi, Kampong Cimaung, and Kampong Middle Mengger referring to the environmental quality standard threshold values based on Minister of Health Regulation Number 32 2017. Results The study showed that the quality of well water in slum areas for parameters of physics and organic-inorganic chemistry was not heavily polluted because it did not exceed the required environmental quality standards. The opposite results in the actual condition of water quality classified as heavily polluted are shown in microbiological parameters that have exceeded the quality standards, namely total coliform of 2400 APM/100 mL, and Escherecia Coli of 2-17 APM/100 mL. The parameter for increasing the maximum threshold for the condition of the quality of water in residential wells is due to the lack of order in settlement development and the layout of the distance between septic tanks adjacent to the location of well water accompanied by waste disposal from settlements. From the results of the Pollution Index (IP), it can be concluded that the status of consumptive water quality is 2 Parts which are categorized as Light Polluted, and 1 Part is categorized as Meets Quality Standards. The middle section of consumptive well water with the category of meeting quality standards. Meanwhile, the upper and lower sections are categorized as lightly polluted.

Keywords: clean water, settlements, total Coliform, Escherichia coli

Introduction

Population growth in an area will result in an increase in space requirements for residents. This phenomenon will increase the area of settlements and utilization of natural resources [1, 2]. These conditions affect an important part of life and have a big role in

* e-mail: edirus.ut@gmail.com, edi@ecampus.ut.ac.id

Fig 1. Study Area Map in Settlement Area in Bandung City, Indonesia.

the sustainability of life, especially the availability of water sources [3, 4]. Humans and other living things that do not live in water, are always looking for places to live near water so that it is easy to take water for their living needs [5, 6]. Water is a basic need for life, especially for humans who have always needed water throughout their lives [7, 8]. Globally, in terms of volume, groundwater has a greater capacity compared to surface water volumes such as lakes and rivers [9]. Not only that, the different volumes of earth's water and its limited capacity in an area make the management of earth's water pay attention to the principles of existing water balance [10, 11].

Clean water is one of the basic needs needed in life [12]. Almost every activity carried out by the community requires clean water, from drinking, bathing, cooking, washing, and other activities [13-15]. The importance of water in this life makes the need for clean water and its availability must be considered [16]. When discussing water availability, it is necessary to know the calculation of the need for clean water for each person so that they can calculate the amount of clean water needed [17]. According to [18], water is divided into four groups, namely water that is used for drinking water directly (without having to be processed first), raw water that is processed as drinking water and household needs, water for fisheries and animal husbandry purposes, and water for agricultural purposes as well as urban business, industry, and power generation. This opinion is in line with [19] which states "If a confined aquifer is taken for water freely (irregularly) it causes the condition of the aquifer to change from saturated to unsaturated so that the characteristics of the aquifer will change and will not return to normal, even though This water-unsaturated condition is returned to a water-saturated condition. Therefore, the role of groundwater in the water resources management system by looking at its quality is very important [20, 21].

Clean water research in Rokan Hilir Riau by comparing well water quality parameters, especially degree of acidity (pH), biochemical oxygen demand (BOD), and chemical oxygen demand (COD) parameters, which shows that groundwater conditions are experiencing serious problems due to increased wastewater pollution [22], in line with the results of research by [23] which states that the impact of polluted

