

# 3<sup>rd</sup> INTERNATIONAL CONFERENCE ON ENERGY, ENVIRONMENT AND INFORMATION SYSTEM 2018 (ICENIS 2018)

Tuesday - Wednesday, August 14<sup>th</sup> - 15<sup>th</sup>, 2018

Theme:

“Strengthening Planning and Implementation on Energy, Environmental and Information System Toward Low Carbon Society”

### Keynote Speakers



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Kyushu University, Japan



Prof. Dr. Nasrudin  
University of Malaya, Malaysia



Prof. Ho Ching Siong  
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Dr. Junichi Fujino  
IOES - Japan



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Rajamangala University of Technology Phra Nakhon, Thailand



Dr. Ing. Sudarno  
School of Postgraduate Studies Diponegoro University, Indonesia

### A Call for Participant

After Successful in the previous event with 200 selected paper, we invite for 3<sup>rd</sup> ICENIS 2018 on August 14<sup>th</sup> - 15<sup>th</sup>, 2018 at Santika Premier Hotel Semarang, with the theme “Strengthening Planning and Implementation on Energy, Environmental and Information System Toward Low Carbon Society”

### Topics of Conference

- Energy
  - Energy Management and Policy
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  - Renewable Energy
  - Nonrenewable Energy / Fossil Energy
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  - Environmental Conservation
  - Environmental Policy, Planning and Education
  - Environmental Technology
  - Environmental Health and Toxicology
  - Environmental Epidemiology
  - Pollution Control
  - Waste Management
  - Green Infrastructure and Resilience
- Information System
  - Business Intelligence
  - Supply Chain Information Systems
  - Industrial Information Systems
  - Decision Support Systems
  - Smart Information Systems
  - Health, Safety and Environment Information Systems
- Societal Change, Culture and Low Carbon Development
  - Infrastructure Development and Low Carbon Society
  - Economic Perspective in Low Carbon Society
  - Government and International Relation
  - Public Policy
  - Labour and Formal- Informal Worker
  - Health and Gender
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### Publication

All accepted papers will published in **Scopus - Indexed EIS Web of Conferences Series**.

### Important Dates

Abstract Submission : before July 09<sup>th</sup>, 2018  
Full Paper Submission : before July 13<sup>th</sup>, 2018  
Early Registration Payment : before July 16<sup>th</sup>, 2018

### Registration Fee

Before July 10 <sup>th</sup> , 2018	
Indonesian Presenter	IDR 2.500.000,00/paper
International Presenter	USD 290/paper
Student Presenter	IDR 2.400.000,00/paper
Indonesian Participant	IDR 1.400.000,00
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### Venue / Place

Santika Premier Hotel – Semarang  
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### More information

Conference Website:

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# Preface

This is the proceeding of the 3<sup>rd</sup> International Conference on Energy, Environmental and Information System (**ICENIS**) 2018. The theme of ICENIS 2018 is “Strengthening Planning and Implementation Energy, Environment, and Information System Toward Low Carbon Society. ICENIS 2018 discussing the sustainability of the natural system, i.e energy management and policy, energy conservation, environmental education and planning, environmental conservation, environmental technology, environmental health, pollution control, waste management, green infrastructure and resilience, system information of supply chain and decision support system. Moreover the ICENIS 2018 introducing discussion of social aspect in low carbon society such as economic perspective, government, public policy and international relation, formal informal worker, gender, media and culture development

ICENIS 2018 organized by school of Postgraduate Studies, Diponegoro University has been conducted 14-15<sup>th</sup> august 2018. The conference has successfully performing forum to transferring and discussing research result among the researcher, students, government, private sector or industries. More than 390 participants and presenters from several countries such as Indonesia, Malaysia, Germany, Sudan, Australia, Japan, Libya have attended the conference to share their significant contribution in research related to energy, environment and information system. This proceeding contains 334 selected paper from the conference.

We would like to express our gratitude to all authors and members of scientific committee, reviewers and also organizing committee for their contribution to the success of the conference.

Guest Editors

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Volume 73 (2018)

### The 3<sup>rd</sup> International Conference on Energy, Environmental and Information System (ICENIS 2018)

Semarang, Indonesia, August 14-15, 2018  
Hadiyanto, Maryono and Budi Warsito (Eds.)

