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Preface

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Preface

Kitakyushu has become well-known around the world as a green growth city. Today, Kitakyushu is turning its eyes towards the ultimate goal of achieving a "zero-carbon society," which has been agreed upon at the international level to be indispensable in building a bright and happy future for Asia. To this goal, the University of Kitakyushu promotes collaboration research, human development, and business development of research outcomes in collaboration with many universities in different countries.

One of the results of this effort was implementing the first ICRC (International Conference Research Collaboration) in March 2018, on Improvement of City Environmental Quality, in which 10 universities participated from 3 countries. The purpose of this conference was to build international networking between the University of Kitakyushu and the universities included Universitas Andalas, Universitas Lampung, Universitas Pasundan, Universitas Pendidikan Indonesia, Institut Teknologi Bandung, Universitas Negeri Malang, Universitas Padjadjaran, Universitas Langlangbuana, Universitas Sumatera Utara, Universitas Janabadra, and University of Malaya, Malaysia. These universities have similar research interests for the Improvement of Urban Environmental Quality. In this first conference in 2018, 54 articles of the consortium at the conference were disseminated and published through the ICRC scientific journal.

For the second ICRC, the total of 132 participants have come from 30 universities which include UPI, University of Malaya, State University of Malang, University of North Sumatra, ITB, University of Lampung, University of Pakuan, University of Diponegoro, University of Airlangga, University of Trisakti, IPB, Ndejje University, and many more. The discussions cover the following topics:

1. Solid Waste Management and Treatment
2. Air Pollution Monitoring
3. Water Treatment and Resource Management
4. Low Carbon Initiative
5. Environmental Education
6. Environmental Culture
7. Environmental Health
8. Renewable Energy

Since the active cases of COVID-19 in Japan were still increasing, the conference was held in an online meeting on April 25-26, 2021, using the Zoom Application. The organizing committee invited 5 keynote speakers: Prof. Dr. Muhammad Ali, M.A. (Universitas Pendidikan Indonesia); Prof. Yu Chun Wang (Chung Yuan Christian University); Prof. Hiroyuki Miyake (The University of Kitakyushu); Assoc. Prof. Dr. Norlidah Alias (University of Malaya); and Dina Ibrahim (Mansoura University) who is divided into 2 plenary sessions. Each speaker was given 25 minutes for the talk and 15 minutes for discussion. Then, the parallel session was conducted using the breakout room facility provided by the Zoom Application. We made 8 rooms where each room consists of 9-10 presenters. The presenter and participant were allowed to enter any room they like. However, the presenter is intended to join the room 10 minutes before they give a talk. This conference again opens opportunities for collaboration between the University of Kitakyushu and all academics interested in researching environmental management, education, and technology.

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This "Collaboration Research Program" has been ongoing for 6 years. There have been plenty of scientific journals produced through the conference conducted, and more exciting research resulted from this conference.

We selected 62 high-quality manuscripts for submission in Earth and Environmental Science IOP Proceedings. These papers consist of environmental management, health, technology, science, and education. All of the manuscripts are peer-reviewed to meet the quality of a scientific publication. We want to express our gratitude to the chairwoman of this conference, distinguished keynote speaker, reviewers, moderators of the parallel session, and all of the participants. We want to acknowledge the IOPP for publishing our conference proceedings. We hope that the readers could get some valuable information and knowledge from our proceedings. We apologize for all of the mistakes that found during the conference and also found in the published papers.

Since the Japan embassy cannot accept any foreign tourist (lockdown) from January until April 2021, the conference committees held the International Conference on Research Collaboration of Environmental Science (ICRC) 2021 in an online setting using the Zoom Application 25-26, 2021. The virtual conference was successfully held by inviting 5 keynote speakers, 132 participants from 30 universities and 8 countries, 8 moderators, and 18 committees to attend this meeting. Each keynote speaker has 15 minutes to talk and 15 minutes for discussion. The presenter has 10 minutes for giving a talk and 5 minutes for questions and answers. Sixty-two (62) high-quality papers are submitted to IOP conference proceedings. We want to acknowledge all conference parties for their dedication, contributions and supports to this conference. Without their help, this meeting means nothing. We apologize for all of the mistakes found during the conference and found in the published papers.

