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GCEE 2019 - Abstract Submission GCEE 2019: 092-059

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Tue, Jul 9, 2019 at 5:17 AM

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Water Quality Indices for Rainwater Quality Assessment in Bandung Urban Region

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Abstract. Water quality index (WQI) using STORET method has been used to assess rainwater quality in the Bandung urban regions, based on monitoring data in three locations (Coblong, Sumur Bandung, and Buah Batu). Rainwater samples were analyzed by detecting pH, SO_4^{2-}, NO_3^-, Cl^-, and heavy metals (As, Cd, Cr, Pb, and Zn), compared with Indonesian Government Regulation No. 82/ 2001. Rainwater quality showed polluted quality based on the parameters of the water quality index analysis using the Class I and Class II criteria. Rainwater quality parameters that did not meet the quality standards were minimum and average pH value as well as the maximum concentrations of Pb and Zn. Rainwater can potentially become a water sources alternative for domestic use and urban farming in Bandung urban region, but it requires further treatment for better quality.

Keyword: rainwater quality indices; STORET

1. Introduction

The water quality index is a single number to state the quality of water sources, the determination of the water quality index is carried out through 4 (four) stages, namely (1) parameter selection; (2) parameter transformation which transforms unit differences and dimensions to the general scale; (3) parameter weighting and (4) aggregation of sub-indices to produce the final index value [1].

The research on the water quality index in Izombe of Niger Delta Region in monitoring the level of rainwater pollution and borehole water as the primary water source in the region compared to the drinking water quality standards from World Health Organization (WHO) showed that the parameters of temperature and color in rainwater exceeded WHO standards for drinkable water. The results of the analysis showed that the pH of rainwater samples was acidic with a pH range of 5.1-6.4 (average of 5.8). This indicated that the rainwater was more acidic than borehole water [2].

The rainwater analysis in Africa aimed to identify rainwater parameters as compared to water quality standards from WHO showed that rainwater in the Metropolis City of Uyo was not safe for drinking, where the total value of Pollution Index (PI) had the presence of Ni, Cd, Pb, and Fe which caused rainwater to be risky when consumed [3].

The use of rainwater in Indonesia has been regulated according to the Regulation of the Minister of Environment No. 12 of 2009 concerning the use of rainwater, but the utilization of rainwater as raw water in Indonesia must meet water quality standard requirements based on Government Regulation No.82 of 2001 concerning Management of Water Quality and Water Pollution Control. The most widely used water quality index method in Indonesia is the STORET method.

Analysis of the water quality index on raw water sources, especially rainwater, has shown that the water quality index analysis method can produce recommendations regarding the feasibility of using rainwater as raw water for drinking water and domestic needs.

The Bandung urban region has high rainfall every year, between 2,000 - 3,000 mm/year, but the use of rainwater must consider the potential contamination from air pollution due to human activities and industrialization both sourced from local and long-distance sources. Therefore, the water quality index analysis can be used as a method for rainwater quality analysis in the Bandung urban region. This paper aims to explain the results of rainwater quality index analysis in the Bandung urban region using the STORET method to determine the feasibility of rainwater before being utilized.

2. Material and Method

2.1. Study Region

Weekly rainwater samples were collected in bulk during rainfall from different locations in 3 (three) locations in the urban regions of Bandung, namely (1) Coblong region, (2) Sumur Bandung region, and (3) Buah Batu region, as explained in Figure 1. Sampling was carried out in 2016 and 2017; samples were collected and analyzed in the laboratory.

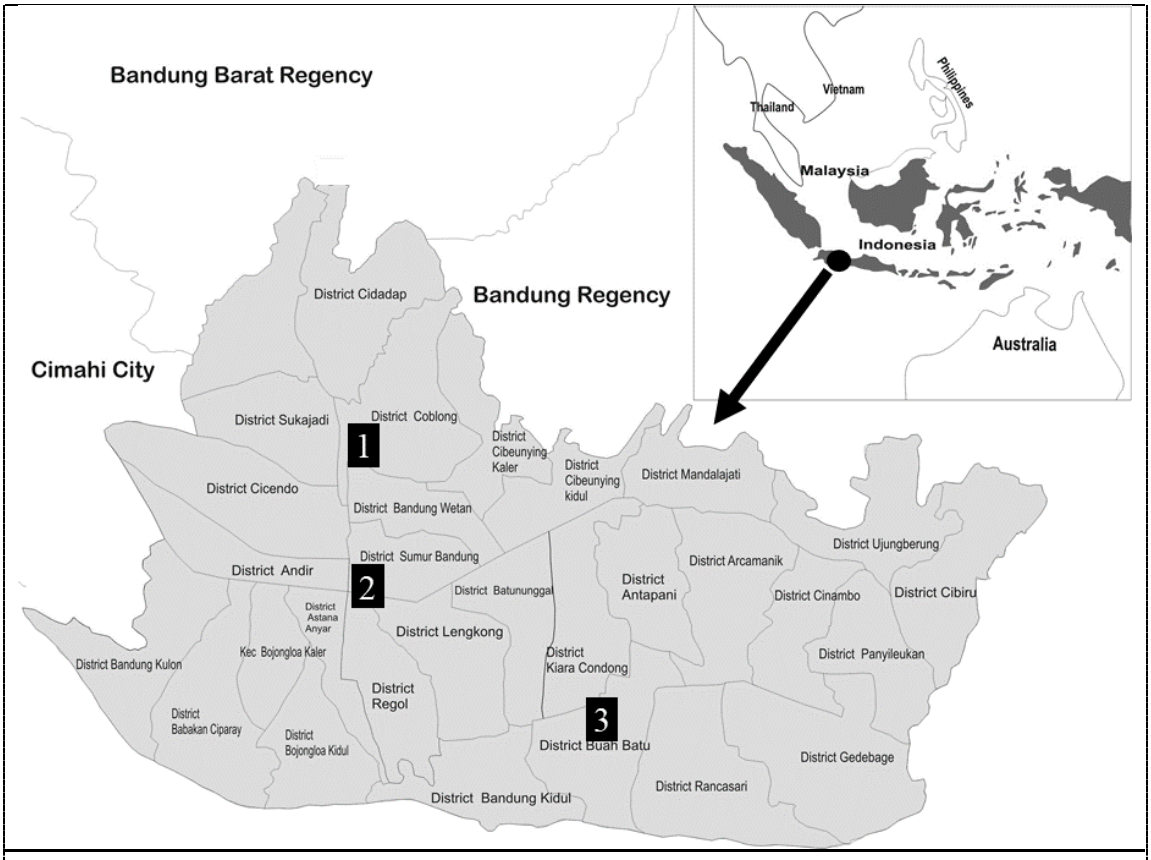

Figure 1. Sampling location in Bandung urban region

2.2. Rainwater analysis

The pH of rainwater varied between 3.0-7.5 pH units, as measured using a pH meter with a measurement accuracy of ± 0.01 pH units at a measurement temperature of 25°C. The pH meter has been calibrated with standard solution of pH 4, pH 6.86, and pH 10.

Ion chromatography (IC) was used to measure rainwater concentration of sulfate ions, nitrate and chloride, while heavy metals (As, Cd, Cr, Pb, and Zn) using a multi-element method with inductively couple plasma (ICP) [4]. The detection limits for heavy metal analysis were As (< 0.002 mg/L), Cd (< 0.001 mg/L), Cr (< 0.001 mg/L), Pb (< 0.001 mg/L) and Zn (< 0.002 mg/L).

2.3. Data Analysis

The STORET method is one commonly used method for determining the status of water quality in Indonesia. This method identifies which parameters meet or exceed water quality standards. The STORET method compares the water quality data with the adjusted water quality standard to determine water quality status.

The parameters analyzed to obtain index values were pH, SO_4^{2-}, NO_3^-, Cl^-, As, Cd, Cr, Pb, and Zn. The parameter values were then compared with water quality criteria according to Government Regulation No. 82 of 2001, as described in Table 1.

Table 1. Criteria of water quality based on class

Parameter	Unit	Class	
		I	II
pH	-	6 – 9	6 – 9
SO_4^{2-}	mg/L	400	(-)
NO_3^-	mg/L	10	(-)
Cl^-	mg/L	600	(-)
As	mg/L	0,05	1,00
Cd	mg/L	0,01	0,01
Cr	mg/L	0,05	0,05
Pb	mg/L	0,03	0,03
Zn	mg/L	0,05	0,05

The water quality classification used in this study was Class I and Class II. Class I, is the raw water designated for drinking water, and/or other designation which requires water quality that is the same as the utility. Class II, is the water designated for water recreation facilities/infrastructure, cultivation of freshwater fish, livestock, water for irrigating plantations, and/or other designations that require water quality that is the same as those uses. Thus, it is expected that rainwater can potentially be used as an alternative for raw water for drinking water and other domestic needs such as irrigating plants in urban regions (urban farming).