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Root Uptake and Distribution of Radionuclides  $^{134}\text{Cs}$  and  $^{60}\text{Co}$  in Sunflower Plants  
(*Helianthus annuus. L*) 05027

Chalid Afif Alfajrin Achmad and Hadiyanto

Published online: 21 December 2018

DOI: <https://doi.org/10.1051/e3sconf/20187305027>

PDF (1.340 MB) | [References](#) | [NASA ADS Abstract Service](#)

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The Design Of Grain Drying Oven Using Residual Exhaust Gas From Diesel Engine With  
Heat Transfer Analysis 05028

Sahupala Peter, Perenden Daniel and Wely Wullur Christian

Published online: 21 December 2018

DOI: <https://doi.org/10.1051/e3sconf/20187305028>

PDF (5.402 MB) | [References](#) | [NASA ADS Abstract Service](#)

---

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Static and Dynamic Analysis of Vibro Fluidized Bed Dryer using Finite Element Method  
05029

Yohana Eflita, Haryanto Ismoyo, Dwiputra Muhamad Adrian and Luqmanul H Yusuf

Published online: 21 December 2018

DOI: <https://doi.org/10.1051/e3sconf/20187305029>

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---

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Characterization Of Coal Acid Water In Void Pools Of Coal Mining In South Kalimantan  
05030

Kiswanto, Heru Susanto and Sudarno

Published online: 21 December 2018

DOI: <https://doi.org/10.1051/e3sconf/20187305030>

PDF (1.587 MB) | [References](#) | [NASA ADS Abstract Service](#)

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Life Cycle Assessment of Food Processing Systems in Toba Samosir Regency 05031

Asido Situmorang and Yosef Manik

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---

**- Environmental Health, Toxicology and Epidemiology**

Open Access

### Analysis of a Prey-Predator Fishing Model for Harvesting with The Limited Effect of Density and Toxicity 06001

Anies Munawwaroh Dita, Sutimin and Khabibah Siti

Published online: 21 December 2018

DOI: <https://doi.org/10.1051/e3sconf/20187306001>

PDF (9.250 MB) | [References](#) | [NASA ADS Abstract Service](#)

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### Mercury toxicity potential from artisanal and small scale gold mines in Lebong Regency, Bengkulu Province 06002

Munawar Ali, Suhartoyo Hery and Suci Asriani Putri

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DOI: <https://doi.org/10.1051/e3sconf/20187306002>

PDF (1.162 MB) | [References](#) | [NASA ADS Abstract Service](#)

---

 Open Access

### Why it is often underestimated: Historical Study of Ammonia Gas Exposure Impacts towards Human Health 06003

Mutia Pratiwi Diana, Widaningroem Soemantodjo Roekmijati and Warno Utomo Suyud

Published online: 21 December 2018

DOI: <https://doi.org/10.1051/e3sconf/20187306003>

PDF (1.153 MB) | [References](#) | [NASA ADS Abstract Service](#)

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 Open Access

### Assessment of Water Quality in Cilutung Watershed 06004

Oktariani Alvira, Kusratmoko Eko and Kuswantoro

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DOI: <https://doi.org/10.1051/e3sconf/20187306004>

PDF (5.575 MB) | [References](#) | [NASA ADS Abstract Service](#)

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 Open Access

### Efficacy of Insecticide Formulation of Organo Phosphate 5 Ec Mixture of Maltahion on Mosquito *Aedes Aegypti* 06005

Supriyo Edy, Broto Wisnu, Pujiastuti Isti and Arifan Fahmi

Published online: 21 December 2018

DOI: <https://doi.org/10.1051/e3sconf/20187306005>

PDF (1.174 MB) | [References](#) | [NASA ADS Abstract Service](#)

Open Access

Effect of Cadmium Exposure in Polymorphisms Gene NOS3, Blood Cadmium Level, Nitric Oxide Level, Blood Pressure and Antioxidant Enzymes 06006

Hernayanti, Santoso Slamet and Lestari Sri

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---

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The Effect of Green Purchase Intention Factors on The Environmental Friendly Detergent Product (Lerak) 06007

Budi Puspitasari Nia, Ika Rinawati Dyah, Suliantoro Hery and Dwi Sutrisno Bayu

Published online: 21 December 2018

DOI: <https://doi.org/10.1051/e3sconf/20187306007>

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---

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Kinetics Of The Enzymatic Transesterification Of Tuna Oil Catalyzed By Immobilized *Candida Rugose* Lipase To Produce Structured Lipid High In Omega-3 Fatty Acids 06008

Amalia Rizka, Wahyuningsih Wahyuningsih, Broto RTD Wisnu, Endy Yulianto Mohamad, Rama Devara Hafizh and Yunita Indah Sari Dwi

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DOI: <https://doi.org/10.1051/e3sconf/20187306008>

