

Submit Paper (<https://ijrp.org/paper-submit>) | Check Paper Status (<https://ijrp.org/check-status>) |

Download Certificate (<https://ijrp.org/check-status>) | FAQ (<https://ijrp.org/faq>) |

Archive (<https://ijrp.org/archive>) | Join as an Editor-Reviewer (<https://ijrp.org/join>) |

Login (<https://ijrp.org/login>)

Search Here...



[Home \(https://ijrp.org/\)](https://ijrp.org/)

[Journal List \(https://ijrp.org/journallist\)](https://ijrp.org/journallist)

[About Us](#)



[Call For Papers \(https://ijrp.org/call-for-paper\)](https://ijrp.org/call-for-paper)

[For Authors](#)



[Archive \(https://ijrp.org/archive\)](https://ijrp.org/archive)

[Contact Us \(https://ijrp.org/contact\)](https://ijrp.org/contact)

### Indexing Partner



### Papers

[Architecture & Civil Engineering \(11\) \(https://ijrp.org/paper/Architecture—Civil-Engineering/9/home\)](https://ijrp.org/paper/Architecture—Civil-Engineering/9/home)

[Arts Literature & Linguistics \(15\) \(https://ijrp.org/paper/Arts-Literature—Linguistics/15/home\)](https://ijrp.org/paper/Arts-Literature—Linguistics/15/home)

[Biology and Life Sciences \(52\) \(https://ijrp.org/paper/Biology-and-Life-Sciences/1/home\)](https://ijrp.org/paper/Biology-and-Life-Sciences/1/home)

[Business Studies \(33\) \(https://ijrp.org/paper/Business-Studies/12/home\)](https://ijrp.org/paper/Business-Studies/12/home)

[Chemistry & Chemical Engineering \(34\) \(https://ijrp.org/paper/Chemistry—Chemical-Engineering/2/home\)](https://ijrp.org/paper/Chemistry—Chemical-Engineering/2/home)

## International Journal of Research Publications

Volume-69, Issue-1, January 2021

ISSN number 2708-3578 (Online)

Accepted and Published Manuscript

Pollution Analysis in Rural Areas in Indonesia Using the Multiple Correspondence Analysis (MCA) Method

Faradiba Faradiba, St. Fatimah Azzahra

---

PII : Faradiba Faradiba.100691120211671

DOI: 100691120211671

Web: <https://ijrp.org/paper-detail/1672>

To appear in: International Journal of Research Publication (IJRP.ORG)

Received date: 26 Jan 2021

Accepted date: 27 Jan 2021

Published date: 05 Feb 2021

Please cite this article as: Faradiba Faradiba, St. Fatimah Azzahra , Pollution Analysis in Rural Areas in Indonesia Using the Multiple Correspondence Analysis (MCA) Method , International Journal of Research Publication (Volume: 69, Issue: 1), <https://ijrp.org/paper-detail/1672>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this final version of the manuscript.

[ICI World of Journals \(/search/form\)](#) / **International Journal of Research Publications**[← Back](#)

## International Journal of Research Publications

**English title:**

International Journal of Research Publications

**ISSN:**

1254-4655

**GICID:***n/d***DOI:***n/d***Website:**<http://ijrp.org> (<http://ijrp.org>)**Publisher:**

International Journal of Research Publication

**Country:**

GB

**Language of publication:***n/d***Deposited publications:** > Full text: % | Abstract: % | Keywords: % | References: %[Issues and contents](#)[Journal description \(\)](#)[Details \(\)](#)[Scientific profile \(\)](#)[Editorial office \(\)](#)[Publisher \(\)](#)[Metrics \(\)](#)

As part of our website we use cookies to provide you with services at the highest level , including in a manner tailored to individual needs . Using the site without changing the settings for cookies results in saving them in your device . You can change cookies' settings any time you want in your web browser. More details in our Cookies Policy

**+** 2017[Join as an Editor / Reviewer \(https://ijrp.org/join\)](https://ijrp.org/join)

## Archive Volume 69, Issue 1, January 2021

[An Investigation of Authorial Visibility, Self-mention and Discourse Functions in Applied Linguistics Dissertations \(https://ijrp.org/paper-detail/1648\)](https://ijrp.org/paper-detail/1648)

Published Online: 24 January 2021 Pages: 1-9

DOI: 10.47119/IJRP100691120211647 (<https://doi.org/10.47119/IJRP100691120211647>) , Views: **196**  
, Download: **175**

 [Download PDF \(https://ijrp.org/filePermission/fileDownlaod/4/1de0cba0650a5fcd286abd60c359a159/3\)](https://ijrp.org/filePermission/fileDownlaod/4/1de0cba0650a5fcd286abd60c359a159/3)

[LEVEL OF COMMUNITY KNOWLEDGE OF MEDAN DENAI DISTRICT ABOUT VISUM ET REPERTUM \(https://ijrp.org/paper-detail/1646\)](https://ijrp.org/paper-detail/1646)

Published Online: 27 January 2021 Pages: 10-13

DOI: 10.47119/IJRP100691120211645 (<https://doi.org/10.47119/IJRP100691120211645>) , Views: **221**

, Download: **190**

 [Download PDF \(https://ijrp.org/filePermission/fileDownlaod/4/5ff49447081ecde8379818761e06773d/3\)](https://ijrp.org/filePermission/fileDownlaod/4/5ff49447081ecde8379818761e06773d/3)

[ANALYSIS OF THE EFFECT OF RESTAURANT ENVIRONMENTAL CUES AND NON-ENVIRONMENTAL CUES ON CUSTOMER SATISFACTION IN FORMING CUSTOMER LOYALTY MODERATED BY MOTIVATION OF DE MANDAILING CAFE AND EATERY JEMURSARI CUSTOMERS IN SURABAYA \(https://ijrp.org/paper-detail/1647\)](https://ijrp.org/paper-detail/1647)