The determination of the status of water quality is through the value system from USEPA by classifying water quality in four classes, as described in Table 2.

Table 2. Classification of water status base on the STORET index

	Grade	Status
0	A	Very good
$-1 \leq x \leq -10$	B	Good
$-11 \leq x \leq -30$	C	Polluted
≤ -31	D	Highly polluted

3. Result and Discussion

3.1. Rainwater concentration

Table 3 shows the concentration of rainwater parameters based on the results of data collection. The results showed that the pH of rainwater in the Bandung region wass 3.13-7.06. The concentration of sulfate ions in rainwater shows a range of 8.86 - 17.82 mg/L, nitrate with 0.56-7.02 mg/L and chloride with 0.12 - 2.74 mg/L. The range of heavy metal concentrations detected in the Bandung urban region were As (< 0.002-0.046), Cd (< 0.001-0.011 mg/L), Cr (< 0.001- 0.011), Pb (< 0.001-0.593) and Zn (< 0.002- 0.665).

Table 3. Characteristic of rainwater in Bandung urban region

Parameter	Unit	Coblong			Sumur Bandung			Buah Batu		
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
pH	-	3.13	7.06	5.40	4.10	6.70	5.50	4.30	6.86	5.52
SO_4^{2-}	mg/L	0.86	6.50	3.15	1.54	9.24	4.01	1.00	17.82	3.92
NO_3^-	mg/L	0.69	4.19	1.66	0.69	3.90	1.75	0.56	7.02	1.68
Cl^-	mg/L	0.12	2.74	0.42	0.14	1.39	0.43	0.12	1.44	0.41
As	mg/L	< 0.002	0.034	0.01	< 0.002	0.046	0.011	< 0.002	0.032	0.010
Cd	mg/L	< 0.001	0.011	0.010	< 0.001	0.014	0.001	< 0.001	0.007	0.001
Cr	mg/L	< 0.001	0.011	0.001	< 0.001	0.004	0.001	< 0.001	0.002	<0.001
Pb	mg/L	< 0.001	0.153	0.016	< 0.001	0.593	0.040	< 0.001	0.110	0.016
Zn	mg/L	< 0.002	0.015	0.002	< 0.002	0.326	0.016	< 0.002	0.665	0.022

3.2. Rainwater quality index

The rainwater quality index result Table 4 shows in Table 4. The rainwater quality index in the Coblong region based on the STORET calculation is categorized as moderately polluted with a score of -10. Parameters that did not meet Class I and Class II water quality standards were the minimum pH value (3.13) and the average pH value (5.4) and the maximum concentration of Pb (0.153 mg/L). Other metal parameters, As, Cd, Cr and Zn in the Coblong region showed that the concentration meet the quality standards at minimum concentrations, maximum concentrations and average concentrations, with standard quality for As (0.05 mg/L), Cr (0.01 mg/L) and Zn (0.05 mg/L).

Rainwater quality index in Sumur Bandung region was categorized as moderately polluted with a score of -20. Parameters that do not meet Class I and Class II quality standards were the minimum pH values (4.10) and the average pH value (5.50). In other hand, the parameters of heavy metals that did not meet the quality standards were the maximum concentration of Cd (0.014 mg/L), maximum

concentration and average Pb concentration (0.593 mg/L and 0.040 mg/L) and maximum concentration of Zn (0.326 mg/L).

Rainwater quality index in the Buah Batu region was categorized as moderately polluted with a score of -12. Parameters that did not meet the Class I and Class II quality standards were the minimum pH values (4.3) and the average pH value (5.52). The parameters of heavy metals that did not meet the quality standards include the maximum concentration of Pb (0.110 mg/L) and the maximum concentration of Zn (0.665 mg/L).

Table 4. The result of the STORET index for rainwater in the Bandung region

Sampling region	Class I			Class II		
	Score index	Grade	Status	Score index	Grade	Status
Coblong	-10	B	Good	-10	B	Good
Sumur Bandung	-20	C	Polluted	-20	C	Polluted
Buah Batu	-12	C	Polluted	-12	C	Polluted

4. Conclusion

Determining rainwater quality in the Bandung urban region was important before rainwater was using for water resources of drinking water or other uses such as agriculture in urban regions (urban farming). Therefore, with the detection of heavy metals such as Pb in rainwater, the possibility of Pb accumulation must be considered, especially in plants, if consumed directly.

Utilization of rainwater, it must pay attention to the quality of rainwater in each urban region despite the results of the analysis of rainwater quality showing the presence of heavy metals and do not meet the quality standards. This is done to prevent the impact of rainwater utilization on human health.

Exposure to extreme water pH values on human health can irritate the eyes, skin, mucous membranes, and gastrointestinal tract in sensitive people. A pH value of less than 4 can cause red eyes and irritation, and if the pH is less than 2.5, it will cause irreversible and extensive damage to the epithelial tissue [5].

EPA explained that the solubility of oxides of nitrogen and sulfur dioxide in acid rain is related to health problems, especially irritation of the eyes and lung diseases such as asthma and bronchitis, NO_x is a significant contributor to the formation of ozone in the atmosphere which also has disruptive health effects on resources such as contaminating food and water.

Rainwater utilization, such as rainwater harvesting systems, must pay attention to regional characteristics such as topography, season conditions and air pollutants that can be sources of rainwater contaminants and their effects on health [6,7]. The rainwater can then be used for drinking water, agricultural irrigation, urban greening, and other needs that require good water quality [8].

Acknowledgements

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Invitation Letter + Conference Schedule of GCEE 2019

The 2nd International Conference on Green Civil and Environmental Engineering <gcee@confbay.com> Thu, Aug 15, 2019 at 6:51 PM
Reply-To: The 2nd International Conference on Green Civil and Environmental Engineering <gcee@confbay.com>
To: niayhasan@gmail.com

Dear author,

We are pleased to announce that our department, Department of Civil Engineering, Universitas Negeri Malang, Indonesia, will host The 2nd International Conference on Green Civil and Environmental Engineering (GCEE 2019) in 4-6 September 2019. The theme of this international conference is “Discovering Innovative and Environmentally-sound Construction for Sustainable Living” with topic areas including green building, green material, green construction and technology, a sustainable technique in building and infrastructure, sanitation system and technology options, water resource management, solid and hazardous waste management.

On behalf of organising committee, we would like to invite you to present your research paper(s) at the designated parallel session. The schedule of the parallel session will be attached in the conference book and will be distributed at the registration desk (Day 1). Should you prepare a presentation file in Microsoft Powerpoint extension to be delivered for 8 minutes. Please kindly copy the presentation file using Flashdisk to our committee at the registration desk.

Should you have further questions, please do not hesitate to contact us.

Best regards

GCEE 2019

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Water Quality Indices for Rainwater Quality Assessment in Bandung Urban Region

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Abstract. Water quality index (WQI) using STORET method has been used to assess rainwater quality in the Bandung urban regions, based on monitoring data in three locations (Coblong, Sumur Bandung, and Buah Batu). Rainwater samples were analyzed by detecting pH, SO_4^{2-}, NO_3^-, Cl^-, and heavy metals (As, Cd, Cr, Pb, and Zn), compared with Indonesian Government Regulation No. 82/ 2001. Rainwater quality showed polluted quality based on the parameters of the water quality index analysis using the Class I and Class II criteria. Rainwater quality in Bandung urban region were lightly polluted (Coblong region) and moderately polluted (Sumur Bandung and Buah Batu region). Rainwater can potentially become a water sources alternative for domestic use and urban farming in Bandung urban region, but it requires further treatment for better quality.
Keyword: rainwater quality indices; STORET

1. Introduction

The water quality index is a single number to state the quality of water sources, the determination of the water quality index is carried out through 4 (four) stages, namely (1) parameter selection; (2) parameter transformation which transforms unit differences and dimensions to the general scale; (3) parameter weighting and (4) aggregation of sub-indices to produce the final index value [1].

The research on the water quality index in Izombe of Niger Delta Region in monitoring the level of rainwater pollution and borehole water as the primary water source in the region compared to the drinking water quality standards from World Health Organization (WHO) showed that the parameters of temperature and color in rainwater exceeded WHO standards for drinkable water. The results of the analysis showed that the pH of rainwater samples was acidic with a pH range of 5.1 -- 6.4 (average of 5.8). This indicated that the rainwater was more acidic than borehole water [2].