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Assessment of Heavy Metal Contamination in Saguling Reservoir Water West Java Province Indonesia 06009

Wardhani Eka, Notodarmojo Suprihanto and Roosmini Dwina

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Acclimatization, Water Intake Adequacy Rate, Individual Characteristics and Heat Strain: A Cross-Sectional Study on Heat Exposed Workers 06010

Imas Tejo Sutono Kemala, Setyaningsih Yuliani and Suroto

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Improving The Quality and Quantity of Instant Functional Beverages of Ginger at KUB Tlogosari, Temanggung 06011

Wahyuningsih Wahyuningsih, Pudjihastuti Isti, Arifan Fahmi, Amalia Rizka and Rama Devara Hafiz

Published online: 21 December 2018

DOI: <https://doi.org/10.1051/e3sconf/20187306011>

PDF (2.856 MB) | [References](#) | [NASA ADS Abstract Service](#)

---

Open Access

Mapping of Work Hazards Environment and Illness Risk of Employment on Brass Craftsman Based on Geographic Information System (GIS) 06012

Debora Ambarita Sannita, Setyaningsih Yuliani, Lestantyo Daru and Dharmawan Yudhy

Published online: 21 December 2018

DOI: <https://doi.org/10.1051/e3sconf/20187306012>

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---

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Factors affecting low back pain complaint to workers in gravity casting area automotive industry Indonesia 06013

Rachmawati Siti and Muthia Zulfia

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The Resistance of Potatoes by Application of *Trichoderma viride* Antagonists Fungus 06014

Purwantisari Susiana, Priyatmojo Achmadi, P. Sancayaningsih Retno, S. Kasiamdari Rina and Budihardjo Kadarwati

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DOI: <https://doi.org/10.1051/e3sconf/20187306014>

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---

Open Access

The potential leaves extract of *Piper methysticum* (piperaceae) as botanical insecticide against *Crociodomia pavonana* (f.) larvae mortality (lepidoptera:crambidae) 06015

A. Mendes Johana, Y. Ekowati Nurhening, S. Susanti Diana, Sembiring Jefri, Prasetia Andri and Widijastuti Rosmala

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DOI: <https://doi.org/10.1051/e3sconf/20187306015>

PDF (1.450 MB) | [References](#) | [NASA ADS Abstract Service](#)

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Study Amendment of Post-Field Classification of Illegal Gold in Kolaka Regency, Southeast Sulawesi Province 06016

eka suardana Alfian and Muhammad Fuad

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Correlation of Container Characteristic, Water-Container Draining Practice, and the Ownership Status of Residence with the Presence of *Aedes Sp* Larvae in Tembalang, Semarang 06017

Anggie Praditya Aprisa, Martini Martini and Dian Saraswati Lintang

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PDF (1.207 MB) | [References](#) | [NASA ADS Abstract Service](#)

---

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Analysis of optimal harvesting of a prey-predator fishery model with the limited sources of prey and presence of toxicity 06018

Sutimin, Khabibah Siti and Anies Munawwaroh Dita

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PDF (800.3 KB) | [References](#) | [NASA ADS Abstract Service](#)

---

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Habitat characteristics with *an. barbirostris* larva density in Bulukumba 06019

Suryadi Iwan

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---

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A Model for Hypogalactia Treatment Using *Electrical Acupoint* to Increase Breast Milk Volume and Improve Prolactin Content 06020

Najwatul Maula Sheyla, Nurul Widyawati Melyana and Suryono Suryono

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DOI: <https://doi.org/10.1051/e3sconf/20187306020>

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Susanto Novie, Budiawan Wiwik and Fardiansyah Ahmad

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The Use of Paint Waste as A Raw Material of Paving Block 07001

Permana-Citra Ari Dina, Purwanto Purwanto and Soenoko Henna Rya

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PDF (1.463 MB) | [References](#) | [NASA ADS Abstract Service](#)

---

Open Access

Study of Rendement of Red Ginger Essential Oil from Red Ginger Waste by Using Steam Distillation Process 07002

Widayat Widayat, Ayu Sofiati Dita, Cahyono Bambang and Satriadi Hantoro

Published online: 21 December 2018

DOI: <https://doi.org/10.1051/e3sconf/20187307002>

PDF (1.202 MB) | [References](#) | [NASA ADS Abstract Service](#)

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The Effectiveness of Using Hyacinth Plant As Phytoremediation Agent On Paper Industry Liquid Waste 07003

Kartika Febriani Ika and Hadiyanto

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DOI: <https://doi.org/10.1051/e3sconf/20187307003>