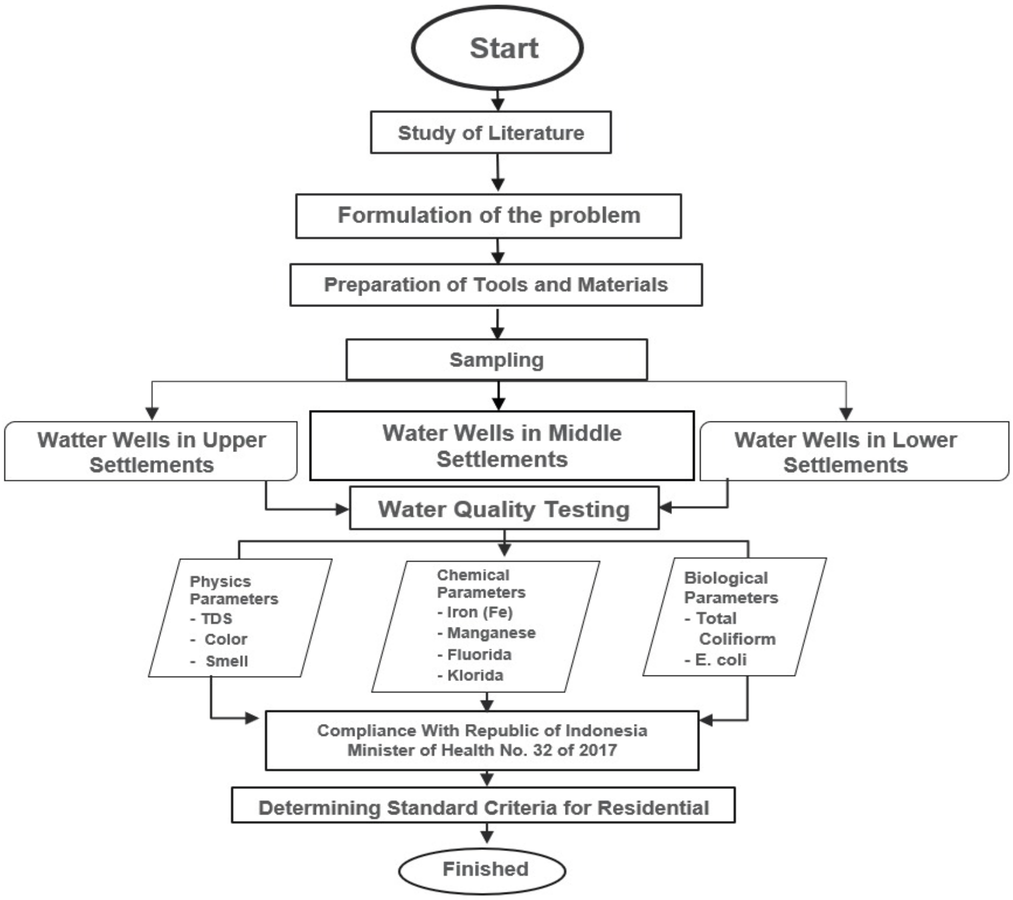

Fig 2. Research Flowchart.

well water is caused by increasing population activity and lack of control due to pollution so it is important to use activated carbon to improve the quality of well water contaminated with wastewater contamination, and groundwater management in the Bangka Belitung Regency area which is difficult for the community to obtain can be replaced with groundwater management techniques using reservoir techniques [24]. Based on the many studies related to the importance of clean water needs, the condition of clean water is increasingly becoming a serious problem and management needs to be minimized, especially in guaranteeing the lives of the population and for the sake of sustainable use of clean water, reviewing several studies on clean water in Indonesia, no one has conducted research related to the distribution of quality. Clean water wells in slum settlements, the results of this study aim to be able to answer problems regarding the potential quality of well water and the efficiency of production wells so that it does not have a serious impact on the use of water for consumption by residents in the slum area of Bandung City. This study aims to estimate the value and distribution index of the quality of well water for residents in the slum area of Bandung City, West Java Province, Indonesia.

Materials and Methods

Sampling of well water, data collection, and analysis was carried out from January to May 2019 around the residential area of Bandung City. Water sampling was carried out at 3 location points that entered densely-slum residential areas, namely Kampong Pelangi (The Upper Dago Village), Kampong Cimaung (The Middle Tamansari Village), and Kampong Middle Mengger (The Lower Mengger Village), as shown in Fig 1.

Primary data was obtained by measuring and calculating the number of well water samples in settlements around the densely populated slum area of Bandung City, West Java Province, Indonesia. Secondary data was obtained from related literature and agencies such as the Bandung City Environmental Service and Government Regulation (PP) No. 82 of 2001 and conformity with PERMENKES Becomes Republic of Indonesia Minister of Health Number 32 of 2017. The research data was obtained by observing and taking water samples with the research stages presented in Fig 2. Laboratory results data were then compared with existing quality standards and given a category for each location with an assessment of environmental quality service.

Sampling of well water at the study site using plastic bottles. For total suspended solid (TSS) parameters,

Table 1. Reference of physico-chemical and biological parameters of well water quality.

No	Parameter	Unit	Methods/Tools used
1	Smell	-	Organoleptic
2	TDS	mg/L	SNI 06-6989.27:2005
3	Color	PtCo	SNI 06-6989.24:2005
4	Besi (Fe)	mg/L	SNI 06-6989.4:2009
5	Fluorida	mg/L	SNI 6989.29:2005
6	$CaCO_3$ Hardness	mg/L	SNI 06-6989.13:2004
7	Klorida	mg/L	SNI 06—6989.19:2009
8	Manganese	mg/L	SNI 06—6989.5:2009
9	Nitrate as N	mg/L	Spektrofotometri
10	Nitrite as N	mg/L	SNI 06—6989.9:2004
9	Detergent	mg/L	SNI 06-2476:1991
10	Total coliform	APM/100 mL	SNI 01-2897:1992
11	Escherecia coli	APM/100 mL	SNI 01-2897:1992

Table 2. Analysis of Pollution Index.

No	Pollution Index Score	Description
1	0 -1,0	Good
2	1,1 – 5,0	Lightly blackened
3	5,1 - 10	Medium blackened
4	>10	Heavy Polluted

Source: State Decree for the Environment No 115 2013

color, and odor or odor, use a 1 liter plastic bottle which is then tightly closed and then put in an ice box so that the water temperature is maintained so it doesn't damage or change the quality of the two parameters. Furthermore, water sampling for levels of iron, fluoride, chloride and manganese used a 300 mL Winkler bottle. Measurement of well water quality uses the clean water quality standards of the Republic of Indonesia Minister of Health No. 32 of 2017. The water quality parameters are limited to the main parameters of clean water quality related to pollutant sources around residential well water, namely odor, TDS, color, iron, chloride, manganese, nitrate as N, total coliform and Escherichia coli. Methods/tools for measuring water quality can be seen in Table 1.