Published Online: 04 February 2021 Pages: 14-34

DOI: 10.47119/IJRP100691120211646 (<https://doi.org/10.47119/IJRP100691120211646>) , Views: **150**  
, Download: **154**

 [Download PDF \(https://ijrp.org/filePermission/fileDownlaod/4/db992b2ab1969ae21ef606d33105b1c0/2\)](https://ijrp.org/filePermission/fileDownlaod/4/db992b2ab1969ae21ef606d33105b1c0/2)

[The Music Instruction of the Special Program in the Arts: Grade 9 students of DepEd Region X, Mindanao Philippines \(https://ijrp.org/paper-detail/1649\)](https://ijrp.org/paper-detail/1649)

Published Online: 04 February 2021 Pages: 35-61

DOI: 10.47119/IJRP100691120211648 (<https://doi.org/10.47119/IJRP100691120211648>) , Views: **195**  
, Download: **206**

 [Download PDF \(https://ijrp.org/filePermission/fileDownlaod/4/57b1f9719699688f6447fb2d76ee15a7/3\)](https://ijrp.org/filePermission/fileDownlaod/4/57b1f9719699688f6447fb2d76ee15a7/3)

[The Leadership Skills and Organizational Climates in the Public Higher Educational Institution in Zamboanga del Sur, Philippines \(https://ijrp.org/paper-detail/1650\)](https://ijrp.org/paper-detail/1650)

Published Online: 04 February 2021 Pages: 62-72

DOI: 10.47119/IJRP100691120211649 (<https://doi.org/10.47119/IJRP100691120211649>) , Views: 173 , Download: 194

 [Download PDF \(https://ijrp.org/filePermission/fileDownlaod/4/f891974cfe8f91aa33f4fd15ef40a4d2/2\)](https://ijrp.org/filePermission/fileDownlaod/4/f891974cfe8f91aa33f4fd15ef40a4d2/2)

### THE QUALITY OF VISUM ET REPERTUM OF LIVE VICTIMS OF INJURY CASES IN H. ABDUL MANAN SIMATUPANG GENERAL HOSPITAL (RSUD) KISARAN DATED FROM 1st OCTOBER 2018 TO 31st MAY 2019

(<https://ijrp.org/paper-detail/1651>)

Published Online: 04 February 2021 Pages: 73-79

DOI: 10.47119/IJRP100691120211650 (<https://doi.org/10.47119/IJRP100691120211650>) , Views: 231 , Download: 164

 [Download PDF \(https://ijrp.org/filePermission/fileDownlaod/4/01c841293f1dc4588cf2df99c529f8a2/2\)](https://ijrp.org/filePermission/fileDownlaod/4/01c841293f1dc4588cf2df99c529f8a2/2)

### The Effect of Consumption Value, Attitude Toward Local Food and Food Destination Image towards Repurchase Intention on The Culinary Tourism of Bakso Bakar Trowulan Malang According to Tourists from Surabaya City

(<https://ijrp.org/paper-detail/1654>)

Published Online: 04 February 2021 Pages: 80-94

DOI: 10.47119/IJRP100691120211653 (<https://doi.org/10.47119/IJRP100691120211653>) , Views: 155 , Download: 176

 [Download PDF \(https://ijrp.org/filePermission/fileDownlaod/4/569d25b3ed071b5eb25bcb718cb22756/2\)](https://ijrp.org/filePermission/fileDownlaod/4/569d25b3ed071b5eb25bcb718cb22756/2)

### Absolute lymphocyte count as a predictor of CD4+ Tcell count in children with HIV infection

(<https://ijrp.org/paper-detail/1655>)

Published Online: 04 February 2021 Pages: 95-100

DOI: 10.47119/IJRP100691120211654 (<https://doi.org/10.47119/IJRP100691120211654>) , Views: 201 , Download: 176

 [Download PDF \(https://ijrp.org/filePermission/fileDownlaod/4/6028a197095759ed6c7d52a3a6f2fe27/2\)](https://ijrp.org/filePermission/fileDownlaod/4/6028a197095759ed6c7d52a3a6f2fe27/2)

### THE MAPPING OF POSITIVE EMOTIONS IN COLOURS MAGAZINE: A NATURAL SEMANTIC METALANGUAGE APPROACH (<https://ijrp.org/paper-detail/1656>)

Published Online: 04 February 2021 Pages: 101-110

DOI: 10.47119/IJRP100691120211655 (<https://doi.org/10.47119/IJRP100691120211655>) , Views: 176 , Download: 154

 [Download PDF \(https://ijrp.org/filePermission/fileDownlaod/4/49e31164d4faf07c93faebf5d5bf55dd/2\)](https://ijrp.org/filePermission/fileDownlaod/4/49e31164d4faf07c93faebf5d5bf55dd/2)

### ANALYSIS OF THE EFFECT OF FIRM SIZE, GROWTH, TANGIBILITY, LIQUIDITY, AND PROFITABILITY ON STOCK RETURN WITH DEBT LEVEL AS INTERVENING VARIABLES ON LQ45 SHARES IN INDONESIA STOCK EXCHANGE

<https://ijrp.org/paper-detail/1662>

Published Online: 04 February 2021 Pages: 111-121

DOI: 10.47119/IJRP100691120211661 (<https://doi.org/10.47119/IJRP100691120211661>) , Views: **180**  
, Download: **163**

 [Download PDF \(https://ijrp.org/filePermission/fileDownload/4/3161fde370c7498649be1e0aabb6653b/2\)](https://ijrp.org/filePermission/fileDownload/4/3161fde370c7498649be1e0aabb6653b/2)

**THE INFLUENCE ANALYSIS OF SOCIAL MEDIA MARKETING ACTIVITIES' DIMENSIONS ON CUSTOMER LOYALTY THROUGH VALUE EQUITY, BRAND EQUITY, AND RELATIONSHIP EQUITY TO SHOPEE INDONESIA CUSTOMERS IN SURABAYA** (<https://ijrp.org/paper-detail/1665>)