PDF (1.481 MB) | [References](#) | [NASA ADS Abstract Service](#)

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# Assessment of Heavy Metal Contamination in Saguling Reservoir Water West Java Province Indonesia

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**Abstract.** Saguling reservoir in West Java Province is becoming increasingly polluted by heavy metals. The purpose of this study was to determine the level of four heavy metals such as Cd, Cr, Cu, and Pb concentration at Saguling Reservoir at 12 sampling location. Water samples were collected during rainy and summer 2008-2017 to determine the spatial distribution seasonal and temporal variation of different heavy metal contents. Mean metals concentrations in summer seasons were Cd, Cr, Cu, and Pb higher than rainy season. Mean concentration of Cd, Cu, Cr, and Pb in water samples were accordance water quality standard in both season. Heavy metal pollution that occurs in the Saguling reservoir must be monitored because this reservoir is planned to be a source of raw water for Bandung City.

**Keywords:** Assessment; Concentration; Heavy Metal; Saguling; Water.

## 1 Introduction

Recently water pollution has become a extremely severe and visible form of environmental contamination as water bodies [1]. Heavy metals are one of the main pollutants of the environment, especially in urban areas. The pollution from industrial effluents, urban and agricultural waste in some rivers, reservoir, and water bodies has reached serious levels in Indonesia. Heavy metals are natural compounded elements occurring in the environment and different in concentrations along the earth crust. Although metals are natural constituents of our earth and they are present in all environments, their concentrations are drastically altered by man-made actions. The natural distributions of metals have been distressed in terrestrial and aquatic environment due to industrialization and urbanization in last few decades [2]. Heavy metals are natural trace components of the aquatic environment, but their levels have increased due to domestic, industrial, mining and agricultural activities [3-4]. Heavy metal concentrations can change during the year in the ecosystem, can also change during the growing season [5].

Saguling reservoir waters receive contaminants via local anthropogenic activities and through riverine inputs. This Reservoir was built on The Citarum River. The Citarum Watershed is home to the largest industrial area in West Java Province. Several economic activity are performed along Citarum River, including mining and agriculture.

The main objective of this paper was to determine level of selected heavy metals (Cd, Cr, Cu, Pb) concentration at Saguling Reservoir in the rainy and dry season.

## 2 Material and Methods

### 2.1 Study area

The Saguling is an artificial reservoir was built on the Citarum River, the largest river in West Java Province, in February 1985. The catchment areas of the reservoir or the upper Citarum River basin are faced with high population pressure. This is because over 50% of the population with a high annual growth rate (2.34% is the national average). The growth of population has caused the decrease of landholding and this condition forced them to extend their agricultural land by forest clearing and utilize marginal lands. As a consequence, there is a prevailing problem of floods accompanied by accelerated soil erosion in rainy seasons. Due to the high population density in the upper catchment of the reservoir, extensive agricultural land, soil erosion and the presence of industries, the reservoir water became polluted and alsocontaminated by heavy metals, pesticides, etc [6,7].

The maximum depth of Saguling reservoir during rainy and dry season is 46.4 meters and 30 meters respectively at station 9 (near Intake structure). The most shallow depth is at point 2 (Cihaur Village Cipeundeuy) which is 7.5 meters and 12.1 meters in the

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rainy and dry season. Saguling reservoir is a reservoir with extreme depth fluctuations because the water catchment area has been damaged. The annual rainfall varies from 1,200 to 3,000 mm, with an average of 2,215 mm. The monthly rainfall during the wet season (November-April) is about 250 mm, varying from 100-500 mm. During the dry season (July-September) monthly rainfall usually is less than 50 mm based on data from the Meteorology, Climatology, and Geophysics Agency of West Java province [8].

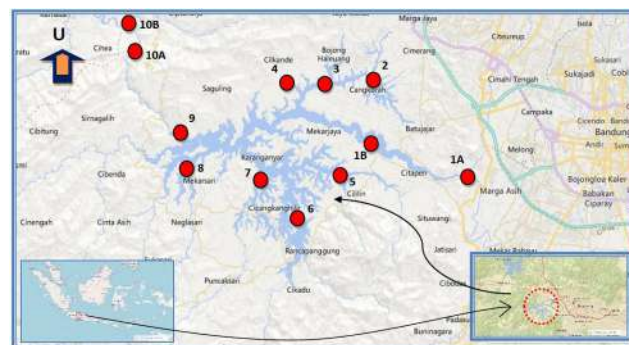
## 2.2 Data collection

This study uses secondary data obtained from official documents of Indonesia Power Firm from 2008 to 2017. sampling location are presented in Table 1. Two stations (1A and 1B) were located in the Citarum River (Saguling reservoir inlet), eight stasions (2-9) located in the Saguling reservoir inundation, and two stations (10A and 10B) were located in the Citarum River (Saguling reservoir outlet). The 12 point of water sampling location around Saguling reservoir are presented in Figure 1. The main parameters in the analysis are the concentration of heavy metal (Cd, Cr, Cu, and Pb) in water.