The water sample analysis method was carried out based on the analytical procedures of the Indonesian National Standard (SNI) on water and wastewater which refers to the Standard Methods for the Examination of Water and Wastewater [25]. As a reference in analyzing laboratory results of well water in settlements around densely populated slums in Bandung City, West Java Province, class I water quality standards are used. This is because well water in densely populated slum suburbs is one of the sources of raw water used by residents. The next analytical method is pollution index analysis, with equations [26, 27]:

$$IP_j = \sqrt{\frac{\left(C_i/L_{ij}\right)_M^2 + \left(C_i/L_{ij}\right)_R^2}{2}}$$

Where :

IPj = Pollution Index for designation

Ci = Concentration parameter test results

Lij = Parameter concentration according to quality standard for water designation j

$(Ci/Lij)_M$ = Maximum Ci/Lij value

$(Ci/Lij)_R$ = Average Ci/Lij values

Results and Discussion

Potential Need for Clean Water (Physics, Organic Chemistry and Inorganic)

Sampling of well water and laboratory analysis of consumptive well water quality in densely populated slum settlements in Bandung City was carried out from January to March 2019. The results of water quality analysis of wells in riverside settlements are as follows:

Total Dissolve Solid (TDS) and Color of Residential Well Water Quality

Total dissolve solid (TDS) is the amount of dissolved solids. Dissolved solids are solids due to waste disposal, so that the analysis of dissolved solids is a continuation of suspended solids [28, 29]. The color in water can be caused by the presence of organic and inorganic materials, due to the presence of plankton, humus and metal ions and other materials [30, 31]. TDS results and the color of residential well water in the upper part of the densely inhabited slum area of Bandung City in Kampong Pelangi settlement (Dago Village) shows a TDS content of around 265 mg/L with a color value of 2 PtCo, in the central part of Kampong Cimaung settlement (Taman Sari Village) TDS content ranged from 175 mg/L with a color value of 4 PtCo and different results were produced in the settlement area of Kampong Mengger Tengah (Mengger Village) with a dissolved solids value of 293 mg/L with a color value of 9. TDS and color values were based on laboratory tests. Respectively, each sample on average is below the environmental quality standards stipulated in Government Regulation Number 82 of 2001 which corresponds to environmental health quality standards for drinking water media for sanitary hygienic purposes

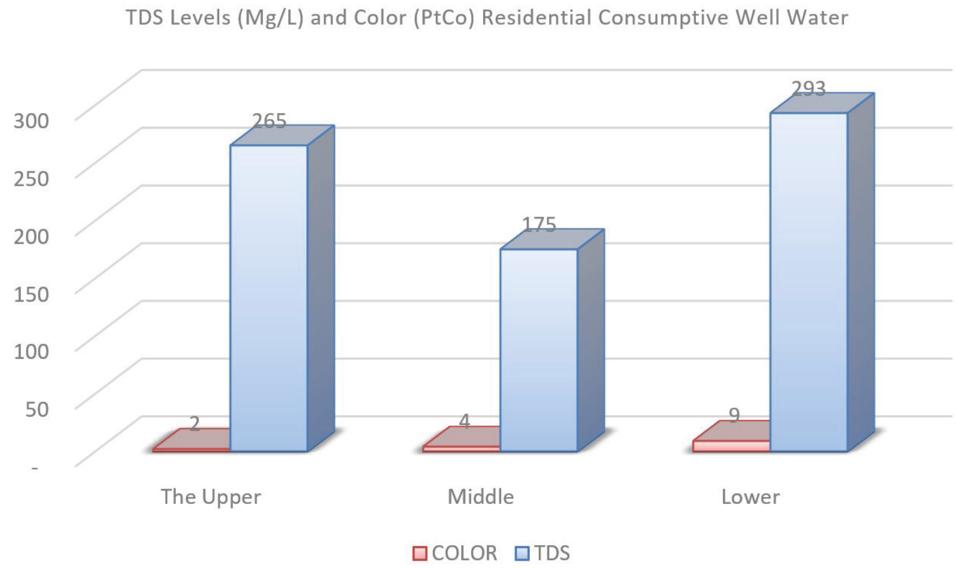

Fig. 3. Graph of TDS Concentration and Color in Residential Well Water.

based on Minister of Health Regulation Number 32 of 2017 which both require a threshold the quality standard limit is 1000 mg/L (TDS) and 50 PtCo (color). This is very important in the management of residential well water, which contains high levels of dissolved solids that need to be treated first so that it is safely discharged into public waters. The results of TDS and color measurements in residential well water samples are presented in Fig. 3.

The high TDS levels at the top and bottom are due to the location of the dug well, which is < 1 meter from the septic tank and ditch. Ditch water around the dug wells comes from residents' domestic activity waste water (gray water). The location of the ditch ≤ 25 meters will affect the TDS condition of the groundwater. This is because the water from the ditch contains organic, inorganic, sediment, and other solid waste materials dissolved in the water.

Organic and Inorganic Chemical Content of Residential Well Water

Iron, Manganese, Fluoride and Chloride

Based on the results of the overall measurement of the quality of consumptive well water in densely populated slums in Bandung City, the content of Iron, Manganese, Fluoride and Chloride has increased in value close to the maximum threshold for water quality standards required by the Minister of Health Regulation Number 32 of 2017. According to [32], the water quality of settlement wells which are sourced from groundwater carries residues from the ground, and what is important to note is that there are sources of pollution that can seep into groundwater.