The rainwater analysis in Africa aimed to identify rainwater parameters as compared to water quality standards from WHO showed that rainwater in the Metropolis City of Uyo was not safe for drinking, where the total value of Pollution Index (PI) had the presence of Ni, Cd, Pb, and Fe which caused rainwater to be risky when consumed [3].

The use of rainwater in Indonesia has been regulated according to the Regulation of the Minister of Environment No. 12 of 2009 concerning Rainwater Utilization were activities to collected, using, and adsorbing rainwater into soil as groundwater conservation. Rainwater as raw water in Indonesia must

meet water quality standard requirements based on Government Regulation No.82 of 2001 concerning Management of Water Quality and Water Pollution Control. The most widely used water quality index method in Indonesia is the STORET (Storage and Retrieval) method.

Analysis of the water quality index on raw water sources, especially rainwater, has shown that the water quality index analysis method can produce recommendations regarding the feasibility of using rainwater as raw water for drinking water and domestic needs.

The Bandung urban region has high rainfall every year, between 2,000-3,000 mm/year, but the use of rainwater must consider the potential contamination from air pollution due to human activities and industrialization both sourced from local and long-distance sources. Therefore, the water quality index analysis can be used as a method for rainwater quality analysis in the Bandung urban region. This paper aims to explain the results of rainwater quality index analysis in the Bandung urban region using the STORET method to determine the feasibility of rainwater before being utilized.

2. Material and Method

2.1. Study Region

Weekly rainwater samples were collected in bulk polyethylene bottle during rainfall from different locations at 3 (three) locations in the urban regions of Bandung: (1) Coblong region (06°55'11,07"S 107°36'04,54" E), (2) Sumur Bandung region (06°55'11,07"S 107°36'39,34"E) , and (3) Buah Batu region (06°53'26,69"S 107°36'43,73"U) , as explained in Figure 1. Sampling was carried out in 2016 (and 2017, samples were collected and analyzed in the laboratory.

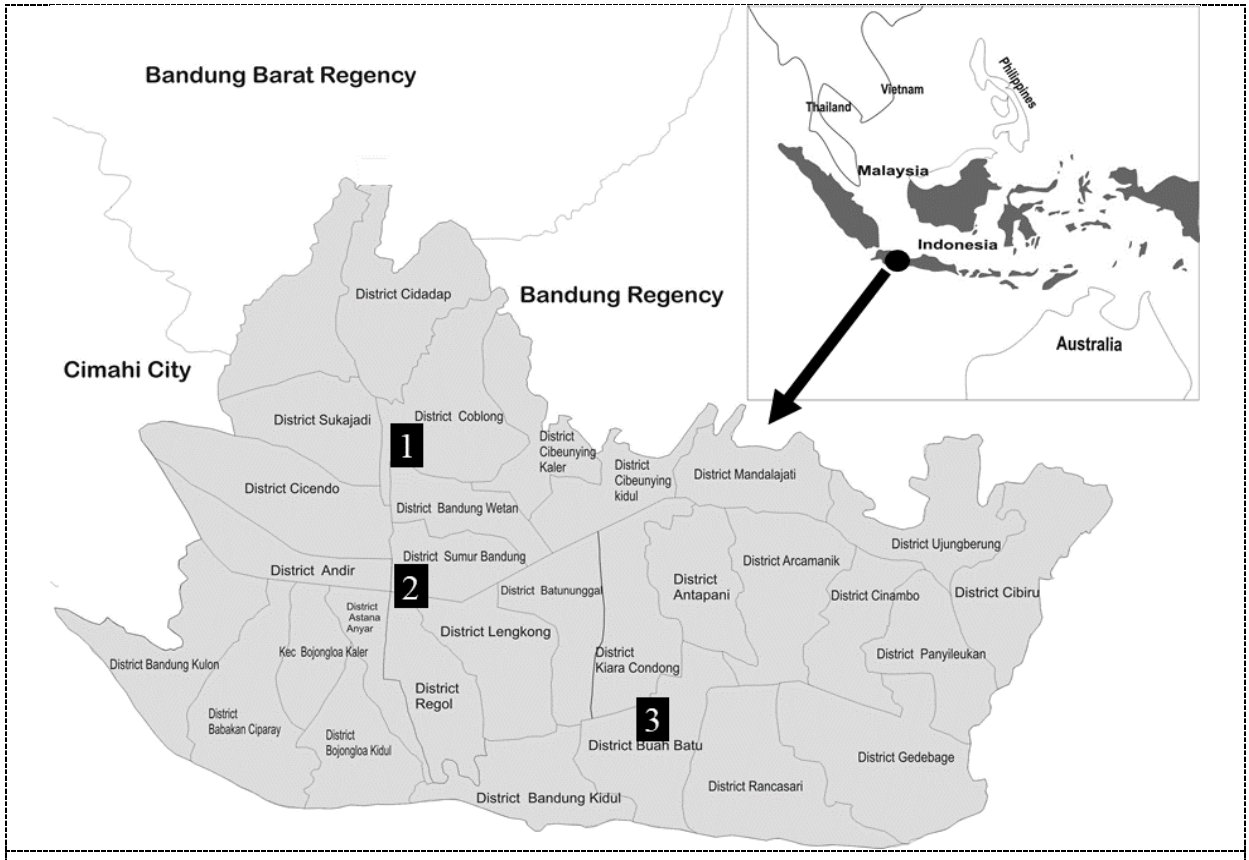

Figure 1. Sampling location in Bandung urban region

2.2. Rainwater analysis

The pH of rainwater varied between 3.0-7.5 pH units, as measured using a pH meter with a measurement accuracy of ± 0.01 pH units at a measurement temperature of 25°C. The pH meter has been calibrated with standard solution of pH 4, pH 6.86, and pH 10.

Ion chromatography (IC) was used to measure rainwater concentration of sulfate ions, nitrate and chloride, while heavy metals (As, Cd, Cr, Pb, and Zn) using a multi-element method with inductively couple plasma (ICP) [4]. The detection limits for heavy metal analysis were As (< 0.002 mg/L), Cd (< 0.001 mg/L), Cr (< 0.001 mg/L), Pb (< 0.001 mg/L), and Zn (< 0.002 mg/L).

2.3. Data Analysis

STORET refers overall to "STORage and RETrieval" was an electronic data system for water quality monitoring data developed by EPA. The STORET method is one commonly used method for determining the status of water quality in Indonesia. This method identifies which parameters meet or exceed water quality standards. The STORET method compares the water quality data with the adjusted water quality standard to determine water quality status.

The parameters analyzed to obtain index values were pH, SO_4^{2-}, NO_3^-, Cl^-, As, Cd, Cr, Pb, and Zn. The parameter values were then compared with water quality criteria according to Government Regulation No. 82 of 2001, as described in Table 1.

Table 1. Criteria of water quality based on class

Parameter	Unit	Class	
		I	II
pH	-	6 – 9	6 – 9
SO_4^{2-}	mg/L	400	(-)
NO_3^-	mg/L	10	(-)
Cl^-	mg/L	600	(-)
As	mg/L	0,05	1,00
Cd	mg/L	0,01	0,01
Cr	mg/L	0,05	0,05
Pb	mg/L	0,03	0,03
Zn	mg/L	0,05	0,05

The water quality classification used in this study was Class I and Class II. Class I, is the raw water designated for drinking water, and/or other designation which requires water quality that is the same as the utility. Class II, is the water designated for water recreation facilities/infrastructure, cultivation of freshwater fish, livestock, water for irrigating plantations, and/or other designations that require water quality that is the same as those uses. Thus, it is expected that rainwater can potentially be used as an alternative for raw water for drinking water and other domestic needs such as irrigating plants in urban regions (urban farming).

The determination of the status of water quality is through the value system from USEPA by classifying water quality in four classes, as described in Table 2. The classification of water quality base on STORET index were good condition, lightly polluted, moderately polluted, and heavely polluted.

Table 2. Classification of water status base on the STORET index

Class	Criteria	Score	Quality status
A	Very good condition	0	Good condition
B	Good condition	$-1 \leq x \leq -10$	Lightly polluted
C	Moderately good condition	$-11 \leq x \leq -30$	Moderately polluted
D	Bad condition	≤ -31	Heavely polluted

3. Result and Discussion

3.1. Rainwater concentration

The concentration of rainwater parameter based on the result of data collection shows in Table 3. The results showed that the pH of rainwater in the Bandung region wass 3.13-7.06. The concentration of sulfate ions in rainwater shows a range of 8.86 - 17.82 mg/L, nitrate with 0.56-7.02 mg/L and chloride with 0.12 - 2.74 mg/L. The range of heavy metal concentrations detected in the Bandung urban region were As (< 0.002-0.046), Cd (< 0.001-0.011 mg/L), Cr (< 0.001- 0.011), Pb (< 0.001-0.593) and Zn (< 0.002- 0.665).