Assessment of heavy metal contamination by comparing the concentration of heavy metal with water quality standards based on the Indonesian Republic Government Regulation no. 82 of 2001 concerning water quality management and water pollution control [9]. The water class used is class 3 for the cultivation of freshwater fish, livestock, water for irrigation, and other uses requiring the same water quality as those uses. Data were analysis using Pearson correlation, the level of significance thereby being set at 5% (probability limit of  $p < 0,05$ ). Data analysis was done using Minitab Software 2016.

**Table 1.** Sampling stations in Saguling lake

Station	Location	Coordinate	
		South	East
1A	Citarum River Nanjung section	06°56'29.8"	107°32'10.7"
1B	Citarum River section Trash Boom Batujajar	06°54'58.9"	107°28'35.0"
2	Cihaur Village Cipeundeuy	06°53'13.5"	107°28'32.3"
3	Cimerang	06°53'13.4"	107°27'09.0"
4	Cihaur Estuary Maroko Village	06°54'13.0"	107°25'54.4"
5	Cipatik Estuary	06°56'07.6"	107°27'25.5"
6	Ciminyak Estuary-fishing floating located	06°57'14.6"	107°26'03.8"
7	Cijere Estuary	06°56'14.9"	107°24'50.8"
8	Cijambu Estuary	06°56'00.4"	107°22'22.4"
9	Near Intake Structure	06°54'54.4"	107°22'26.3"
10A	Tailrace	06°51'49.8"	107°20'57.0"
10B	Bantar Caringin	06°51'10.8"	107°20'58.0"

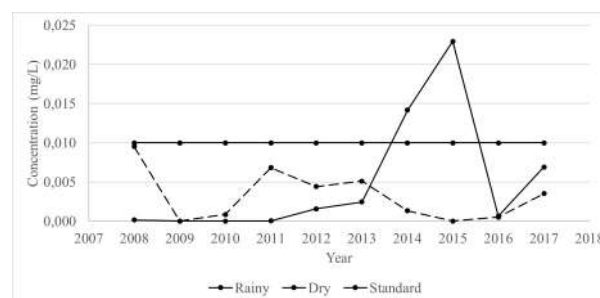


**Fig. 1.** Study Area and sampling location

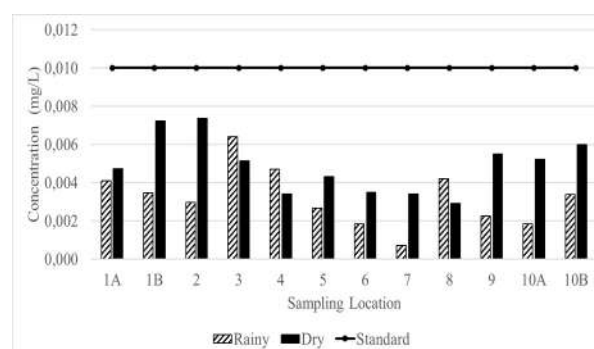
## 3 Result and Discussion

### 3.1 Cadmium

During the rainy season of highest concentration at station 1A with concentration 0.007 mg/L and lowest at site 4,7,8 value 0.003 mg/L. The average concentration in the rainy and dry seasons is  $0.005 \pm 0.001$  mg/L and  $0.003 \pm 0.002$  mg/L, respectively. The average concentration in the rainy season is greater than the dry season. The highest concentration of dry season is located at point 3 with the value of 0.006 mg/L and the lowest at the point 7 of 0.001 mg/L.



**Fig. 2.** Cd concentration in the last 10 years



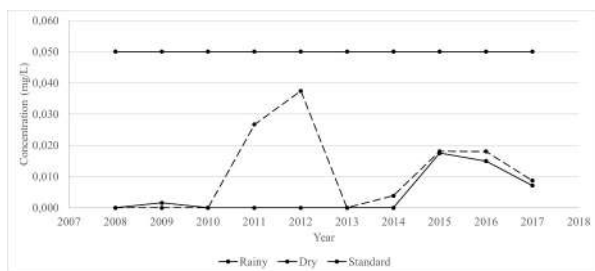
**Fig. 3.** Cd concentration at 12 point of water sampling location around Saguling Reservoir

The last 10 years Cd concentrations in the rainy season have decreased in the other hand during the dry season have increased. The last 10 years Cd concentrations meet the quality standard of 0.01 mg/L in all sampling points in the rainy and dry seasons except in 2014 and 2015 as described in the figure 2 and 3.