The results of measuring the content of iron, fluoride, chloride and manganese in residential well water in the upper part of the densely inhabited slum area of Bandung City in the Kampong Pelangi settlement (Dago Village) showed an iron content of around 0.0285 mg/L, a fluoride value of 0.0198 mg/L, a Chloride value of 2 mg/L with a Manganese content of 0.03 mg/L, in the middle of Kampong Cimaung settlement (Tamansari Village) the iron content ranges from 0.0285 mg/L, a

Table 3. Content of iron, fluoride, chloride and manganese in residential well water.

Well Water Samples	Iron (Fe)	Fluoride	Chloride	Manganese
The Upper (Kampong Pelangi)	< LoD (0,0285)	< LoD (0,0198)	2	0,03
Middle (Kampong Cimau)	< LoD (0,0285)	0,31	30,46	0,34
Lower (Kampong Middle Mengger)	< LoD (0,0285)	0,23	33.27	0,03
Unit	mg/L	mg/L	mg/L	mg/L
Maksimum Limit	1	1,5	(-)	0,5

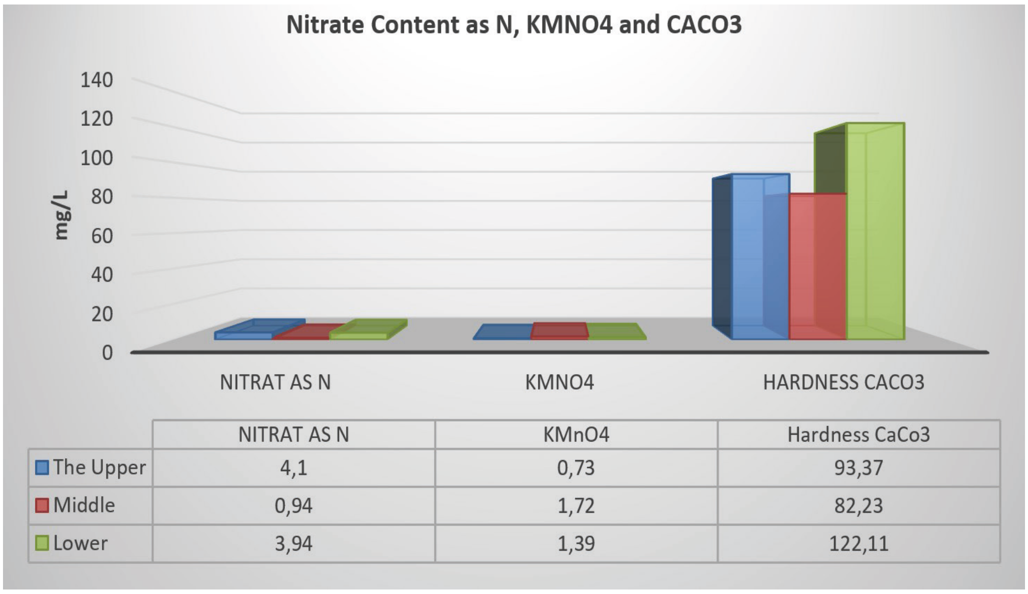

Fig 4. Nitrate content as N, organic matter ($KMnO_4$) and $CaCO_3$ hardness.

fluoride value of 0.31 mg/L, a chloride value of 30.46 mg/L and a manganese content of 0.34 mg/L and the results of laboratory measurements and calculations in the settlement area of Kampong Middle Mengger (Mengger Village) with a dissolved solids value of 0.0285 mg/L, a fluoride value of 0. 23 mg/L, chloride value of 33.27 mg/L and manganese content of 0.03 mg/L. Manganese concentrations in surface water rarely exceed 1.0 mg/L, but much higher concentrations can occur in groundwater under anaerobic conditions. WHO has set a manganese concentration value to be used as a guideline, which is 0.5 mg/L, while for health a lower level is recommended, namely 0.1 mg/L [33].

Nitrate as N, Organic Substance ($KMnO_4$) and $CaCO_3$

Nitrate is the main form of nitrogen in water and the main nutrient for plants and algae. According to [34] states that nitrate compounds are produced from the perfect oxidation process of nitrogen compounds in waters. The condition of increasing levels of organic matter ($KMnO_4$) and $CaCO_3$ in dug well water (groundwater) can be influenced by the condition of the well itself or the cleanliness of the environment around the well [35, 36]. In line with [37] revealed that sources of nitrate pollution in water generally come from industrial waste, septic tanks, animal waste, and water transportation waste, which greatly affect the health of the community's clean water consumption.

The results of laboratory measurements of Nitrate content as N, organic matter ($KMnO_4$) and $CaCO_3$ hardness of residential well water do not show an excess of the maximum threshold for consumptive water quality standards required by Minister of Health Regulation Number 32 of 2017 as shown in Fig. 4 which shows the upper part of the Cikapundung riverbank area in the Kampong Pelangi settlement (Dago Village) showed a Nitrate as N content of around 4.1 mg/L, the measurement results for the $KMnO_4$ value were 0.73 mg/L, and the content of the $CaCO_3$ hardness value was 93.37 mg/L, in the middle of the settlement Kampong Cimaung (Tamansari Village) the Nitrate content as N ranges from 0.94 mg/L, the measurement results for the $KMnO_4$ value are 1.72 mg/L, and the $CaCO_3$ hardness value is 82.23 mg/L. The results of laboratory measurements and calculations in the settlement area of Kampong Mengger Tengah (Mengger Village) with a value of Nitrate as N ranged from 3.94 mg/L, the measurement results for a $KMnO_4$ value of 1.93 mg/L, and a $CaCO_3$ hardness value of 122.11 mg/L.