Published Online: 04 February 2021 Pages: 122-134

DOI: 10.47119/IJRP100691120211664 (<https://doi.org/10.47119/IJRP100691120211664>) , Views: **180**  
, Download: **184**

 [Download PDF \(https://ijrp.org/filePermission/fileDownload/4/3a4b38519a8c31b05ca5c7490a429c97/2\)](https://ijrp.org/filePermission/fileDownload/4/3a4b38519a8c31b05ca5c7490a429c97/2)

**Teachers Teaching Life-Cycle and Academic Productivity: A Pilot Study of One Higher Education Institutions in Northern Mindanao** (<https://ijrp.org/paper-detail/1666>)

Published Online: 04 February 2021 Pages: 135-147

DOI: 10.47119/IJRP100691120211665 (<https://doi.org/10.47119/IJRP100691120211665>) , Views: **168**  
, Download: **166**

 [Download PDF \(https://ijrp.org/filePermission/fileDownload/4/1a174852d8cd43b6b772137080e505ca/3\)](https://ijrp.org/filePermission/fileDownload/4/1a174852d8cd43b6b772137080e505ca/3)

**Indoor Scene Recognition using ResNet-18** (<https://ijrp.org/paper-detail/1668>)

Published Online: 04 February 2021 Pages: 148-154

DOI: 10.47119/IJRP100691120211667 (<https://doi.org/10.47119/IJRP100691120211667>) , Views: **318**  
, Download: **223**

 [Download PDF \(https://ijrp.org/filePermission/fileDownload/4/ae6e38f05925570b02babe3ff6dbc8fa/2\)](https://ijrp.org/filePermission/fileDownload/4/ae6e38f05925570b02babe3ff6dbc8fa/2)

**The Influence of Financial Performance on Dividend Policy and Implications on Company Value. (Studies on Issuers in the Food and Beverage Sub-Sector in 2015-2019)** (<https://ijrp.org/paper-detail/1669>)

Published Online: 05 February 2021 Pages: 155-167

DOI: 10.47119/IJRP100691120211668 (<https://doi.org/10.47119/IJRP100691120211668>) , Views: **179**  
, Download: **167**

 [Download PDF \(https://ijrp.org/filePermission/fileDownload/4/ae390dac931f30368b005f9683d02177/4\)](https://ijrp.org/filePermission/fileDownload/4/ae390dac931f30368b005f9683d02177/4)

**Pollution Analysis in Rural Areas in Indonesia Using the Multiple Correspondence Analysis (MCA) Method** (<https://ijrp.org/paper-detail/1672>)

Published Online: 05 February 2021 Pages: 168-180

DOI: 10.47119/IJRP100691120211671 (<https://doi.org/10.47119/IJRP100691120211671>) , Views: **261**  
 , Download: **161**

 [Download PDF \(https://ijrp.org/filePermission/fileDownlaod/4/8040146f3f9a843f5390df6819e3586f/1\)](https://ijrp.org/filePermission/fileDownlaod/4/8040146f3f9a843f5390df6819e3586f/1)

### **BEYOND MOTHERS LIGHT: THE ADAPTATION STORY OF OFW MILLENNIAL MOTHERS IN QATAR**

(<https://ijrp.org/paper-detail/1684>)

Published Online: 05 February 2021 Pages: 181-200

DOI: 10.47119/IJRP100691120211683 (<https://doi.org/10.47119/IJRP100691120211683>) , Views: **328**  
 , Download: **206**

 [Download PDF \(https://ijrp.org/filePermission/fileDownlaod/4/ca99cf95e3c6f573c39d6b2a00bffc85/2\)](https://ijrp.org/filePermission/fileDownlaod/4/ca99cf95e3c6f573c39d6b2a00bffc85/2)

### **The E-commerce Era: A Qualitative Study on the Growth Strategies of Online Business among Philippine School Doha Senior High School Students** (<https://ijrp.org/paper-detail/1688>)

Published Online: 05 February 2021 Pages: 201-227

DOI: 10.47119/IJRP100691120211687 (<https://doi.org/10.47119/IJRP100691120211687>) , Views: **967**  
 , Download: **461**

 [Download PDF \(https://ijrp.org/filePermission/fileDownlaod/4/233ed59a3668ea120a16842d6ec5e753/2\)](https://ijrp.org/filePermission/fileDownlaod/4/233ed59a3668ea120a16842d6ec5e753/2)

### **Corporate Development Using Open-System Diagnostic Model** (<https://ijrp.org/paper-detail/1652>)

Published Online: 06 February 2021 Pages: 228-234

DOI: 10.47119/IJRP100691120211651 (<https://doi.org/10.47119/IJRP100691120211651>) , Views: **186**  
 , Download: **162**

 [Download PDF \(https://ijrp.org/filePermission/fileDownlaod/4/606abd146c451d77ef72f34ab3cccd4/2\)](https://ijrp.org/filePermission/fileDownlaod/4/606abd146c451d77ef72f34ab3cccd4/2)

### **Towards a Theory of Coop-members Satisfaction** (<https://ijrp.org/paper-detail/1664>)

Published Online: 06 February 2021 Pages: 235-244

DOI: 10.47119/IJRP100691120211663 (<https://doi.org/10.47119/IJRP100691120211663>) , Views: **184**  
 , Download: **166**

 [Download PDF \(https://ijrp.org/filePermission/fileDownlaod/4/877facf1b5cfc0118b27edc705cbf2c7/2\)](https://ijrp.org/filePermission/fileDownlaod/4/877facf1b5cfc0118b27edc705cbf2c7/2)

### **THE EFFECT OF RETURN ON EQUITY, DIVIDEND YIELD, PRICE EARNING RATIO, EARNING PER SHARE, AND FIRM SIZE ON STOCK RETURN ON LQ45 SHARES IN INDONESIA STOCK EXCHANGE** (<https://ijrp.org/paper-detail/1667>)