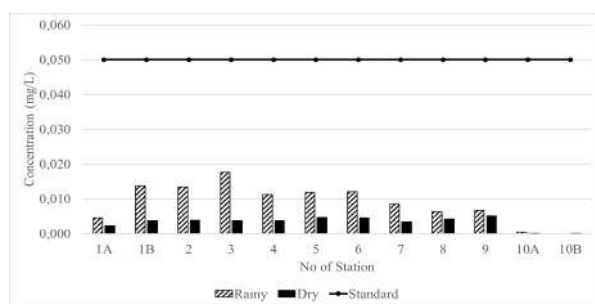
### 3.2 Chromium

Cr, as well as Zn, are the most abundant of the “heavy metals” with a concentration of about 69 mg/kg in the lithosphere. Cr occurs in nature mainly in the mineral chromite. The metallurgy industry uses the highest quality chromite ore whilst the lower-grade ore is used for refractory bricks in melting furnaces. Major atmospheric emissions are from the Cr alloy and metal producing industries. Cr<sup>6+</sup> is a potent carcinogen and Cr<sup>3+</sup> is an essential trace element [10].

The concentrations of Cr in Saguling reservoir water are shown in Figure 4 and 5. During the rainy season of highest concentration at station 3 with concentration 0.018 mg/L and lowest at site 10A and 10B. The average concentration in the rainy and dry seasons is 0.009± 0.005 mg/L and 0.003±0.002 mg/L, respectively. The average concentration in the rainy season is greater than the dry season. The highest concentration of dry season is located at point 9 with the value of 0.005 mg/L and the lowest at the point 10A and 10B. The last 10 years Cd concentrations in the rainy season and dry season the concentration trend has increased. The last 10 years Cr concentrations meet the quality standard of 0.05 mg/L in all sampling points in the rainy and dry seasons.



**Fig. 4.** Cr concentration in the last 10 years



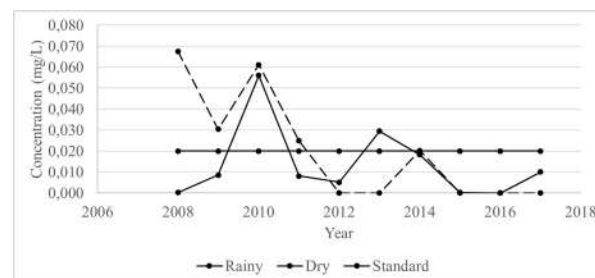
**Fig. 5.** Cr concentration at 12 point of water sampling location around Saguling Reservoir

### 3.3 Copper

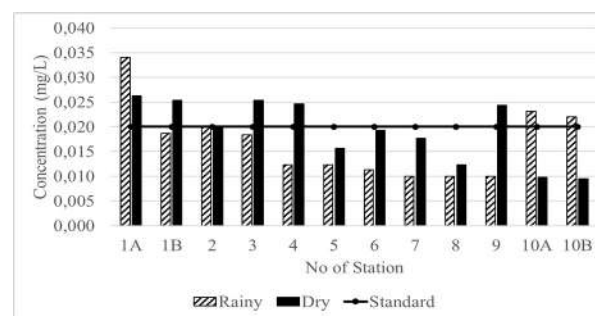
Copper is an essential element for organisms and is also considered a priority pollutant by U.S. EPA [11]. Because of the widespread use of copper as an algicide, aquatic herbicide, fungicide, and bactericide, as well as discharges from smelting, refining, and other copper-producing industries, copper occurs in particulate, colloidal, dissolved, organic, and inorganic chemical forms [12].

During the rainy season of highest concentration at station 1A with concentration 0.026 mg/L and lowest

at site 10A and 10B. The average concentration in the rainy and dry seasons is 0.019± 0.006 mg/L and 0.017±0.007 mg/L, respectively. The average concentration in the rainy season is greater than the dry season. The highest concentration of dry season is located at point 1A with the value of 0.034 mg/L and the lowest at the point 7 and 8. The last 10 years Cd concentrations in the rainy season and dry season the concentration trend has decreased. The last 10 years Cu concentrations does not meet the quality standard of 0.02 mg/L in some sampling points in the rainy and dry seasons as described in the figure 6 and 7.