Total Coliform Bacteria and Escherichia Coli

The results of measurements of total Coliform and Escherichia coli show that in the observation of residential consumptive well water, there is a tendency to increase due to domestic activities in the vicinity. According to [38] and [39], high Total Coliform counts can occur due to high contamination of pathogenic bacteria originating from the digestive tract of humans and animals and other pathogenic agents. The results of measurements of total coliform and Escherichia coli at the water well research location in Kampong Pelangi settlement (Dago Village), the central part of Kampong Cimaung settlement (Tamansari Village), and Kampong Mengger Tengah (Mengger Village), as shown in Fig. 5.

The results of laboratory analysis showed that the quality of well water in densely populated slum settlements in Bandung City contained total coliform and e. coli there is an increase in the value exceeding the maximum threshold for consumptive water quality standards required by the Minister of Health Regulation Number 32 of 2017. So the water conditions

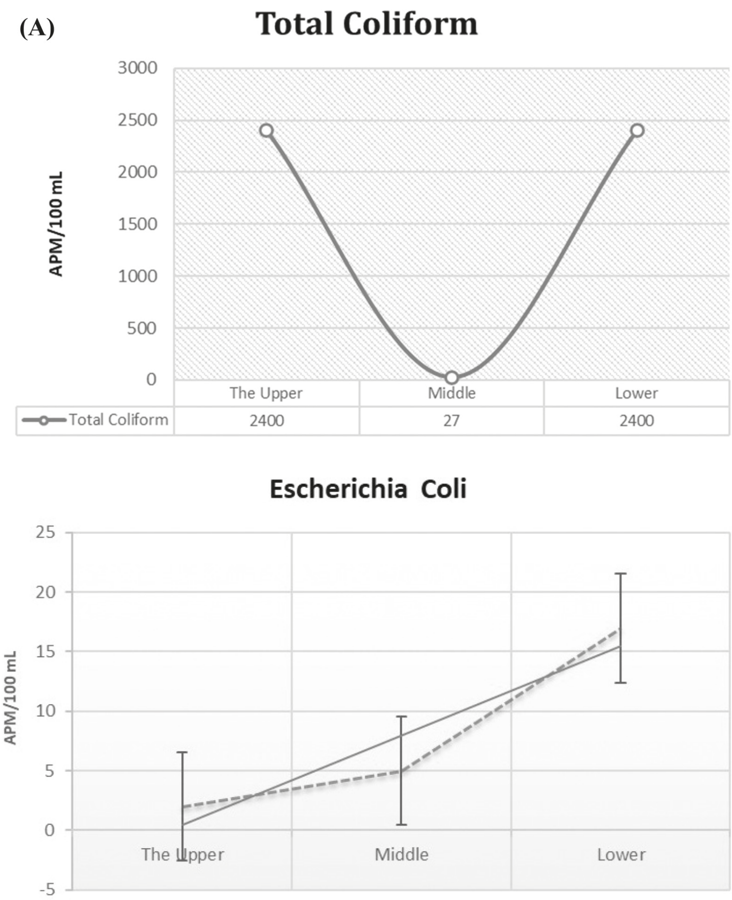

Fig 5. Total Coliform (A) and Escherichia Coli (B) Residential Consumptive Well Water.

of residential wells are based on the World Health Organization (WHO) guidelines, European Commission (EC) standards, and U.S. Environmental Protection Agency (USEPA) standards. For the quality of bacteria (Total Coliform and Escherichia coli), they must not be detected in water, especially when the capacity exceeds the environmental quality standard threshold for water. The general requirements for drinking water specify that total coliforms should not be detected in 100 mL samples, indicating the absence of coliform organisms and Escherichia coli bacteria [40, 41]. This is due to the high levels of waste disposal (septic tanks) in dug wells which are no more than 2-3 meters from the water sources of residential wells plus the lack of order and narrow distances between settlements [42].

Table 4. Summary of Pollution Index Results.

No	Consumptive Well Water	Pollution Index	Information
1	The Upper	2.187	Light Black
2	Middle	0.689	Good Condition
3	Lower	1.354	Light Black

Pollution Index

The Pollution Index Method is an index-based method built based on two quality indices. First, the average index (IR) shows the average pollution level of all parameters in 1 (one) observation. Second, the maximum index (IM) which shows one type of dominant parameter causes a decrease in water quality in one observation. The results of calculating the comparative value of the analysis results with the water quality standard values can be seen in Table 4.