Published Online: 06 February 2021 Pages: 245-253

DOI: 10.47119/IJRP100691120211666 (<https://doi.org/10.47119/IJRP100691120211666>) , Views: **262**  
 , Download: **205**

 [Download PDF \(https://ijrp.org/filePermission/fileDownlaod/4/5d996918b6bfc565f3a097509992129d/2\)](https://ijrp.org/filePermission/fileDownlaod/4/5d996918b6bfc565f3a097509992129d/2)

# Pollution Analysis in Rural Areas in Indonesia

## Using the Multiple Correspondence Analysis (MCA) Method

Faradiba <sup>a\*</sup>, St. Fatimah Azzahra <sup>b</sup>

<sup>a</sup> [faradiba@uki.ac.id](mailto:faradiba@uki.ac.id)

<sup>a</sup>Physics Education Study Program, Universitas Kristen Indonesia, Jl. Mayjen Sutoyo No. 2, Cawang-Jakarta 13630, Indonesia

<sup>b</sup>Chemistry Education Study Program, Universitas Kristen Indonesia, Jl. Mayjen Sutoyo No. 2, Cawang-Jakarta 13630, Indonesia

---

### Abstract

Regional development is a driving force in advancing a country. In its application, it often causes a number of negative impacts, one of which is pollution. The pollution that is formed will vary in depth if it is broken down according to the distribution medium. This study measures the depth of pollution measured by index using the Multiple Correspondence Analysis (MCA) method. The data used in this study includes village data from the 2018 Podes data collection. The results of this study indicate that the soil pollution index is the index that plays the most important role in the formation of the pollution index in general. The range of the index formed was -10.02 to 0.37. Efforts from the government and local communities are needed, to anticipate the bad impacts that can be caused in order to preserve nature.

Keyword: Development; Multiple correspondence analysis (MCA); pollution

---

### 1. Introduction

Development is an important aspect of the country's goals. The state is asked to fulfill a number of aspects for the welfare of society. However, the existence of development often creates a number of problems in terms of the environment and public health (S. Chen, 2015; Landrigan, 2017; Li et al., 2014; H. Wang & Wheeler, 2003). Pollution problems can be exposed to water, soil and air media.

Pollution is a big problem in many countries (Desaigues et al., 2011; Islam et al., 2015; Siddharthan et al., 2018). However, on the other hand, the country must continue to carry out development. This phenomenon becomes two blades, on the one hand it will have a positive impact, but on the other hand it has a bad impact. Therefore, there are often differences of opinion between observers who are struggling for the sector they are engaged in.

Based on information from the Ministry of Health of the Republic of Indonesia, the times have led to an increase in industrial and transportation activities. This triggers air pollution (air pollution) which has an impact on health, especially in industrial areas and big cities. Air pollution has an impact on health including respiratory disorders, heart disease, cancer of various organs of the body, reproductive

---



disorders and hypertension (high blood pressure). (Curtis et al., 2006; Schraufnagel et al., 2019). Some of the most common types of air pollution are Carbon Monoxide (CO), Nitrogen Oxide (NO<sub>2</sub>), Sulfur Oxide (SO<sub>x</sub>), Photochemical Oxide and Particles. Sources of air pollution can be classified into stationary sources and mobile sources. Silent sources consist of industry, power plants and households. Meanwhile, the movable sources are motor vehicle activities and sea transportation. Air pollution does not only exist outside, it turns out indoors, such as in homes, offices and other closed rooms, it can also experience air pollution. Air pollution that occurs indoors is caused by the use of cigarettes, glues, paints, and materials that contain chemicals. This can also occur due to unclean room conditions, such as mattresses that are rarely cleaned so that when you sleep the dirt is inhaled and enters the respiratory tract. (Simandjuntak, 2013; Sudrajad, 2006).

In Indonesia, there have been many standard measures for calculating pollution levels (Rahim & Soeprbowati, 2019; Suriadikusumah et al., 2020; Tanjung & Hamuna, 2019). In the area of the national capital, the air quality index has been calculated. This condition is intended as an early warning for policy makers when a threshold has been reached. The calculated index is often associated with several variables to measure the level of influence and the relationship between variables (Nurbiantara, 2010; Suryanto, 2012).

Pollution based indices are often calculated on the air aspect (Swamee & Tyagi, 1999; X.-K. Wang & Lu, 2006). Even though the pollution that arises can be interrelated between various media (water, land, and air). Therefore it is necessary to calculate an index that can calculate the aggregate for all factors as a pollution medium.

## 2. Methodology

The index calculation in this study refers to the results of the research conducted by Yokota dkk (2017) using the Multiple Correspondence Analysis (MCA) method. This method has been used to measure an index based on categorical data (Abdi & Valentin, 2007; Asselin & Anh, 2008; Rodrigues et al., 2016). In the calculation process, there are a number of K variables, and each variable has a level of J<sub>k</sub> and the number of J<sub>k</sub> is equal to J. In addition there are as many as I observations. The I x J matrix is denoted by X. Establishing a correspondence analysis on the indicator matrix will produce two sets of factor scores: one for rows and one for columns. These factor scores are generally scaled such that the variance equals the corresponding eigenvalues.

The total value of the matrix of the arrangement is denoted by N, and the first step of the analysis is to calculate the probability matrix  $Z = N^{-1}X$ . We denote  $r$  the vector of the total row Z, (i.e.,  $r = Z1$ , where 1 is the corresponding vector of 1) and  $c$  is the vector of the total column. The notation  $D_r = \text{diag} \{r\}$  and  $D_c = \text{diag} \{c\}$ . The factor score is obtained from the decomposition of a single value in the following equation:

$$D_r^{-\frac{1}{2}} (Z - rc^T) D_c^{-\frac{1}{2}} = P\Delta Q^T$$

( $\Delta$  is a diagonal matrix of single values, and  $\Lambda = \Delta^2$  is a matrix of eigenvalues). The row and column factor scores (respectively) are obtained by means of the following equation:

$$F = D_r^{-\frac{1}{2}} P\Delta \quad G = D_c^{-\frac{1}{2}} Q\Delta$$

Distance squared ( $\chi^2$ ) of rows and columns can be denoted in the following equation:

$$d_r = \text{diag} \{FF^T\} \quad d_c = \text{diag} \{GG^T\}$$

This study uses data from the results of the 2018 Village Potential data collection which includes 30 variables and 75,436 villages. The results of the Podes data collection were in the form of answer choices from village officials regarding the existence of detailed pollution events. Villages that are affected by certain conditions will be given the code “1”, while the code “0” for the opposite condition.