Table 3. Characteristic of rainwater in Bandung urban region

Parameter	Unit	Coblong			Sumur Bandung			Buah Batu		
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
pH	-	3.13	7.06	5.40	4.10	6.70	5.50	4.30	6.86	5.52
SO_4^{2-}	mg/L	0.86	6.50	3.15	1.54	9.24	4.01	1.00	17.82	3.92
NO_3^-	mg/L	0.69	4.19	1.66	0.69	3.90	1.75	0.56	7.02	1.68
Cl^-	mg/L	0.12	2.74	0.42	0.14	1.39	0.43	0.12	1.44	0.41
As	mg/L	< 0.002	0.034	0.01	< 0.002	0.046	0.011	< 0.002	0.032	0.010
Cd	mg/L	< 0.001	0.011	0.010	< 0.001	0.014	0.001	< 0.001	0.007	0.001
Cr	mg/L	< 0.001	0.011	0.001	< 0.001	0.004	0.001	< 0.001	0.002	<0.001
Pb	mg/L	< 0.001	0.153	0.016	< 0.001	0.593	0.040	< 0.001	0.110	0.016
Zn	mg/L	< 0.002	0.015	0.002	< 0.002	0.326	0.016	< 0.002	0.665	0.022

3.2. Rainwater quality index

Rainwater quality index in Bandung urban region base on STORET index showed different quality status index between different location, because of small spatial difference in this region. The rainwater quality index result shows in Table 4. The rainwater quality index in the Coblong region based on the STORET calculation is categorized as lightly polluted with a score of -10. Parameters that did not meet Class I and Class II water quality standards were the minimum pH value (3.13), the average pH value (5.4), and the maximum concentration of Pb (0.153 mg/L). Other metal parameters, Cd in the Coblong region showed that the maximum concentration did not meet the quality standards Class II (0.011 mg/L).

Rainwater quality index in Sumur Bandung region was categorized as moderately polluted with a score of -20. Parameters that did not meet Class I and Class II quality standards were the minimum pH values (4.10), and the average pH value (5.50). On the other hand, the parameters of heavy metals that

did not meet the quality standards Class I and Class II were the maximum concentration of Cd (0.014 mg/L), maximum and average Pb concentration (0.593 mg/L and 0.040 mg/L), and maximum concentration of Zn (0.326 mg/L).

Rainwater quality index in the Buah Batu region was categorized as moderately polluted with a score of -12. Parameters that did not meet the Class I and Class II quality standards were the minimum pH values (4.3) and the average pH value (5.52). The parameters of heavy metals that did not meet the quality standards Class I and Class II include the maximum concentration of Pb (0.110 mg/L), maximum and average concentration of Zn (0.665 and 0.022 mg/L).

Table 4. The result of the STORET index for rainwater in the Bandung region

Sampling region	Class I			Class II		
	Score index	Class	Quality Status	Score index	Grade	Quality Status
Coblong	-10	B	Good condition	-10	B	Good condition
Sumur Bandung	-20	C	Moderately polluted	-20	C	Moderately polluted
Buah Batu	-12	C	Lightly polluted	-12	C	Lightly polluted

The heavy metal of rainwater especially Pb and Zn in Sumur Bandung region was influence of local emissions of motorized vehicle activities in Bandung urban centers, while Zn emissions in Buah Batu region was possible from local industries emission. Coblong region was a urban area with a densely populated and dominated by domestic activities. The differences of rainwater in 3 (three) region in Bandung urban area were impacted of different landuse.

The dominant anthropogenic sources of heavy metals in rainwater represent coal combustion, automobile exhaust, and industrial emissions [5,6,7,8]. Heavy metals from rainwater accumulate in the biosphere and may cause adverse human health and environmental effects [9,10].

Exposure to extreme water pH values on human health can irritate the eyes, skin, mucous membranes, and gastrointestinal tract in sensitive people. A pH value of less than 4 can cause red eyes and irritation, and if the pH is less than 2.5, it will cause irreversible and extensive damage to the epithelial tissue [11].

EPA explained that the solubility of oxides of nitrogen and sulfur dioxide in acid rain is related to health problems, especially irritation of the eyes and lung diseases such as asthma and bronchitis, NO_x is a significant contributor to the formation of ozone in the atmosphere which also has disruptive health effects on resources such as contaminating food and water.

Rainwater utilization, such as rainwater harvesting systems, must pay attention to regional characteristics such as topography, season conditions and air pollutants that can be sources of rainwater contaminants and their effects on health [12,13]. The rainwater can then be used for drinking water, agricultural irrigation, urban greening, and other needs that require good water quality [14].

4. Conclusion

Determining rainwater quality in the Bandung urban region was important before rainwater was using for water resources of drinking water or other uses such as agriculture in urban regions (urban farming). Utilization of rainwater, it must pay attention to the quality of rainwater in each urban region despite the results of the analysis of rainwater quality showing the presence of heavy metals and do not meet the quality standards for Class I and Class II. This is done to prevent the impact of rainwater

utilization on human health. Therefore, with the detection of heavy metals such as Pb in rainwater, the possibility of Pb accumulation must be considered, especially in plants, if consumed directly.

Acknowledgements
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Water Quality Indices for Rainwater Quality Assessment in Bandung Urban Region

N Y Hasan[1], Driejana[2], A Sulaeman[3] and H D Ariesyady[2]

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Abstract. Water quality indices (WQI) using STORET method has been used to assess rainwater quality in the Bandung urban regions, based on monitoring data at three locations (Coblong, Sumur Bandung, and Buah Batu). Rainwater samples were analyzed by detecting pH, SO_4^{2-}, NO_3^-, Cl^-, and heavy metals (As, Cd, Cr, Pb, and Zn) compared with Indonesian Government Regulation No. 82 Year 2001. Rainwater quality showed polluted based on the parameters of the water quality indices analysis using the Class I and Class II criteria. Rainwater quality in Bandung urban region were lightly polluted (Coblong) and moderately polluted (Sumur Bandung and Buah Batu). Rainwater can potentially become a water sources alternative for domestic use and urban farming in Bandung urban region, but it requires further treatment for better quality.
Keyword: rainwater quality indices, STORET

1. Introduction

The water quality indices is a single number to state the quality of water sources, the determination of water quality indices is carried out through 4 (four) steps: (1) parameter selection, (2) parameter transformation which transforms unit differences and dimensions to the general scale, (3) parameter weighting, and (4) aggregation of sub-indices to produce the final indices value [1].

The research on the water quality indices in Izombe of Niger Delta Region in monitoring the level of rainwater pollution and borehole water as the primary water source in the region compared to the drinking water quality standards from World Health Organization (WHO) showed that the parameters of temperature and color in rainwater exceeded WHO standards for drinking water. The results of analysis showed that the pH of rainwater samples was acidic with a pH range of 5.1-6.4 (average 5.8). This indicated that the rainwater was more acidic than borehole water [2].

The rainwater analysis in Africa to identify rainwater parameters as compared to water quality standards from WHO showed that rainwater in the Metropolis City of Uyo was not safe for drinking, where the total value of Pollution Index (PI) had indicated presence of Ni, Cd, Pb, and Fe which caused rainwater have a risk when consumed [3].

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meet water quality standard requirements based on Government Regulation No.82 Year 2001 about Management of Water Quality and Water Pollution Control. The most widely used water quality indices method in Indonesia is the STORET (Storage and Retrieval) method.

Analysis of the water quality indices on raw water sources, especially rainwater, has shown that the water quality indices analysis method can produce recommendations regarding the feasibility of using rainwater as raw water for drinking water and domestic needs.

The Bandung urban region has high rainfall every year between 2,000-3,000 mm/year, but rainwater utilization must consider the potential contamination from air pollution due to human activities and industrialization both local and long-distance pollutant sources. Therefore, the water quality indices analysis can be used as a method for rainwater quality analysis in the Bandung urban region. This paper aims to explain the results of rainwater quality indices analysis in the Bandung urban region using the STORET method to determine the feasibility of rainwater before being utilized.

2. Material and Method

2.1. Study Region

Weekly rainwater samples were collected in bulk polyethylene bottle during rainfall from different locations at 3 (three) locations in the urban regions of Bandung: (1) Coblong region (06°55'11,07"S 107°36'04,54" E), (2) Sumur Bandung region (06°55'11,07"S 107°36'39,34"E), and (3) Buah Batu region (06°53'26,69"S 107°36'43,73"U), as explained in Figure 1. Sampling was carried out in 2016 and 2017, samples were collected and analyzed in the laboratory.