Table 4 shows that the Groundwater Pollution Index (IPj) score around the densely populated slums of the City of Bandung at the top is 2.187, the middle is 0.689, and the bottom is 1.354. The Upper, Middle and Lower Sections have a total escherichia coli value of 2-5 APM/100ML but the IPj values obtained are 0.689-2.187 (1.1 – 5.0) so they are still in good condition and are lightly polluted. Based on Minister of Health Regulation Number 32 of 2017 concerning Water Quality Status, Pollution Index values with an IPj score of 0 – 1.0 are categorized as meeting the Quality Standards. This is because in the middle part there are no parameters that exceed the quality standards in the well water quality samples. At the top and bottom IPj values 1.1 – 5.0 are categorized as lightly polluted due to several factors, such as locations too close to septic tanks of

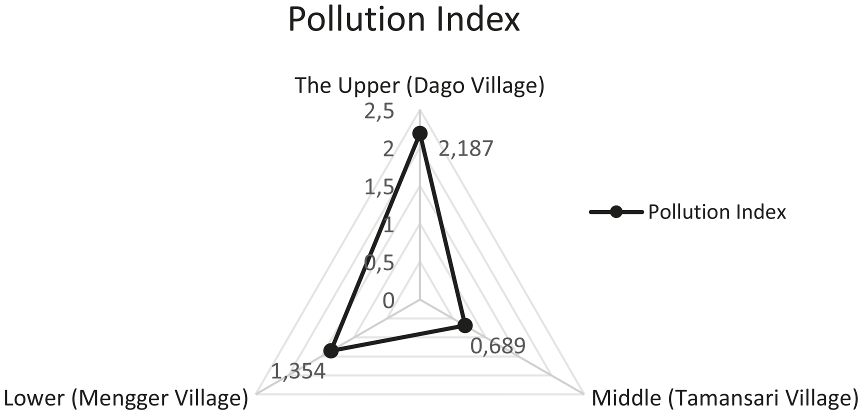

Fig 6. Residential Consumptive Well Water Pollution Index.

microorganisms in waters, household waste, industry, and waste management sites [43, 44].

Based on the results of the pollution index, the best steps are needed regarding the importance of using consumptive residential water, especially in minimizing the condition of water that is classified as lightly polluted in well water, by first carrying out processing techniques so that it is suitable for drinking water. Processing can be done physically or chemically (Fig. 6). Physical processing can be done by using certain filters to filter out polluted levels and suspensions in the water. However, physical processing requires quite expensive costs, such as filters that are widely traded [45]. Therefore, chemical processing can also be done, for example, the use of alum and capolrit. The use of coagulants is very easy and cheap [46]. So that it becomes the basis of environmental management [47, 48].

Conclusions

Residential well water quality in terms of physics, organic chemistry and an organic parameters does not show severe pollution because the polluted level does not exceed the maximum threshold for environmental quality standards required for environmental health quality standards for drinking water media for hygienic sanitation purposes based on Minister of Health Regulation Number 32 of 2017. Results On the contrary, the actual water quality of wells in densely populated slum settlements in Bandung City is classified as heavily polluted, indicated by microbiological parameters that have exceeded the quality standard, namely total coliform of 2400 APM/100 mL, and Escherecia Coli of 2-17 APM/100 mL. From the results of the Pollution Index (IP), it can be concluded that the status of consumptive water quality is 2 (two) Parts which are categorized as Light Polluted and 1 (one) Part is categorized as Meets Quality Standards. The middle section of consumptive well water with the category of meeting quality standards. Meanwhile, the upper and lower sections are categorized as lightly polluted.

Acknowledgements

The research was conducted in Bandung City, West Java Province, Indonesia, with the Open University research team. Thank you to residential communities and stakeholders around the research location for their participation in helping the research team in efforts to manage the environmental quality of community well water so that the results of this research can be completed on time.

Conflict of Interest

All the authors declare having no conflict of interest.

References

1. RUSDIYANTO E., SITORUS S.R.P., PRAMUDYA B., SOBANDI R. The Dynamic of Built Land Development in the Cikapundung Riverside Area, Bandung City, Indonesia. Journal of AES Bioflux, **12** (2), 146, **2020**.
2. MUNAWIR A., JUNE T., KUSMANA C., SETIAWAN Y. Dynamics factors that affect the land use change in the Lore Lindu National Park. Proceeding of SPIE 11372, Sixth Internasional Symposium on LAPAN-IPB Satelite. Bogor Indonesia, **2019**.
3. FOROUZANI M., EZATOLLAH K. Agricultural water poverty index and sustainability. Agronomy for Sustainable Development, **31**, 415, **2011**.
4. DE LIMA A.P.M., PRADO R.B., LATAWIEC A.E. Payment for Water-Ecosystem Services Monitoring in Brazil. Rev Ambient Água, 16, **2021**.
5. MEKONNEN M.M., HOEKSTRA A.Y. Four billion people facing severe water scarcity. Science Advances, **2** (2), **2016**.
6. JUNDE W., YANZHAO J., XIAOJUAN T. Study on Analysis of Risk for Rainwater Collection and Utilization for Rural Safe Drinking Water Project. IOP Conference