### 3. Results and Discussion

Based on table 1, it is known that villages that have a negative index in developing areas as a percentage tend to have relatively high numbers when compared to other categories. Negative conditions indicate that the village is experiencing pollution. Where the more negative the index value is, the deeper the pollution that occurs in an area. This can be due to the fact that the development process in developing villages tends to be higher. The impact of development will have an impact on environmental pollution. This phenomenon is in line with previous research (Bruce et al., 2000; B. H. Chen et al., 1990; Wheeler, 2001).

When viewed in detail, the air pollution index is an index that has a percentage when compared to other types of pollution. This phenomenon is due to the fact that the air medium is sensitive to the main source of pollution. The conditions are in accordance with previous research on the role of air media in pollution (Beelen et al., 2014). For example, noise due to factory activity. Commonly, pollution will arise in water media due to the presence of liquid waste resulting from production activities. However, without realizing it, the noise generated from production activities can also trigger air pollution. This condition will disturb the hearing of the local community, and the extreme condition will disturb the sense of hearing. So that this activity will trigger pollution that can be spread by various media. This condition is in accordance with the results of previous research (Arnold et al., 2016; Gulas et al., 2017).

Table 1. Index Distribution by Village Development Category in 2018

Index	Development Category			Total	
	Underdeveloped	Developing	Developed		
<b>Pollution Index</b>					
Negatif	Abs.	2,211	14,156	1,625	17,992
	%	2.93	18.77	2.15	23.85
Positif	Abs.	12,252	41,219	3,973	57,444
	%	16.24	54.64	5.27	76.15
<b>Water Pollution Index</b>					
Negatif	Abs.	1,886	11,425	1,295	14,606
	%	2.50	15.15	1.72	19.36
Positif	Abs.	12,577	43,950	4,303	60,830
	%	16.67	58.26	5.70	80.64
<b>Soil Pollution Index</b>					
Negatif	Abs.	1,975	11,657	1,330	14,962
	%	2.62	15.45	1.76	19.83

Positif	Abs.	12,488	43,718	4,268	60,474
	%	16.55	57.95	5.66	80.17
<b>Air Pollution Index</b>					
Negatif	Abs.	2,284	14,766	1,712	18,762
	%	3.03	19.57	2.27	24.87
Positif	Abs.	12,179	40,609	3,886	56,674
	%	16.14	53.83	5.15	75.13

Indonesia is an archipelago, where each island has unique characteristics. If classified based on the large islands in Indonesia, in general, the negative pollution index is mostly found in villages on the island of Java. This result is in line with previous research which states that Java Island is the island with the highest pollution index (Kusminingrum & Gunawan, 2008; Yuwono et al., 2021). Meanwhile, the smallest negative pollution index was in the islands of Bali, Nusa Tenggara, Maluku and Papua. This phenomenon is in accordance with the conditions of development in Indonesia, because Java Island is the center of Indonesian government and economy. Islands located in the eastern region of Indonesia tend to have a relatively small pollution index, this result is consistent with previous research (Hamuna & Tanjung, 2020; Thahir & Lagoa, 2018). The interaction between sectors in the city center will tend to be larger and more dynamic. This will cause a number of negative effects, one of which is pollution. However, on the other hand, the city center will benefit from various conveniences, such as public facilities and access to jobs (Pradhan & Van Soest, 1995; Tahmasbi et al., 2019).

Table 2. Index Distribution by Island in 2018

Indekx		Islands						Total
		1	2	3	4	5	6	
<b>Pollution Index</b>								
Negatif	Abs	5,612	6,694	579	2,856	1,534	717	17,992
	%	7.44	8.87	0.77	3.79	2.03	0.95	23.85
Positif	Abs	17,629	15,778	4,100	3,768	7,270	8,899	57,444
	%	23.37	20.92	5.44	4.99	9.64	11.80	76.15
<b>Water Pollution Index</b>								
Negatif	Abs	4,496	5,192	434	2,624	1,197	663	14,606
	%	5.96	6.88	0.58	3.48	1.59	0.88	19.36
Positif	Abs	18,745	17,280	4,245	4,000	7,607	8,953	60,830
	%	24.85	22.91	5.63	5.30	10.08	11.87	80.64
<b>Soil Pollution Index</b>								
Negatif	Abs	4,610	5,334	452	2,678	1,238	650	14,962
	%	6.11	7.07	0.60	3.55	1.64	0.86	19.83
Positif	Abs	18,631	17,138	4,227	3,946	7,566	8,966	60,474
	%	24.70	22.72	5.60	5.23	10.03	11.89	80.17

<b>Air Pollution Index</b>								
Negatif	Abs	5,963	6,910	653	2,933	1,582	721	18,762
	%	7.90	9.16	0.87	3.89	2.10	0.96	24.87
Positif	Abs	17,278	15,562	4,026	3,691	7,222	8,895	56,674
	%	22.90	20.63	5.34	4.89	9.57	11.79	75.13

- Notes :
- |                           |                     |
|---------------------------|---------------------|
| 1. Sumatera               | 4. Kalimantan       |
| 2. Jawa                   | 5. Sulawesi         |
| 3. Bali and Nusa Tenggara | 6. Maluku and Papua |

If broken down based on the type of index, all types of indexes confirm that Java Island is an island that has a negative pollution index number in its rural areas. This phenomenon is in accordance with several previous studies which stated that, in areas that tend to be advanced, the level of pollution tends to be high. This phenomenon is in line with previous studies that analyzed the level of pollution in developed regions (Kumar et al., 2015; Mayer, 1999; Pospelov et al., 2019).