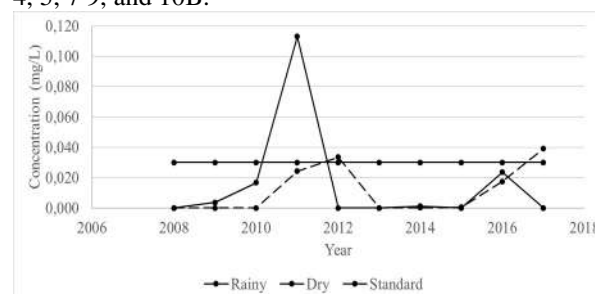
**Fig.6.** Cu concentration in the last 10 years



**Fig. 7.** Cu concentration at 12 point of water sampling location around Saguling Reservoir

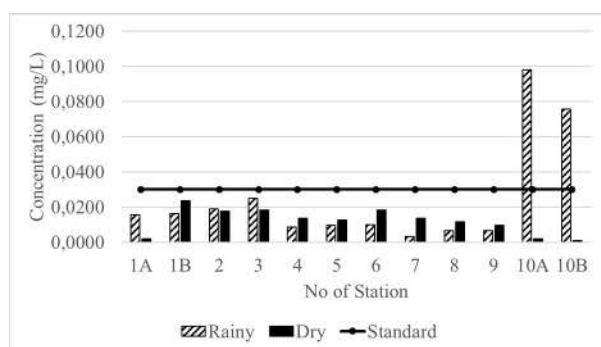
### 3.4 Lead

The concentrations of Pb in Saguling reservoir water are shown in Figure 10 and 11. During the rainy season of highest concentration at station 10A with concentration 0.098 mg/L and lowest at site 7. The average concentration in the rainy and dry seasons is 0.025± 0.030 mg/L and 0.014±0.032 mg/L, respectively. The average concentration in the rainy season is greater than the dry season. The highest concentration of dry season is located at point 3 with the value of 0.113 mg/L and the lowest at the point 1A, 4, 5, 7 9, and 10B.



**Fig. 8.** Pb concentration in the last 10 years

The last 10 years Pb concentrations in the rainy season have increased in the other hand during the dry season has decreased. The last 10 years Cu concentrations meet the quality standard of 0.03 mg/L in all sampling points in the rainy and dry seasons except at 10A and 10B as described in the figure 8 and 9. In the rainy season the average order of heavy metal concentration from the largest is Pb>Cu>Cr>Cd while in dry season that is Cu>Pb>Cr=Cd



**Fig. 9.** Pb concentration at 12 point of water sampling location around Saguling Reservoir

### 3.6 Statistic Analysis

The significant physicochemical parameters including pH, Dissolved Oxygen (DO), Total Dissolved Solid (TDS), temperature, hardness, and turbidity in rainy and dry seasons given in Table 4. pH value in rainy and dry seasons range between 7.1-7.7 and 7.2-7.6 respectively. The average pH value in dry season is greater than the rainy season. The average value of DO and temperature has some grade in the rainy and dry seasons. TDS, hardness, and turbidity are higher in rainy season than dry season. Heavy metals levels in water depend on the physicochemical parameter of water such as pH, DO, TDS, temperature, hardness, and turbidity. It is well known that the solubility of toxic metals increases with the pH decrease [13].

In rainy season there is correlation between heavy metals with the exception of Cd. Pb have a negative correlation with Cr and Cu. Cr was correlated with Cu and Pb. A high correlation coefficient between heavy metals showed heavy metal having a common source, mutually dependent and identical behavior during the transport process. No correlation among heavy metals indicated that observed heavy metals were not controlled by a single factor, but controlled by a combination of phase geochemistry of the heavy metal content [13].

**Table 4.** Physicochemical Parameter of studied Saguling reservoir water

Parameter	Physicochemical parameter in rainy season					
	pH	DO	TDS	Temp	Hardness	Turbidity
		mg/L	mg/L	°C	mg/L	NTU
Ave	7.3	2.9	211.7	27.2	67.1	23.2
Stdev	0.2	1.1	80.9	0.2	13.5	14.1
Max	7.7	5.5	366.9	27.6	91.7	62.6
Min	7.1	2.1	130.8	27.0	54.0	12.5
Physicochemical parameter in dry season						
Ave	7.4	2.9	160.0	27.3	46.5	20.3
Stdev	0.1	0.6	37.1	0.2	10.6	6.2
Max	7.6	4.0	234.6	27.7	66.6	30.0
Min	7.2	1.8	103.1	27.0	28.6	9.2

Pb has positive correlation with DO, while Cr and Cu have negative correlation with DO. Cd, Cd and Cu have positive correlation with TDS. Cr was correlated with hardness and Cd was positive correlated with turbidity. Main factor influence of Cd concentration in water Saguling reservoir was turbidity while Cr, Cu, and Pb concentration in water influence with DO value. The correlation coefficients based on the relationship of the investigated heavy metals and some of physicochemical parameter of Saguling reservoir in rainy season are presented in Table 5.