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Preface

Papers

Assessment of cadmium concentration, bioavailability, and toxicity in sediments from Saguling reservoir, West Java Province

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Assessment of cadmium concentration, bioavailability, and toxicity in sediments from Saguling reservoir, West Java Province

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Abstract. This study aims to assess the concentration, bioavailability, and toxicity of cadmium in sediments. Surface sediment samples were taken from 12 sampling locations during the rainy and dry seasons from 2015-2017. Cadmium concentrations were analyzed using ICP-OES. Potential ecological risk index (PERI) methods assess the quality of lake sediments concerning heavy metal contamination. Risk Assessment Code (RAC) is a method used to assess the bioavailability of metals in aquatic sediments. The concentration of cadmium in the sediments during the rainy and dry seasons is high compared to the standards. The average concentration in rainy season 14.82 ± 1.48 $mg.kg^{-1}$ and dry season 11.12 ± 2.16 $mg.kg^{-1}$. Based on the assessment of sediment quality is categorized as extremely polluted during the rainy and dry seasons. The sediment quality has been contaminated with cadmium with the serious ecological risk category in two seasons. This means that Cadmium pollution has had a serious impact on the reservoir ecosystem. The bioavailability of cadmium in the dry season is higher than in the rainy season. This suggests that in the dry season, cadmium is more bioavailable and more able to enter the food chain. The toxicity of cadmium is higher in the dry season.

1. Introduction

Saguling Reservoir is one of the largest artificial lakes in West Java Province, with its main function as a Hydroelectric Power Plant. Still, along with water needs, this reservoir is used as irrigation water, fisheries, and the final plan as a raw water source for needs, in the Bandung Basin Area. The main water source of the Saguling Reservoir is the Citarum River. The Citarum River watershed is an area with diverse population activities, such as domestic, industrial, agricultural, and mining. [1,2]. The waste from human activities causes the Citarum River quality to be heavily polluted, and there are even some metals that do not meet the quality of raw materials. Pollutants found in the Citarum River, including heavy metals, will accumulate in the Saguling Reservoir [3,4].

The water quality of Saguling Reservoir is getting worse due to the input of polluted Citarum River water. In addition to the high organic content in water, such as Cadmium, Cr, Pb, and Cu [5]. All pollutants that enter the Saguling Reservoir will accumulate in the sediment. The concentration of four heavy metals, namely Cadmium, Cr, Pb, and Cu, in the sediments of the Saguling Reservoir was recorded as high [5]. A sediment is a place for heavy metal accumulation in aquatic ecosystems. Heavy metals will be released and become a source of pollution in these waters. Sediment plays an essential role in the movement and collection of heavy metals, which can cause toxicity impacts on biota [6]. Sediment is the bottom layer of the lake. Generally, heavy metals that are decomposed in the sediment are not too dangerous for aquatic living things. Still, the influence of dynamic marine conditions such as changes in pH and redox potential will cause the metals deposited in the sediments to diffuse into the water [7]. The function of Saguling Reservoir as an area for aquaculture, irrigation water, and a source of raw water requires good water quality. It is free from the presence of heavy metals. The purpose of this study is to determine the concentration of cadmium in water and sediment during the rainy and dry seasons and the value of its bioavailability and toxicity.

2. Methodology

Surface sediment originates from 12 sampling locations in the Saguling Reservoir during two seasons. The research was conducted for three years, from 2015-2017. Sediment samples representing the rainy season were taken in November 2015 and April 2017. The dry season was carried out in August 2016 and September 2017. The sampling locations are presented in table 1 and figure 1.

Table 1. Sampling location.