Series: Materials Science and Engineering, 780, 072040, **2020**.
7. UNICEF. Air, Sanitasi, Higiene, dan Pengelolaan Limbah yang Tepat Dalam Penanganan Wabah COVID-19. Pedoman Sementara WHO dan UNICEF. who-unicef-air-sanitasi-higiene-dan-pengelolaan-limbah-yang-tepat dalam-penanganan-wabah-covid-19.pdf (accessed March 19, 2020)
8. TODD. Groundwater Hydrology (2 ed.). Singapore: John Wiley & Sons inc, **1995**.
9. CAO S., XU D., LIU S. A study of the relationships between the characteristics of the village population structure and rural residential solid waste collection services: Evidence from China. International Journal of Environmental Research and Public Health, **15** (11), 1, **2018**.
10. KHANAL G., THAPA A., DEVKOTA N., PAUDEL U.R. A review on harvesting and harnessing rainwater: An alternative strategy to cope with drinking water scarcity. Water Supply, **20**, 2951, **2020**.
11. BASS D.A., MCFADDEN B.R., COSTANIGRO M., MESSER K.D. Implicit and explicit biases for recycled water and tap water. Water Resources Research, **58** (6), e2021WR030712, **2022**.
12. RUSDIYANTO E., SITORUS S.R.P., PRAMUDYA B., SOBANDI R. Assessment of the Actual Status of the Cikapundung River Waters in the Densely-Inhabited Slum Area, Bandung City. Journal of Ecological Engineering, **22** (11), 198, **2021.**
13. EFFENDI H. Study of Water Quality for Management of Aquatic Resources and Environment. Yogyakarta (ID): Kanisius Publishers (in Indonesian), **2003.**
14. FARDIAZ S. Water and Air Pollution. Yogyakarta (ID): Kanisius Publishers. (in Indonesian), **1992.**
15. FERGUSON B.C., FRANTZASKAKI N., BROWN R.R. A strategic program for transitioning to a water sensitive city. Landscape and Urban Planning, **117**, 32, **2013.**
16. WIJAYA I.M.W., SOEDJONO E.S. Domestic Wastewater In Indonesia: Challenge In The Future Related To nitrogen Content. Faculty of Civil Engineering, Environment, and Earth Science, Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia, Google Scholar, **15**, 32, **2018.**
17. SULISTYOWATI L., NURHASANAH N., RIANI E., CORDOVA M.R. Heavy metals concentration in the sediment of the aquaticenvironment caused by the leachate discharge from a landfill. Global Journal of Environmental Science and Management, **9** (2), 323, **2023.**
18. LUMAELA A.K., OTOK B.W., SUTIKNO S. Pemodelan Chemical Oxygen Deman (COD) Sungai di Surabaya dengan Metode Mixed Geographically Wighted Regression. Jurnal Sains dan Seni Pomits ITS, **2** (1), 100, **2013.**
19. MISSIMER T.M., GUO W., WOOLSCHLAGER J., MALIVA R.G. Long-Term Managed Aquifer Recharge in a Saline-Water Aquifer as a Critical Component of an Integrated Water Scheme in Southwestern Florida, USA. Journal Water, **9**, 774, **2017.**
20. SUTRISNO C.T., SUCIASTUTI E. Teknologi Penyediaan Air Bersih. Jakarta (ID), Rineka Cipta, **2002.**
21. MUNAWIR A., NURHASANAH N., RUSDIYANTO E., MUNA S.U.N. Kebijakan Pemanfaatan Hutan Mangrove Berkelanjutan dengan Teknik Interpretative Structural Modeling di Taman Nasional Rawa Aopa, Sulawesi Tenggara. Buletin Ilmiah Marina Sosial Ekonomi Kelautan dan Perikanan, **8 (**2), 127, **2022.**
22. PUTRA A.Y., YULIA P.A.R. Kajian Kualitas Air Tanah Ditinjau dari Parameter pH, Nilai COD dan BOD pada Desa Teluk Nilap Kecamatan Kubu Babussalam Rokan Hilir Provinsi Riau. Jurnal Riset Kimia, Universitas Andalas, **10** (2), 101, **2019.**
23. YETRI Y., MARANTIKA D.A., ALAMSYAH T., ALIF M.F., RAHMIANA Z. Contribution of Activated Carbon Based on Cacao Peels (Theobroma cacao L.) to Improve the Well Water Quality (COLOR, BOD, and COD). IOP Conf. Series: Materials Science and Engineering, 846, 012003, **2020.**
24. SULANDARI U., SAPEI A., ERIYATNO A.F., KARLINASARI L. Model Pengelolaan Penyediaan Air Bersih Berkelanjutan dengan Memanfaatkan Kolong di Pulau Bangka [Disertasi], Bogor (ID) Institut Pertanian Bogor, **2022.**
25. APHA. Standard Methods for examination of water and wastewater. American Public Health Association (APHA), American Water Works Association (AWWA), Water Environment Federation (WEF), **2005.**
26. YUSUF M. Model Pengelolaan Lingkungan Estuaria Sungai Tallo Kawasan Perkotaan Makassar. Dissertasion IPB, Bogor, Indonesia, **2016**.
27. HANIFAH N.H. Analisis Geokimia Dan Status Mutu Air Tanah Area Winongo Kota Yogyakarta Dengan Parameter Logam Al-Dan Ion Na++, K-, Cl, Dan No3-N. **2022.**
28. DEVESA R., DIETRICH A.M. Guidance for optimizing drinking water taste by adjusting mineralization as measured by total dissolved solids (TDS). Desalination Journal, **439 (**1), 147, **2018.**
29. ADJOVU G.E., STEPHEN H., JAMES D., AHMAD S. Measurement of Total Dissolved Solids and Total Suspended Solids in Water Systems: A Review of the Issues, Conventional, and Remote Sensing Techniques. Remote Sensing, **15** (14), 3534, **2023.**
30. WANG J., ZHUANG S. Removal of various pollutants from water and wastewater by modified chitosan adsorbents. Critical Reviews in Environmental Science and Technology, **47** (23), 2331, **2017.**
31. SAFITA R., KURNIAWAN F. Combination of oil palm empty fruit bunch and multi media layer coir filter to treat water in Mendalo Darat, Jambi. In IOP Conference Series: Materials Science and Engineering, **990** (1), 012011, **2020.**
32. TONG S.T.Y., CHEN W. Modeling the relationship between land use and surface water quality. Journal of Environmental Management, **66** (4), 377, **2002.**
33. TWORT A.C., RATNAYAKA DON D., BRANDT M.J. Water Supply Fifth Edition. Butterworth-Heinemann is an imprint of Elsevier, **2002.**
34. LOTTI T., VAN DER STAR W.R.L., KLEEREBEZEM R., LUBELLO C., VAN LOOSDRECHT M.C.M. The effect of nitrite inhibition on the anammox process. Water Research, **46** (8), 2559, **2012.**
35. STRAUS D.L., DAVID D. Comparison of The Acute Toxicity of Potassium Permanganate to Hybrid Striped Bass in Well Water and Diluted Well Water. Journal of the World Aquaculture Society, **35** (1), 55, **2004.**
36. ROSIDA W., SUDRAJA, MARFAIL M.A. Environmental Quality Analysis Due To Tidal Flood In Pasirkratonkramat Sub-District Pekalongan, Indonesia. Environment & Ecosystem Science (EES), **4** (2), 55, **2020.**
37. SETIOWATI S., ROTO R., WAHYUNI E.T. Monitoring kadar nitrit dan nitrat pada air sumur di daerah catur tunggal yogyakarta dengan metode spektrofotometri uv-vis (Monitoring Of Nitrite And Nitrate Content In Ground Water Of Catur Tunggal Region Of Yogyakarta By UV-VIS Spectrophotometry). Jurnal Manusia dan