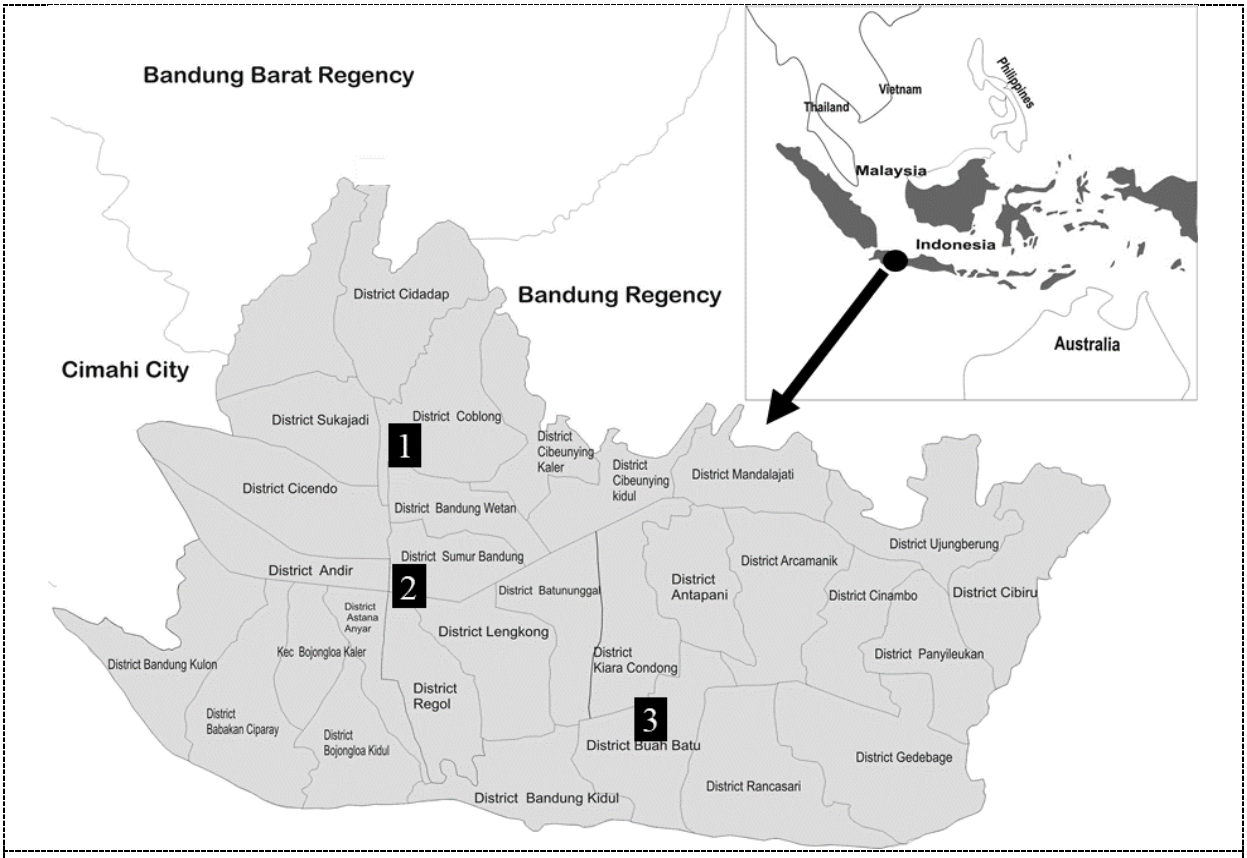

Figure 1. Sampling location in Bandung urban region

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The pH of rainwater varied between 3.0-7.5 pH units, as measured using a pH meter with a measurement accuracy of ± 0.01 pH units at a measurement temperature of 25°C. The pH meter has been calibrated with standard solution of pH 4, pH 6.86, and pH 10.

Ion chromatography (IC) was used to measure rainwater concentration of sulfate ions, nitrate and chloride, while heavy metals (As, Cd, Cr, Pb, and Zn) using a multi-element method with inductively couple plasma (ICP) [4]. The detection limits for heavy metal analysis were As (< 0.002 mg/L), Cd (< 0.001 mg/L), Cr (< 0.001 mg/L), Pb (< 0.001 mg/L), and Zn (< 0.002 mg/L).

2.3. Data Analysis

STORET refers overall to "STORage and RETrieval" was an electronic data system for water quality monitoring data developed by EPA. The STORET method is one commonly used method for determining the status of water quality in Indonesia. This method identifies which parameters meet or exceed water quality standards. The STORET method compares the water quality data with the adjusted water quality standard to determine water quality status.

The parameters analyzed to obtain indices values were pH, SO_4^{2-}, NO_3^-, Cl^-, As, Cd, Cr, Pb, and Zn. The parameter values were then compared with water quality criteria according to Government Regulation No. 82 Year 2001, as described in Table 1.

Table 1. Criteria of water quality based on class

Parameter	Unit	Class	
		I	II
pH	-	6 – 9	6 – 9
SO_4^{2-}	mg/L	400	(-)
NO_3^-	mg/L	10	(-)
Cl^-	mg/L	600	(-)
As	mg/L	0,05	1,00
Cd	mg/L	0,01	0,01
Cr	mg/L	0,05	0,05
Pb	mg/L	0,03	0,03
Zn	mg/L	0,05	0,05

The water quality classification used in this study was Class I and Class II criteria. Class I, is the raw water designated for drinking water, and/or other designation which requires water quality that is the same as the utility. Class II, is the water designated for water recreation facilities/ infrastructure, cultivation of freshwater fish, livestock, water for irrigating plantations, and/or other designations that require water quality that is the same as those uses. Thus, it is expected that rainwater can potentially be used as an alternative for raw water for drinking water and other domestic needs such as irrigating plants in urban regions (urban farming).

The determination of the status of water quality is through the value system from USEPA by classifying water quality in four classes, as described in Table 2. The classification of water quality base on STORET index were good condition, lightly polluted, moderately polluted, and heavy polluted.

Table 2. Classification of water status base on the STORET indices

Class	Criteria	Score	Quality status
A	Very good condition	0	Good condition
B	Good condition	$-1 \leq x \leq -10$	Lightly polluted
C	Moderately good condition	$-11 \leq x \leq -30$	Moderately polluted
D	Bad condition	≤ -31	Heavy polluted

3. Result and Discussion

3.1. Rainwater concentration

The concentration of rainwater parameter based on the result of data collection shows in Table 3. The results showed that the pH of rainwater in the Bandung region wass 3.13-7.06. The concentration of sulfate ions in rainwater shows a range of 8.86-17.82 mg/L, nitrate with 0.56-7.02 mg/L and chloride with 0.12-2.74 mg/L. The range of heavy metal concentrations detected in the Bandung urban region were As (< 0.002-0.046), Cd (< 0.001-0.011 mg/L), Cr (< 0.001-0.011), Pb (< 0.001-0.593) and Zn (< 0.002-0.665).

Table 3. Characteristic of rainwater in Bandung urban region

Parameter	Unit	Coblong			Sumur Bandung			Buah Batu		
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
pH	-	3.13	7.06	5.40	4.10	6.70	5.50	4.30	6.86	5.52
SO_4^{2-}	mg/L	0.86	6.50	3.15	1.54	9.24	4.01	1.00	17.82	3.92
NO_3^-	mg/L	0.69	4.19	1.66	0.69	3.90	1.75	0.56	7.02	1.68
Cl^-	mg/L	0.12	2.74	0.42	0.14	1.39	0.43	0.12	1.44	0.41
As	mg/L	< 0.002	0.034	0.01	< 0.002	0.046	0.011	< 0.002	0.032	0.010
Cd	mg/L	< 0.001	0.011	0.010	< 0.001	0.014	0.001	< 0.001	0.007	0.001
Cr	mg/L	< 0.001	0.011	0.001	< 0.001	0.004	0.001	< 0.001	0.002	<0.001
Pb	mg/L	< 0.001	0.153	0.016	< 0.001	0.593	0.040	< 0.001	0.110	0.016
Zn	mg/L	< 0.002	0.015	0.002	< 0.002	0.326	0.016	< 0.002	0.665	0.022

3.2. Rainwater quality indices

Rainwater quality indices in Bandung urban region base on STORET method showed different quality status indices between different location, because of small spatial difference in this region. The rainwater quality indices result shows in Table 4. The rainwater quality indices at Coblong region based on the STORET calculation is categorized as lightly polluted with a score of -10. Parameters that did not meet Class I and Class II criteria were minimum pH value (3.13), average pH value (5.4), and maximum concentration of Pb (0.153 mg/L). Other metal parameters, Cd in Coblong region showed that the maximum concentration did not meet the quality standards Class II (0.011 mg/L).