Number	Latitude (N)	Longitude (E)	Address
1A	06˚56'29,8"	107º32'10,7"	Citarum River Nanjung Section
1B	06º54'58,9"	107º28'32,3"	Citarum River Batujajar Section
2	06º53'13,5"	107º28'32,3"	Trash Boom Cihaur Village
3	06º53'13,4"	107º27'09,0"	Semarang Village
4	06º53'13,0"	107º25'54,4"	Cihaur Estuary
5	06º56'07,6"	107º27'25,5"	Cipantik Estuary
6	06º57'14,6"	107º26'03,8"	Seminyak Estuary
7	06º56'14,9"	107º24'50,8"	Cijere Estuary
8	06º56'00,4"	107º22'22.4"	Cijambu Estuary
9	06º54'54,4"	107º22'26,3"	intake structure
10A	06º51'49,8"	107º20'57,0"	Trail race
10B	06º51'10,8"	107º20'58,0"	Citarum River Bantar Caringin Village

Surface sediment samples were collected at each sampling location by randomly mixing four to five samples. Heavy metal extraction is carried out using a sediment extraction procedure. The concentrations of cadmium were analyzed using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). The results were analyzed by comparing the heavy metal concentration of cadmium with standards based on the ANZECC (Australian and New Zealand Environmental and Conservation Council 1997 [8]. Other parameters analyzed were dissolved oxygen, redox potential, and pH in water measured directly in the field. The other two parameters are the percentage of clay and the total organic matter content in the sediment. The percentage of clay was analyzed based on the dry sieving method. The method Loss measured total organic matter on Ignition (LOI). The relationship between the physicochemical parameters and the concentration of heavy metals in the sediment was analyzed using the Pearson correlation.

Potential ecological risk index (PERI) methods assess the quality of lake sediments about heavy metal contamination. The principle of the index is to compare the measured heavy metal concentrations in the sediment with its background concentrations. The background concentration is for Cadmium is 0.34 ± 0.10 $mg.kg^{-1}$ [9]. Risk Assessment Code (RAC) is a method used to assess the bioavailability of metals in aquatic sediments. The principle of this method is to determine the number of heavy metal concentrations dissolved in the sediment, where this specific heavy metal can be easily absorbed by aquatic biota [6].

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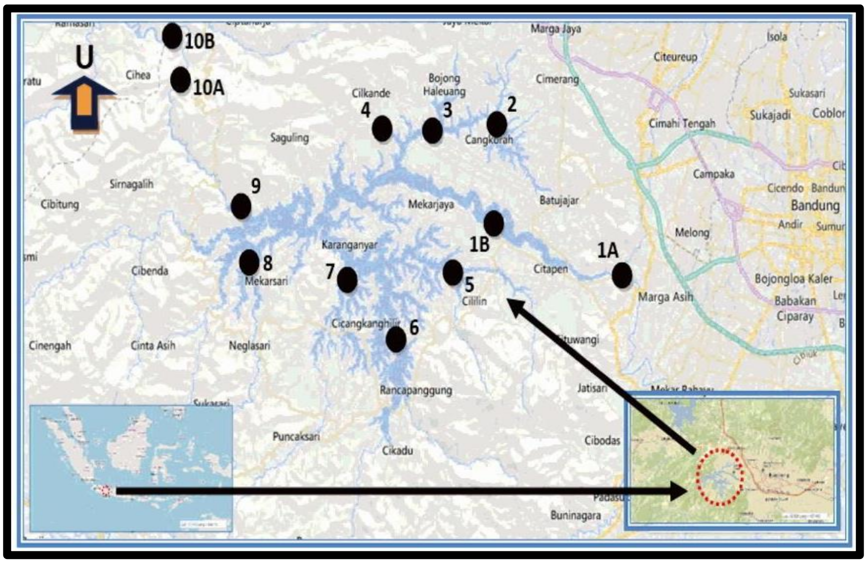

Figure 1. Sampling location.