Lingkungan, **23 (**2), 143, **2016.**
38. KUMAR S., ANWER R., SEHRAWAT A., YADAV M., SEHRAWAT N. Assessment of bacterial pathogens in drinking water: a serious safety concern. Current Pharmacology Reports, **7** (5), 206, **2021.**
39. SASAKOVA N., GREGOVA G., TAKACOVA D., MOJZISOVA J., PAPAJOVA I., VENGLOVSKY J., KOVACOVA S. Pollution of surface and ground water by sources related to agricultural activities. Frontiers in Sustainable Food Systems, **2**, 42, **2018.**
40. KHAQ F.A., SLAMET A. Perencanaan Sistem Pengolahan Air Limbah Domestik Di Kecamatan Sidoarjo, Kabupaten Sidoarjo. Jurnal Teknik ITS, **6 (**2), 137, **2017.**
41. ABDELRAHMAN A.A., ELTAHIR Y.M. Bacteriological quality of drinking water in Nyala, South Darfur, Sudan. Environmental Monitoring and Assessment, **175**, 37, **2011.**
42. SURIAWIRIA U. Water in Healthy Living and Environment. Bandung (ID), Alumni Publisher (in Indonesian), **2003.**
43. HAPSARI D. Kajian Kualitas Air Sumur Gali dan Perilaku Masyarakat di Sekitar Pabrik Semen Kelurahan Karangtalun Kecamatan Cilacap Utara Kabupaten Cilacap. Jurnal Sains &Teknologi Lingkungan, **7** (1), 18, **2015.**
44. VAESSEN V., BRENTFUHRER R. Module Groundwater and Environment. Integration of Groundwater Management Into Transboundary Basin Organization in Africa, **2015.**
45. MUNAWIR A., RUSDIYANTO E., NURHASANAH, FATHAR I.R., MIERZWA J.C. Ozone Method Recycling Domestic Waste To Prevent Waste Water Pollution. Journal of Ecological Engineering, **24** (12), 16, **2023.**
46. FATHAR I.R., RIANI E., NURHASANAH, MUNAWIR A. Utilization of Ozone and Kefir Whey Probiotics as a Green Technology in Coliform Removal in Health Care Facilities Wastewater. ASTONJADRO, **12** (3), 799, **2023.**
47. MUNAWIR A., JUNE T., KUSMANA C., SETIAWAN Y. SEBAL Model to Estimate Biophysics and Energy Flux Variable: Availability of Evapotranspiration Distribution Using Remote Sensing in Lore Lindu National Park. IOP Conference Series: Earth and Environmental Science, **950**, 012022, **2022.**
48. O'SHEA K.E., DIONYSIOU D. Advanced oxidation processes for water treatment. The Journal of Physical Chemistry Letters, 3, 2112–2113. Advanced oxidation processes for water treatment. The Journal of Physical Chemistry Letters, **3** (15), 2112, **2012.**