Rainwater quality indices in Sumur Bandung region was categorized as moderately polluted with a score of -20. Parameters that did not meet Class I and Class II criteria were minimum pH values (4.10), and average pH value (5.50). On the other hand, the parameters of heavy metals that did not meet the quality standards Class I and Class II criteria were maximum concentration of Cd (0.014

mg/L), maximum and average concentration of Pb (0.593 mg/L and 0.040 mg/L), and maximum concentration of Zn (0.326 mg/L).

Rainwater quality indices in Buah Batu region was categorized as moderately polluted with a score of -12. Parameters that did not meet the Class I and Class II criteria were minimum pH values (4.3) and average pH value (5.52). The parameters of heavy metals that did not meet the quality standards Class I and Class II criteria include maximum concentration of Pb (0.110 mg/L), maximum and average concentration of Zn (0.665 and 0.022 mg/L).

Table 4. The result of the STORET index for rainwater in the Bandung region

Sampling region	Class I			Class II		
	Score index	Class	Quality Status	Score index	Grade	Quality Status
Coblong	-10	B	Good condition	-10	B	Good condition
Sumur Bandung	-20	C	Moderately polluted	-20	C	Moderately polluted
Buah Batu	-12	C	Lightly polluted	-12	C	Lightly polluted

The heavy metal of rainwater especially Pb and Zn in Sumur Bandung region was influence of local emissions of motorized vehicle activities in Bandung urban centers, while Zn emissions in Buah Batu region was possible from local industries emission. Coblong region was an urban area with a densely populated and dominated by domestic activities. The differences of rainwater in 3 (three) region in Bandung urban area were impacted of different landuse.

The dominant anthropogenic sources of heavy metals in rainwater represent coal combustion, automobile exhaust, and industrial emissions [5,6,7,8]. Heavy metals from rainwater accumulate in the biosphere and may cause adverse human health and environmental effects [9,10].

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Rainwater utilization, such as rainwater harvesting systems, must pay attention to regional characteristics such as topography, season conditions, and air pollutants that can be sources of rainwater contaminants and their effects on health [12,13]. The rainwater can then be used for drinking water, agricultural irrigation, urban greening, and other needs that require good water quality [14].

4. Conclusion

Determining rainwater quality in the Bandung urban region was important before rainwater was using for water resources of drinking water or other uses such as agriculture in urban regions (urban farming). Utilization of rainwater, it must pay attention to the quality of rainwater in each urban region despite the results of the analysis of rainwater quality showing the presence of heavy metals and do not meet the quality standards for Class I and Class II criteria. This is due to prevent the impact of rainwater utilization on human health. Therefore, with the detection of heavy metals such as Pb in rainwater, the possibility of Pb accumulation must be considered, especially in plants if consumed directly.

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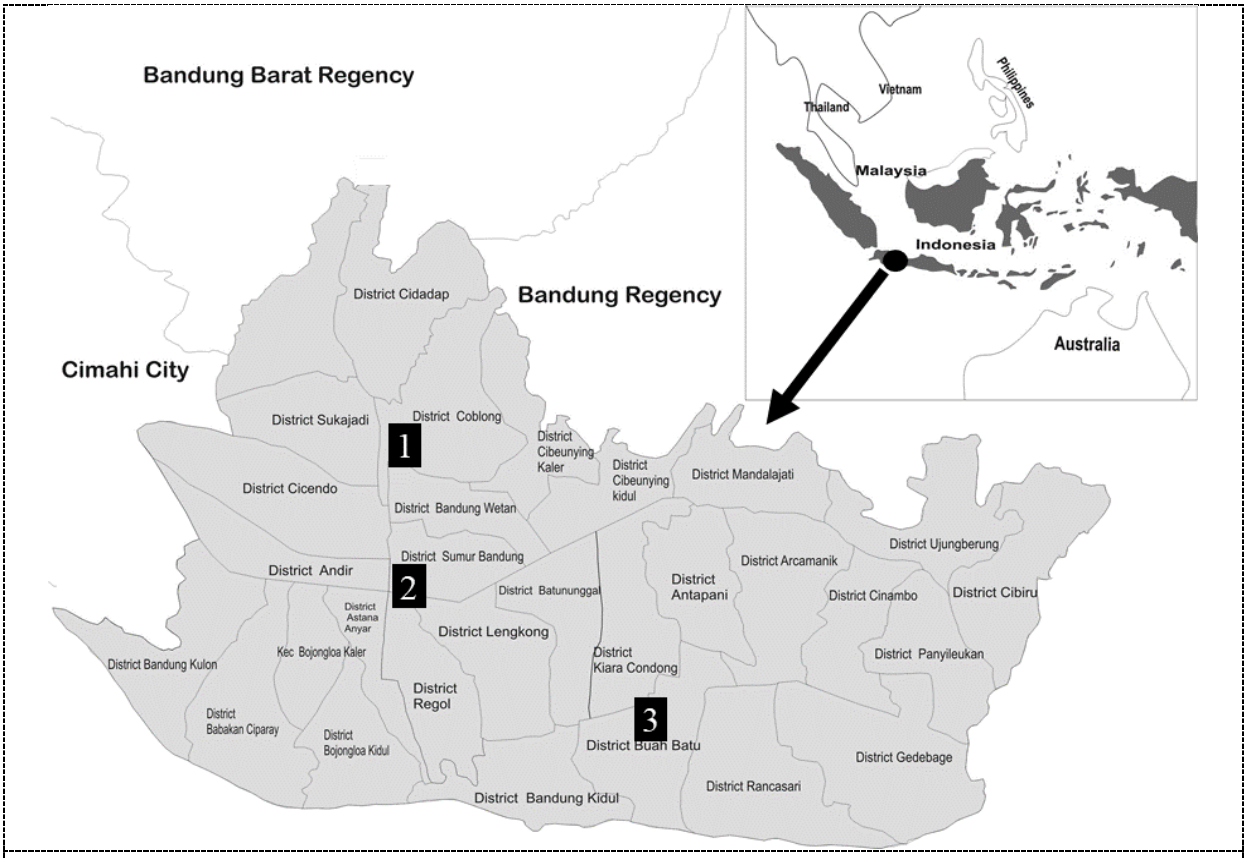

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As	mg/L	0,05	1,00
Cd	mg/L	0,01	0,01
Cr	mg/L	0,05	0,05
Pb	mg/L	0,03	0,03
Zn	mg/L	0,05	0,05

The water quality classification used in this study was Class I and Class II criteria. Class I, is the raw water designated for drinking water, and/or other designation which requires water quality that is the same as the utility. Class II, is the water designated for water recreation facilities/ infrastructure, cultivation of freshwater fish, livestock, water for irrigating plantations, and/or other designations that require water quality that is the same as those uses. Thus, it is expected that rainwater can potentially be used as an alternative for raw water for drinking water and other domestic needs such as irrigating plants in urban regions (urban farming).

The determination of the status of water quality is through the value system from USEPA by classifying water quality in four classes, as described in Table 2. The classification of water quality base on STORET index were good condition, lightly polluted, moderately polluted, and heavy polluted.

Table 2. Classification of water status base on the STORET indices

Class	Criteria	Score	Quality status
A	Very good condition	0	Good condition
B	Good condition	$-1 \leq x \leq -10$	Lightly polluted
C	Moderately good condition	$-11 \leq x \leq -30$	Moderately polluted
D	Bad condition	≤ -31	Heavy polluted

3. Result and Discussion

3.1. Rainwater concentration

The concentration of rainwater parameter based on the result of data collection shows in Table 3. The results showed that the pH of rainwater in the Bandung region wass 3.13-7.06. The concentration of sulfate ions in rainwater shows a range of 8.86-17.82 mg/L, nitrate with 0.56-7.02 mg/L and chloride with 0.12-2.74 mg/L. The range of heavy metal concentrations detected in the Bandung urban region were As (< 0.002-0.046), Cd (< 0.001-0.011 mg/L), Cr (< 0.001-0.011), Pb (< 0.001-0.593) and Zn (< 0.002-0.665).