3. Results and discussion

Saguling Reservoir is one of the main dam in West Java Province. The area of the Saguling Reservoir is 5,607 ha ± 643 m with an irregular shape with a maximum length of 18.4 km, an average width of 3 km with a maximum depth of 90 km, and an average depth of 17.5 km. The volume of the Saguling Reservoir is strongly influenced by the water discharge of the Citarum River, which is the leading water supplier of this reservoir. The maximum volume of the reservoir reaches 982 x 10^6 m^3 with a watershed area of 2,315 km^2. The water catchment area of Saguling Reservoir is the Bandung Basin area which includes Bandung City, Cimahi City, Bandung Regency, West Bandung Regency, and 3 Districts in Sumedang Regency. Anthropogenic activities in water catchment areas are diverse, from domestic, industrial, agricultural, livestock, and mining [1,2]. A total of 556 types of industries are scattered in the catchment area of the Saguling Reservoir. The most significant industries were the textile industry with 442 industries, followed by metals and electronics, food and beverages, rubber and plastics, chemicals, tannery, and paper. The industry is spread across various regions, with the most significant number in Bandung Regency 325 industries, followed by Cimahi City with 101 industries and 90 industries in Bandung City [1].

The concentration of cadmium in the sediments during the rainy and dry seasons is high compared to the standards used based on ANZECC, 1997, of 1.5 $mg.kg^{-1}$. The rainy season ranged from 11.43-16.68 $mg.kg^{-1}$ with an average value of 14.82 ± 1.48 $mg.kg^{-1}$. The average concentration was lower in the dry season than in the rainy season 11.12 ± 2.16 $mg.kg^{-1}$. The concentration of Cadmium ranged from 8.10-15.47 $mg.kg^{-1}$ (figure 2). Research on the concentration of cadmium in sediments has been carried out in several locations. The cadmium concentration in the sediments of the Saguling Reservoir is high in value compared to other countries. High concentrations of Cadmium in Lake Manchar Pakistan range from 4.9-9.7 $mg.kg^{-1}$ [10], Yellow River Delta in China of 4.3 $mg.kg^{-1}$ [11], Han River South Korea ranges between 57.28 ± 21.20 $mg.kg^{-1}$ [12], Dungtug Lake China of 4.65 mg/kg [13], and Losari Beach Makasar ranging from 0.05-0.25 $mg.kg^{-1}$ [14].

Based on the calculation of sediment quality, the sediment quality of the Saguling Reservoir has been contaminated with cadmium in the category of severe ecological risk in the rainy and dry season, meaning that Cadmium pollution has had a powerful impact on the reservoir ecosystem. As a comparison, the PERI value in the North China Luan River ranges from the North China Luan River, which is categorized as Severe ecological risk [15], China Dangting Lake ranges from the category of Serious ecological risk [15], the Djendjen River in North Algeria is categorized as Low ecological risk [16], the Java Sea is classified as Moderate ecological risk [17], and Uzuncayir Dam Tunceli Turkey is categorized as Low ecological risk [18].

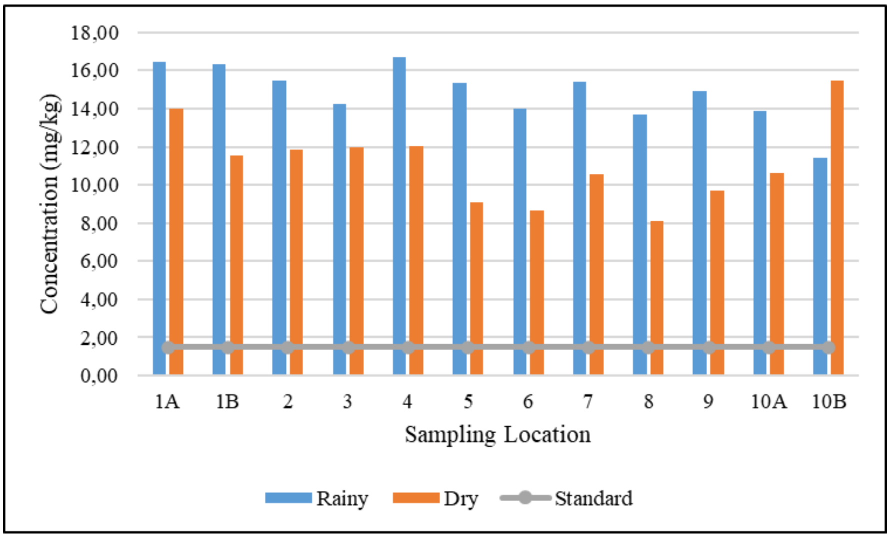

Figure 2. Cadmium concentration in Saguling dam sediment.