Pollution will get worse when the pollution source area interacts with the surrounding area. This interaction will cause bad conditions in the surrounding area. In the case of transporting waste from the DKI Jakarta area through Bekasi, the Provincial Government does not hesitate to spend a number of funds as compensation for the pollution that can be caused when garbage crosses residential areas. (Ishar et al., 2017).

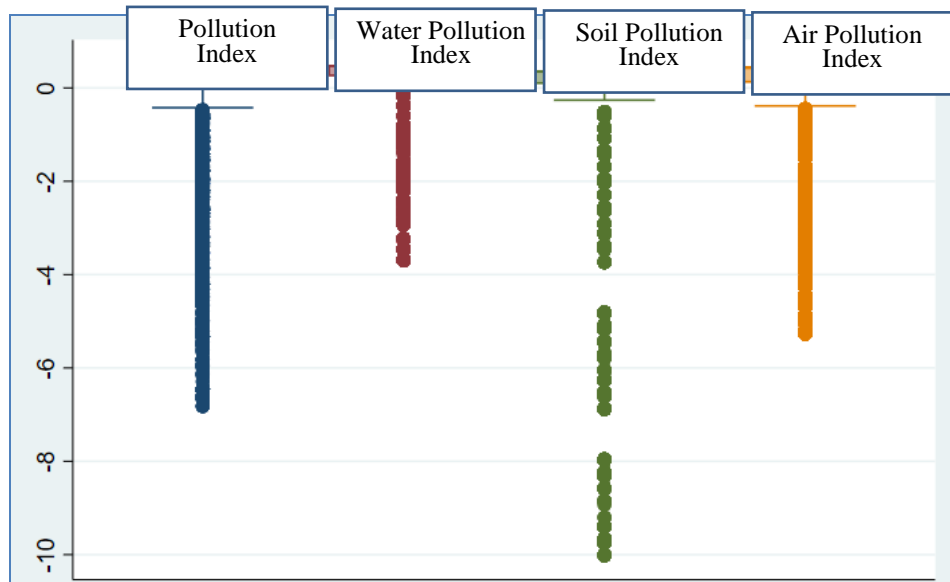


Figure 1. Pollution Index by Type

When viewed from the distribution range, the largest range occurs in the soil pollution index. While the lowest index range occurs in the water pollution index. All pollution will have a negative impact on human life. However, there is severity when viewed from the index formed. The results of the index calculation are in accordance with the phenomena that occur. Soil conditions in urban areas tend to be difficult to plant various types of plants. This is different with land in rural areas, which tends to be easier. Conditions are in

accordance with the results of research that has been done before (Cachada et al., 2018). This phenomenon can be caused by the nutrients present. As a result of air pollution, nutrients will be reduced, thereby inhibiting the rate of plant growth and reproduction. This condition is in line with research conducted by Wasis (2013) dan Zulfiyah serta Aisyah (2016), which states that plant growth is strongly influenced by nutrients in the soil.

Water pollution in developed areas tends to be higher than in disadvantaged areas. Underdeveloped areas still make use of springs. However, over time the number of springs in Indonesia has decreased (Hamidiana et al., 2016). The amount of water pollution in developed areas has caused a number of polemics. On the one hand, water is a basic household need. On the other hand, when the water is polluted, the household must sacrifice time, energy, or money to get hygienic water. In areas that tend to be developed, residents have subscribed to water that is managed by the private sector and the government. However, this solution will affect the proportion of household expenditure. It is known that rural areas are very vulnerable to poverty. Based on BPS data, the number of rural poor households in Indonesia is around 26 million people. A solution is needed from the central and local governments to deal with problems related to basic household needs, because this can cause other problems in the community.