Table 3. Characteristic of rainwater in Bandung urban region

Parameter	Unit	Coblong			Sumur Bandung			Buah Batu		
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
pH	-	3.13	7.06	5.40	4.10	6.70	5.50	4.30	6.86	5.52
SO_4^{2-}	mg/L	0.86	6.50	3.15	1.54	9.24	4.01	1.00	17.82	3.92
NO_3^-	mg/L	0.69	4.19	1.66	0.69	3.90	1.75	0.56	7.02	1.68
Cl^-	mg/L	0.12	2.74	0.42	0.14	1.39	0.43	0.12	1.44	0.41
As	mg/L	< 0.002	0.034	0.01	< 0.002	0.046	0.011	< 0.002	0.032	0.010
Cd	mg/L	< 0.001	0.011	0.010	< 0.001	0.014	0.001	< 0.001	0.007	0.001
Cr	mg/L	< 0.001	0.011	0.001	< 0.001	0.004	0.001	< 0.001	0.002	<0.001
Pb	mg/L	< 0.001	0.153	0.016	< 0.001	0.593	0.040	< 0.001	0.110	0.016
Zn	mg/L	< 0.002	0.015	0.002	< 0.002	0.326	0.016	< 0.002	0.665	0.022

3.2. Rainwater quality indices

Rainwater quality indices in Bandung urban region base on STORET method showed different quality status indices between different location, because of small spatial difference in this region. The rainwater quality indices result shows in Table 4. The rainwater quality indices at Coblong region based on the STORET calculation is categorized as lightly polluted with a score of -10. Parameters that did not meet Class I and Class II criteria were minimum pH value (3.13), average pH value (5.4), and maximum concentration of Pb (0.153 mg/L). Other metal parameters, Cd in Coblong region showed that the maximum concentration did not meet the quality standards Class II (0.011 mg/L).

Rainwater quality indices in Sumur Bandung region was categorized as moderately polluted with a score of -20. Parameters that did not meet Class I and Class II criteria were minimum pH values (4.10), and average pH value (5.50). On the other hand, the parameters of heavy metals that did not meet the quality standards Class I and Class II criteria were maximum concentration of Cd (0.014

mg/L), maximum and average concentration of Pb (0.593 mg/L and 0.040 mg/L), and maximum concentration of Zn (0.326 mg/L).

Rainwater quality indices in Buah Batu region was categorized as moderately polluted with a score of -12. Parameters that did not meet the Class I and Class II criteria were minimum pH values (4.3) and average pH value (5.52). The parameters of heavy metals that did not meet the quality standards Class I and Class II criteria include maximum concentration of Pb (0.110 mg/L), maximum and average concentration of Zn (0.665 and 0.022 mg/L).

Table 4. The result of the STORET index for rainwater in the Bandung region

Sampling region	Class I			Class II		
	Score index	Class	Quality Status	Score index	Grade	Quality Status
Coblong	-10	B	Good condition	-10	B	Good condition
Sumur Bandung	-20	C	Moderately polluted	-20	C	Moderately polluted
Buah Batu	-12	C	Lightly polluted	-12	C	Lightly polluted

The heavy metal of rainwater especially Pb and Zn in Sumur Bandung region was influence of local emissions of motorized vehicle activities in Bandung urban centers, while Zn emissions in Buah Batu region was possible from local industries emission. Coblong region was an urban area with a densely populated and dominated by domestic activities. The differences of rainwater in 3 (three) region in Bandung urban area were impacted of different landuse.

The dominant anthropogenic sources of heavy metals in rainwater represent coal combustion, automobile exhaust, and industrial emissions [5,6,7,8]. Heavy metals from rainwater accumulate in the biosphere and may cause adverse human health and environmental effects [9,10].

Exposure to extreme water pH values on human health can irritate the eyes, skin, mucous membranes, and gastrointestinal tract in sensitive people. A pH value of less than 4 can cause red eyes and irritation, and if the pH is less than 2.5, it will cause irreversible and extensive damage to the epithelial tissue [11].

EPA explained that the solubility of oxides of nitrogen and sulfur dioxide in acid rain is related to health problems, especially irritation of the eyes and lung diseases such as asthma and bronchitis, NO_x is a significant contributor to the formation of ozone in the atmosphere which also has disruptive health effects on resources such as contaminating food and water.

Rainwater utilization, such as rainwater harvesting systems, must pay attention to regional characteristics such as topography, season conditions, and air pollutants that can be sources of rainwater contaminants and their effects on health [12,13]. The rainwater can then be used for drinking water, agricultural irrigation, urban greening, and other needs that require good water quality [14].

4. Conclusion

Determining rainwater quality in the Bandung urban region was important before rainwater was using for water resources of drinking water or other uses such as agriculture in urban regions (urban farming). Utilization of rainwater, it must pay attention to the quality of rainwater in each urban region despite the results of the analysis of rainwater quality showing the presence of heavy metals and do not meet the quality standards for Class I and Class II criteria. This is due to prevent the impact of rainwater utilization on human health. Therefore, with the detection of heavy metals such as Pb in rainwater, the possibility of Pb accumulation must be considered, especially in plants if consumed directly.

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Water quality indices for rainwater quality assessment in Bandung urban region

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Water quality indices for rainwater quality assessment in Bandung urban region

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Abstract. Water quality indices (WQI) using STORET method has been used to assess rainwater quality in the Bandung urban regions, based on monitoring data at three locations (Coblong, Sumur Bandung, and Buah Batu). Rainwater samples were analyzed by detecting pH, SO_4^{2-}, NO_3^-, Cl^-, and heavy metals (As, Cd, Cr, Pb, and Zn) compared with Indonesian Government Regulation No. 82 Year 2001. Rainwater quality showed polluted based on the parameters of the water quality indices analysis using the Class I and Class II criteria. Rainwater quality in Bandung urban region were lightly polluted (Coblong) and moderately polluted (Sumur Bandung and Buah Batu). Rainwater can potentially become a water sources alternative for domestic use and urban farming in Bandung urban region, but it requires further treatment for better quality.

1. Introduction

The water quality indices is a single number to state the quality of water sources, the determination of water quality indices is carried out through 4 (four) steps: (1) parameter selection, (2) parameter transformation which transforms unit differences and dimensions to the general scale, (3) parameter weighting, and (4) aggregation of sub-indices to produce the final indices value [1].

The research on the water quality indices in Izombe of Niger Delta Region in monitoring the level of rainwater pollution and borehole water as the primary water source in the region compared to the drinking water quality standards from World Health Organization (WHO) showed that the parameters of temperature and color in rainwater exceeded WHO standards for drinking water. The results of analysis showed that the pH of rainwater samples was acidic with a pH range of 5.1-6.4 (average 5.8). This indicated that the rainwater was more acidic than borehole water [2].

The rainwater analysis in Africa to identify rainwater parameters as compared to water quality standards from WHO showed that rainwater in the Metropolis City of Uyo was not safe for drinking, where the total value of Pollution Index (PI) had indicated presence of Ni, Cd, Pb, and Fe which caused rainwater have a risk when consumed [3].

The use of rainwater in Indonesia has been regulated according to the Regulation of the Minister of Environment No. 12 Year 2009 about Rainwater Utilization were activities to collecting, using, and adsorbing rainwater into soil as groundwater conservation. Rainwater as raw water in Indonesia must meet water quality standard requirements based on Government Regulation No.82 Year 2001 about

Management of Water Quality and Water Pollution Control. The most widely used water quality indices method in Indonesia is the STORET (Storage and Retrieval) method.

Analysis of the water quality indices on raw water sources, especially rainwater, has shown that the water quality indices analysis method can produce recommendations regarding the feasibility of using rainwater as raw water for drinking water and domestic needs.

The Bandung urban region has high rainfall every year between 2,000-3,000 mm/year, but rainwater utilization must consider the potential contamination from air pollution due to human activities and industrialization both local and long-distance pollutant sources. Therefore, the water quality indices analysis can be used as a method for rainwater quality analysis in the Bandung urban region. This paper aims to explain the results of rainwater quality indices analysis in the Bandung urban region using the STORET method to determine the feasibility of rainwater before being utilized.

2. Material and Method

2.1. Study Region

Weekly rainwater samples were collected in bulk polyethylene bottle during rainfall from different locations at 3 (three) locations in the urban regions of Bandung: (1) Coblong region (06º55'11,07"S 107º36'04,54" E), (2) Sumur Bandung region (06º55'11,07"S 107º36'39,34"E), and (3) Buah Batu region (06º53'26,69"S 107º36'43,73"U), as explained in Figure 1. Sampling was carried out in 2016 and 2017, samples were collected and analyzed in the laboratory.