In dry season Cr was correlated with Pb while Cu was correlated with Cr. Cr has negative correlation with DO, while positive correlation with temperature. Cu has negative correlation with DO, pH, and temperature while has positive correlation with turbidity. Main factor influence of Cr concentration in water Saguling reservoir was DO while Cu concentration in water influence with turbidity value. The correlation coefficients based on the relationship of the investigated heavy metals and some of physicochemical parameter of Saguling reservoir in dry season are presented in Table 6.

Based on correlation pearson analysis concluded that during rainy season and drought physicochemical parameters that most influence concentration of heavy metal in Saguling reservoir water are DO and turbidity. According [14] concentration and toxicity heavy metals is influenced by hardness, pH, alkalinity and oxygen levels. The seasons also contribute to the concentration and solubility of heavy metals, which in the rainy season heavy metal concentration is lower due to the process of dilution by rain water. The dry season increases the concentration of heavy metals resulting from the water debit reaching minimum conditions, so that heavy metals concentrations are evenly distributed [15]. Based on [15] heavy metals concentration in water bodies is affected by climate and debit or current velocity, where the higher the discharge the concentration of heavy metals will be lower.

**Table 5.** Pearson correlation matrix for metal concentration, pH, DO, TDS, Temperature, and hardness in rainy season

Parameter	Cd	Cr	Cu	Pb	pH	DO	TDS	Temp	Hardness	Turbidity
<b>Cd</b>	<b>1</b>									
<b>Cr</b>	0.084	<b>1</b>								
<b>Cu</b>	0.157	0.621	<b>1</b>							
<b>Pb</b>	0.325	-0.626	-0.618	<b>1</b>						
<b>pH</b>	0.423	0.231	0.029	0.201	<b>1</b>					
<b>DO</b>	0.198	-0.810	-0.692	0.916	-0.043	<b>1</b>				
<b>TDS</b>	0.651	0.597	0.498	-0.089	0.668	-0.361	<b>1</b>			
<b>Temp</b>	0.073	0.796	0.287	-0.541	0.413	-0.714	0.537	<b>1</b>		
<b>Hardness</b>	0.499	0.681	0.503	-0.281	0.601	-0.527	0.952	0.621	<b>1</b>	
<b>Turbidity</b>	0.703	0.199	0.310	0.046	-0.056	-0.058	0.524	-0.026	0.434	<b>1</b>

**Table 6.** Pearson correlation matrix for metal concentration, pH, DO, TDS, Temperature, and hardness in dry season

Parameter	Cd	Cr	Cu	Pb	pH	DO	TDS	Temp	Hardness	Turbidity
Cd	<b>1</b>									
Cr	0.051	<b>1</b>								
Cu	0.259	-0.640	<b>1</b>							
Pb	0.666	0.059	0.061	<b>1</b>						
pH	0.187	0.401	-0.330	0.467	<b>1</b>					
DO	-0.321	-0.563	-0.138	-0.152	-0.028	<b>1</b>				
TDS	0.491	-0.254	0.489	0.532	0.582	-0.091	<b>1</b>			
T	0.293	0.543	-0.347	0.498	0.698	-0.471	0.393	<b>1</b>		
Hardness	0.402	-0.483	0.551	0.422	0.465	0.129	0.954	0.228	<b>1</b>	
Turbidity	0.399	-0.291	0.658	-0.050	-0.367	-0.227	0.206	-0.247	0.265	<b>1</b>

## 4 Conclusion

It can be concluded that the spatial and seasonal distribution of heavy metals in the water from Saguling reservoir West Java Province the concentrations of Cd, Cr, Cu, and Pb determined were very low and below the detection limit. Apparently, the Cu and Pb concentrations were determined highest at inlet and outlet Saguling Reservoir. The average concentration of Cd, Cr, Cu, and Pb in the rainy season is greater than the dry season. Heavy metals concentration in water bodies is affected by season and debit or current velocity, where the higher the discharge the concentration of heavy metals will be lower. The concentrations of Cd, Cr, Cu, and Pb is controlled by the association of heavy metals with dissolved oxygen and turbidity.

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