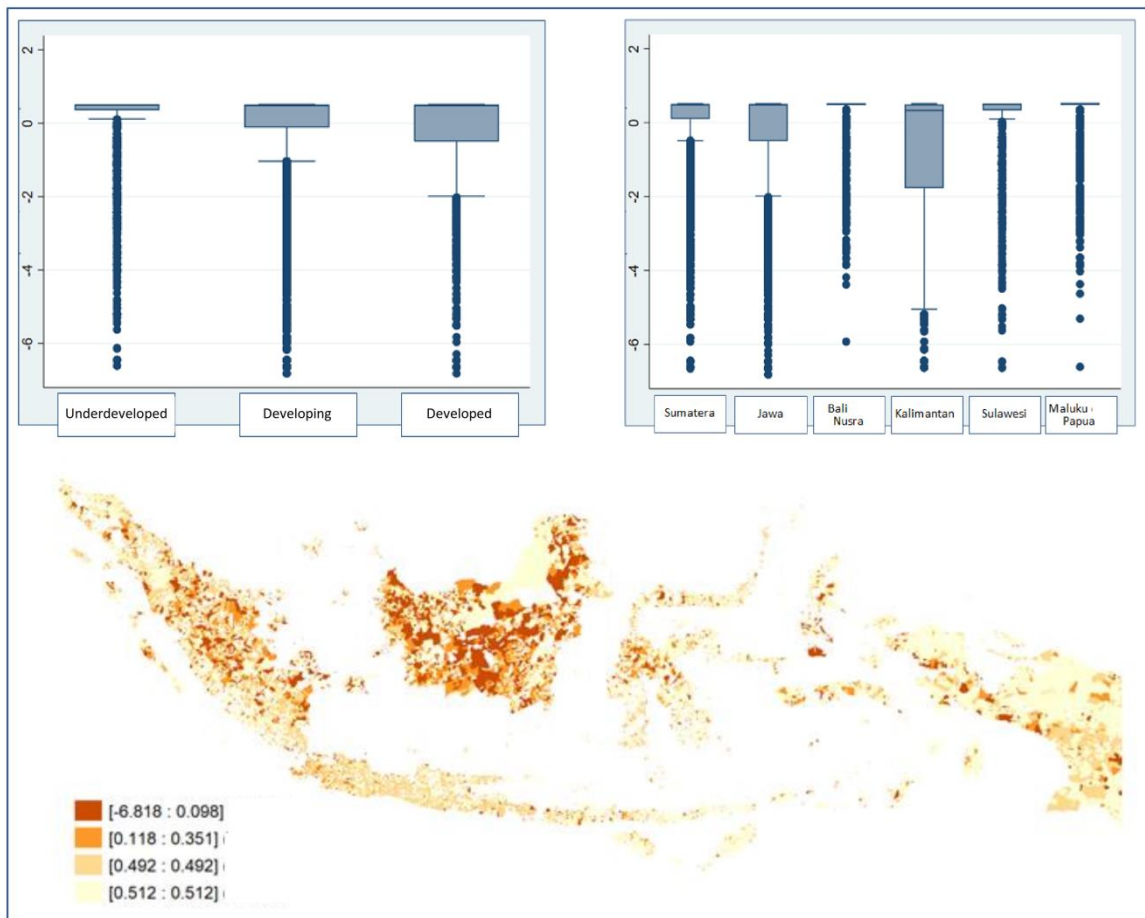


Figure 2. Pollution Index

In general, the severity of the pollution index is in the village which has an independent category. When viewed during the last 1 year, Java and Kalimantan were the islands with the largest index severity. The island of Borneo is the lung of Indonesia. The abundance of forests and good natural ecosystems often supply oxygen for Indonesia and the surrounding countries. However, based on the established index, Kalimantan Island is experiencing a quite deep level of severity, compared to other islands. This condition informs that, Kalimantan Island has experienced a sharp increase in pollution. This result is in line with previous research related to pollution in Kalimantan Island (Albertus & Zalukhu, 2019; Nisa & Arthani, 2011).

On the islands of Sulawesi, Maluku and Papua, the resulting index tends to be good. Islands in eastern Indonesia tend not to be explored, so the pollution they cause is still not visible (Hanım & Noorman, 2018; Yanuarti, 2016). It takes the participation of the community and government to jointly prevent pollution that can occur. Vertical and horizontal government coordination also needs attention, so that the resulting objectives do not have a negative impact on other sectors. Solutions that can be made through early communication on a program, by involving various parties and also accommodating the submitted input.

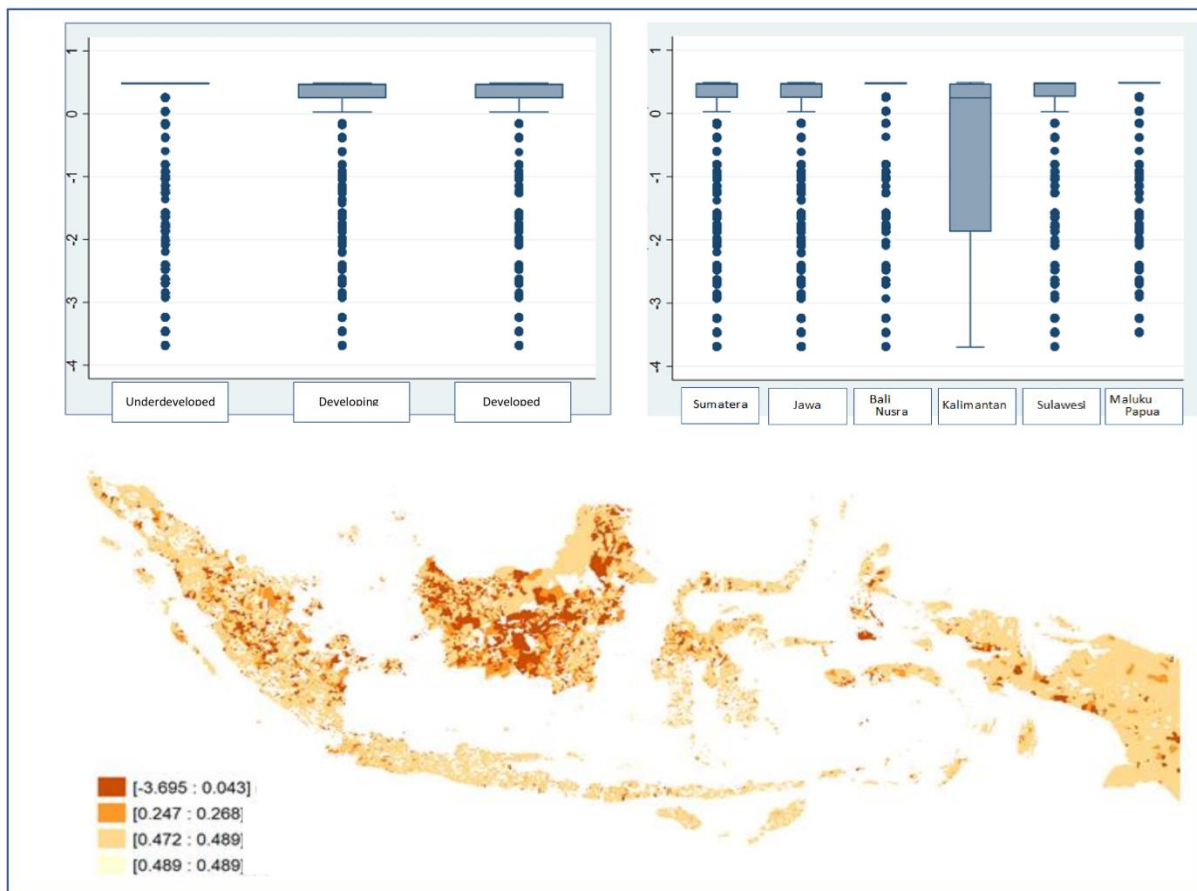


Figure 3. Distribution of Water Pollution Index

The water pollution index severity is in the independent and developing village category. When viewed during the last 1 year, Kalimantan Island is the island with the largest index of severity. This condition informs that the island of Kalimantan has experienced a sharp increase in water pollution over the past year. People in Kalimantan Island feel that things are changing in the quality of their environment, so that the index that is formed is getting deeper. On the islands of Sumatra, Java and Sulawesi, the resulting index tends to be good.