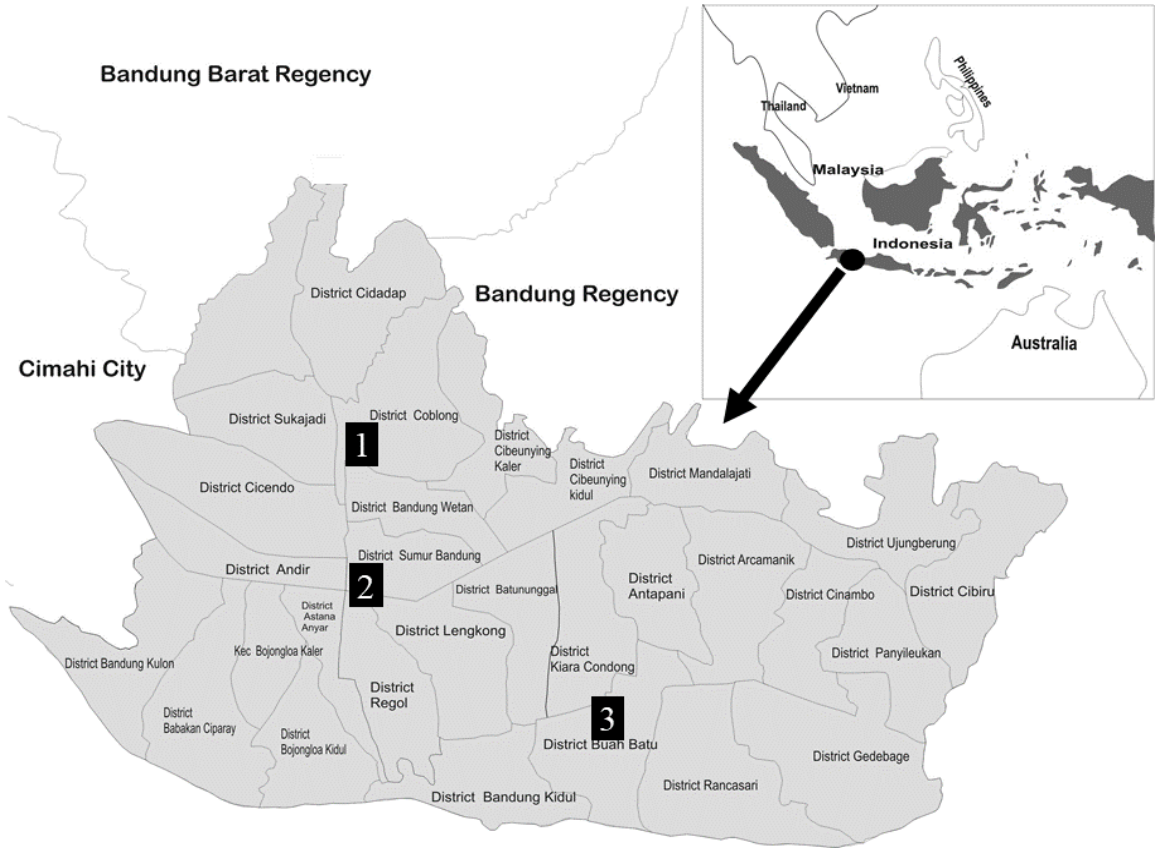

Figure 1. Sampling location in Bandung urban region

2.2. Rainwater analysis

The pH of rainwater varied between 3.0-7.5 pH units, as measured using a pH meter with a measurement accuracy of ± 0.01 pH units at a measurement temperature of 25°C. The pH meter has been calibrated with standard solution of pH 4, pH 6.86, and pH 10.

Ion chromatography (IC) was used to measure rainwater concentration of sulfate ions, nitrate and chloride, while heavy metals (As, Cd, Cr, Pb, and Zn) using a multi-element method with inductively couple plasma (ICP) [4]. The detection limits for heavy metal analysis were As (< 0.002 mg/L), Cd (< 0.001 mg/L), Cr (< 0.001 mg/L), Pb (< 0.001 mg/L), and Zn (< 0.002 mg/L).

2.3. Data Analysis

STORET refers overall to "STORage and RETrieval" was an electronic data system for water quality monitoring data developed by EPA. The STORET method is one commonly used method for determining the status of water quality in Indonesia. This method identifies which parameters meet or exceed water quality standards. The STORET method compares the water quality data with the adjusted water quality standard to determine water quality status.

The parameters analyzed to obtain indices values were pH, SO_4^{2-}, NO_3^-, Cl^-, As, Cd, Cr, Pb, and Zn. The parameter values were then compared with water quality criteria according to Government Regulation No. 82 Year 2001, as described in Table 1.

Table 1. Criteria of water quality based on class

Parameter	Unit	Class	
		I	II
pH	-	6 – 9	6 – 9
SO_4^{2-}	mg/L	400	(-)
NO_3^-	mg/L	10	(-)
Cl^-	mg/L	600	(-)
As	mg/L	0,05	1,00
Cd	mg/L	0,01	0,01
Cr	mg/L	0,05	0,05
Pb	mg/L	0,03	0,03
Zn	mg/L	0,05	0,05

The water quality classification used in this study was Class I and Class II criteria. Class I, is the raw water designated for drinking water, and/or other designation which requires water quality that is the same as the utility. Class II, is the water designated for water recreation facilities/ infrastructure, cultivation of freshwater fish, livestock, water for irrigating plantations, and/or other designations that require water quality that is the same as those uses. Thus, it is expected that rainwater can potentially be used as an alternative for raw water for drinking water and other domestic needs such as irrigating plants in urban regions (urban farming).

The determination of the status of water quality is through the value system from USEPA by classifying water quality in four classes, as described in Table 2. The classification of water quality base on STORET index were good condition, lightly polluted, moderately polluted, and heavy polluted.

Table 2. Classification of water status base on the STORET indices

Class	Criteria	Score	Quality status
A	Very good condition	0	Good condition
B	Good condition	$-1 \leq x \leq -10$	Lightly polluted
C	Moderately good condition	$-11 \leq x \leq -30$	Moderately polluted
D	Bad condition	≤ -31	Heavy polluted

3. Result and Discussion

3.1. Rainwater concentration

The concentration of rainwater parameter based on the result of data collection shows in Table 3. The results showed that the pH of rainwater in the Bandung region wass 3.13-7.06. The concentration of sulfate ions in rainwater shows a range of 8.86-17.82 mg/L, nitrate with 0.56-7.02 mg/L and chloride with 0.12-2.74 mg/L. The range of heavy metal concentrations detected in the Bandung urban region were As (< 0.002-0.046), Cd (< 0.001-0.011 mg/L), Cr (< 0.001-0.011), Pb (< 0.001-0.593) and Zn (< 0.002-0.665).

Table 3. Characteristic of rainwater in Bandung urban region

Parameter	Unit	Coblong			Sumur Bandung			Buah Batu		
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
pH	-	3.13	7.06	5.40	4.10	6.70	5.50	4.30	6.86	5.52
SO_4^{2-}	mg/L	0.86	6.50	3.15	1.54	9.24	4.01	1.00	17.82	3.92
NO_3^-	mg/L	0.69	4.19	1.66	0.69	3.90	1.75	0.56	7.02	1.68
Cl^-	mg/L	0.12	2.74	0.42	0.14	1.39	0.43	0.12	1.44	0.41
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Cd	mg/L	< 0.001	0.011	0.010	< 0.001	0.014	0.001	< 0.001	0.007	0.001
Cr	mg/L	< 0.001	0.011	0.001	< 0.001	0.004	0.001	< 0.001	0.002	<0.001
Pb	mg/L	< 0.001	0.153	0.016	< 0.001	0.593	0.040	< 0.001	0.110	0.016
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Rainwater quality indices in Bandung urban region base on STORET method showed different quality status indices between different location, because of small spatial difference in this region. The rainwater quality indices result shows in Table 4. The rainwater quality indices at Coblong region based on the STORET calculation is categorized as lightly polluted with a score of -10. Parameters that did not meet Class I and Class II criteria were minimum pH value (3.13), average pH value (5.4), and maximum concentration of Pb (0.153 mg/L). Other metal parameters, Cd in Coblong region showed that the maximum concentration did not meet the quality standards Class II (0.011 mg/L).

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maximum and average concentration of Pb (0.593 mg/L and 0.040 mg/L), and maximum concentration of Zn (0.326 mg/L).

Rainwater quality indices in Buah Batu region was categorized as moderately polluted with a score of -12. Parameters that did not meet the Class I and Class II criteria were minimum pH values (4.3) and average pH value (5.52). The parameters of heavy metals that did not meet the quality standards Class I and Class II criteria include maximum concentration of Pb (0.110 mg/L), maximum and average concentration of Zn (0.665 and 0.022 mg/L).

Table 4. The result of the STORET index for rainwater in the Bandung region

Sampling region	Class I			Class II		
	Score index	Class	Quality Status	Score index	Grade	Quality Status
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