Metal speciation in sediments determines its availability (bioavailability) for biota. Metals in fractions 1, 2, and 3 are unstable metals, where environmental conditions greatly influence their movements. Metal in fraction 1 (F1) is the metal with the highest mobility (most available form) because it is the most exchangeable and has fragile binding (weakly adsorbed) to the sediment matrix so that it is most easily released and dissolved in the water column and therefore the most available and potentially absorbed and can cause toxicity to aquatic organisms [19]. The concentration of F1 in the rainy season ranges from 0.01-1.11 mg.kg^{-1} with an average value of 0.27 ± 0.28 mg.kg^{-1}, The average concentration in order from largest to smallest is F4> F2> F3> F1. Dry season F1 concentration ranged from 0.16 to 1.14 mg.kg^{-1} with an average value of 0.31 ± 0.27 mg.kg^{-1}. The average concentration of Cadmium in order from largest to smallest is F4> F2> F3> F1 (table 2).

Based on table 2, it can be seen that the average F1 value in the dry season is more significant than in the wet season. The highest F1 concentration occurs at point 1A, which indicates that there has been Cadmium contamination originating from human activities at that point. The RAC value in the rainy season ranges from 0.07-6.74 with an average value of 1.73, while in the dry season, it ranges from 1.16-8.15 with an average value of 2.79. The dry season RAC value is higher than the wet season, indicating that the cadmium is more bioavailable and more able to enter the food chain in the Saguling Dam in the dry season. The RAC category in the rainy season is included in the low category risk, while in the dry season, it is in the low category risk. During the dry season, all sampling points are included in the low category risk. The highest RAC value in the rainy and dry seasons is point 1A. Based on Table 2, The RAC value at point 1A, namely the inlet of the Saguling Reservoir in the Citarum-Nanjung River, the RAC value is the highest in the rainy and dry season. The RAC value at point 1A is close to medium risk. This must be watched out for because the cadmium at this point is easily dissolved. The results of research from other countries, such as the Xiawangang River in China, show a RAC value of 37.77, including the high-risk category. In Chauho Lake, it ranges from 4-5, including the low-risk category [20].

Determination of heavy metal contamination is an important aspect to reduce and control pollution in the aquatic environment. The bioavailability and toxicity of heavy metals are chemical-dependent. Determination of the contamination factor from metals is crucial to determine the degree of risk from heavy metals to the environment [20]. The release of heavy metals and their rate of speciation is primarily influenced by changes in water pH, sediment disturbance due to physical stirring, and changes in dissolved oxygen which will affect redox values. In aquatic environments, the concentration of heavy metals dissolved in water is low due to precipitation becoming solids or adsorbed into suspended particles and deposited into particles in sediments [20].

Table 2. Cadmium Speciation**.**

Sampling Location	Rainy Seasons					Dry Seasons				
	Total	F1	F2	F3	F4	Total	F1	F2	F3	F4
1A	16.46	1.11	1.55	0.58	9.37	13.98	1.14	0.86	0.66	9.78
1B	16.32	0.35	1.54	0.74	13.06	11.56	0.25	0.97	0.41	8.45
2	15.44	0.19	1.82	0.71	7.73	11.82	0.35	1.00	0.41	7.73
3	14.23	0.05	1.35	0.69	11.69	12.00	0.27	0.76	0.24	9.27
4	16.68	0.15	1.58	0.98	12.90	12.01	0.22	0.95	0.38	8.28
5	15.37	0.23	1.29	1.13	9.63	9.06	0.20	0.86	0.17	6.30
6	14.02	0.21	1.95	0.88	4.34	8.64	0.23	1.03	0.48	4.98
7	15.43	0.36	1.93	0.89	9.38	10.56	0.27	0.80	0.92	4.89
8	13.71	0.22	1.54	1.00	7.26	8.10	0.16	0.73	0.32	4.05
9	14.93	0.14	1.67	0.67	11.77	9.67	0.26	0.96	0.26	5.73
10A	13.86	0.01	0.58	0.63	9.85	10.65	0.16	1.01	0.57	7.98
10 B	11.43	0.16	0.81	0.30	8.26	15.47	0.18	0.69	0.32	12.58
Mean	14.82	0.27	1.47	0.77	9.60	11.13	0.31	0.89	0.43	7.50

The dissolved oxygen value is also influenced by the depth of the sampling point location. The depth of the Saguling Reservoir during the rainy season ranges from 11.25-43.00 m, and in the dry season, it is between 5.00-32.00 m [1]. The value of dissolved oxygen during the dry season ranges from 0.60 to 3.65 mg.L^{-1} with an average of-1.31 ± 0.60 mg.L^{-1}. The rainy season goes from 0.80 to 4.10 mg.L^{-1} with an average of 1.48 ± 0.80 mg.L^{-1} (Table 3).

Table 3. Parameter Influence Heavy Metal Concentration.

Sampling Location	Rainy Seasons					Dry Seasons				
	pH	eH (mVolts)	DO (mg.L^{-1})	Organic content (%)	Clay content (%)	pH	eH (mVolts)	DO (mg.L^{-1})	Organic content (%)	Clay content (%)
1A	7.11	-91.90	2.00	76.65	50.57	7.90	-38.50	1.70	91.16	57.40
1B	5.74	-100.00	1.00	89.61	77.77	7.41	-39.00	0.85	90.74	58.87
2	6.28	-64.80	0.95	86.24	72.69	8.41	-65.00	0.70	88.72	72.87
3	5.61	-60.35	0.90	85.53	83.09	8.19	-55.50	0.60	89.78	76.06
4	4.97	-91.45	1.00	85.27	79.07	7.90	-85.50	0.75	91.01	71.94
5	3.99	-48.55	1.10	88.73	86.96	7.67	-68.00	1.05	90.38	66.81
6	3.85	-56.65	1.25	85.37	82.41	7.67	-77.00	1.20	93.83	70.79
7	5.18	-35.85	0.80	86.75	79.06	7.95	-88.00	1.25	87.23	71.42
8	4.45	-82.15	1.05	85.97	76.37	7.69	-89.00	1.05	83.41	84.92
9	4.82	-73.85	1.00	84.02	77.78	7.78	-80.00	1.25	88.06	67.49
10 A	6.49	-47.95	2.55	33.01	13.06	7.52	-24.00	1.65	33.51	25.30
10 B	6.39	-36.65	4.10	35.13	27.04	7.38	-23.50	3.65	39.30	13.09

The potential redox value of the sediments in the dry season ranges from -89.00 to -23.50 volts with an average of -61.08 ± 24.48 mVolts. The rainy season ranges from -126.90 to -191.45 mVolts with an average of 156.26 ± 19.40 mVolts (table 3). The pH value in the Saguling Reservoir water during the dry season ranges from 7.38-8.41, with an average of 7.79 ± 0.30. The rainy season ranges from 3.85-7.11, with an average of 5.41 ± 1.04 (table 3). The percentage of clay in the sediments during the dry season ranged from 13.09 to 84.94%, with an average of 61.41 ± 21.16%. The rainy season ranges from 13.06-86.96%, with an average of 67.16 ± 23.96 (table 3). The percentage of organic matter in the sediments in the dry season ranges from 58.51-93.83%, with an average of 84.76 ± 11.52%. The rainy season ranges from 76.65 to 89.61%, with an average of 85.19 ± 3.24 (table 3). From the results of the

Pearson correlation in the dry season, it can be concluded that the seven parameters have a relatively low correlation to F1. The higher the organic value in the rainy season, the higher the F1 concentration value in the rainy season.

4. Conclusion

The Saguling Reservoir sediment has been contaminated with cadmium. The category of very high contamination during the rainy and dry seasons at all sampling points. It was meaning that Cadmium pollution has had a severe impact on the reservoir ecosystem. The bioavailability of cadmium in the sediment during the rainy season is between 0.07-6.74 with an average value of 1.73, while in the dry season, it is between 1.16-8.15 with an average value of 2.79. The bioavailability value of the dry season is higher than that of the rainy season, indicating that in the dry season, the cadmium is more bioavailable and more able to enter the food chain in the Saguling Dam.

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