The river is a characteristic that cannot be separated from the island of Borneo. Water in rivers is generally collected from precipitation, such as rain, springs, underground runoff and in certain countries also from melting ice or snow. In this era of globalization, a lot of pollution occurs in rivers due to human negligence who do not protect the environment. Another problem that often arises is the increasing quantity of water that is no longer able to meet the needs and the decreasing quality of water for domestic needs. This phenomenon results in a demand condition that is not proportional to supply, resulting in something to be sacrificed if there is no technology to fulfill water resources. The sacrifices could be money to pay or public health problems at stake (Gurjar et al., 2010; Lee et al., 2014; Mallongi et al., 2020).

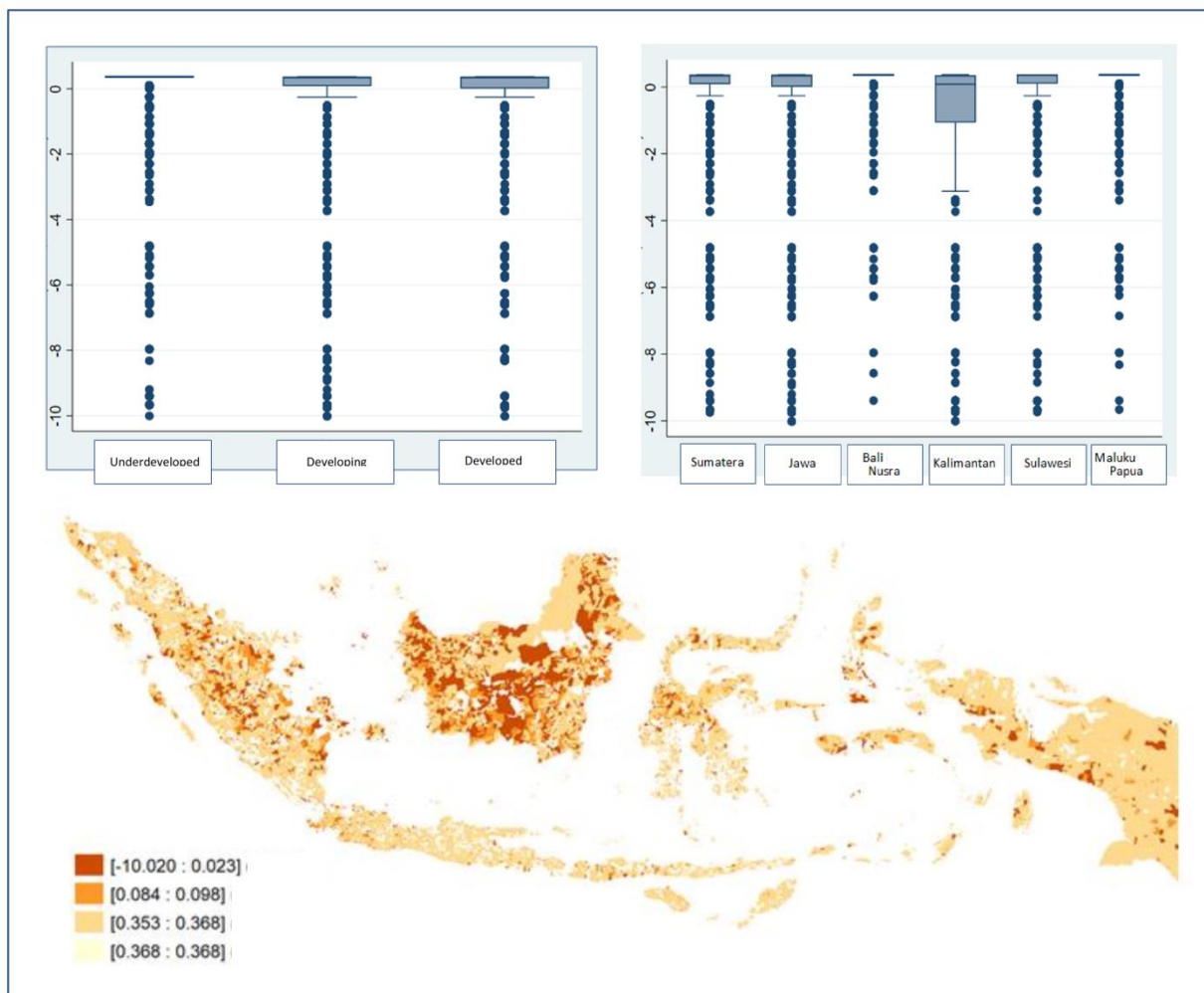


Figure 4. Distribution of Soil Pollution Index

The soil pollution index severity is in the village which has an independent category. When viewed during the last 1 year, Kalimantan Island is the island that has the greatest severity index. This condition informs that, Kalimantan Island has experienced a sharp increase in pollution. People in Kalimantan Island feel that things have changed in the quality of their environment, so that the index formed is getting more negative. On the islands of Sumatra, Java and Sulawesi, the resulting index tends to be good.

On the island of Kalimantan there are many peat forests. Draining and decomposing the peat can cause the peat soil to become thinner. Several cases of peatland damage have occurred in the Kalimantan region. The area is now abandoned acid sulphate land and a source of environmental pollution for the surrounding area (Noor, 2001; Sabiham et al., 2012; Widyati, 2011). When the soil is polluted it will be difficult to use for development based on the natural sector.

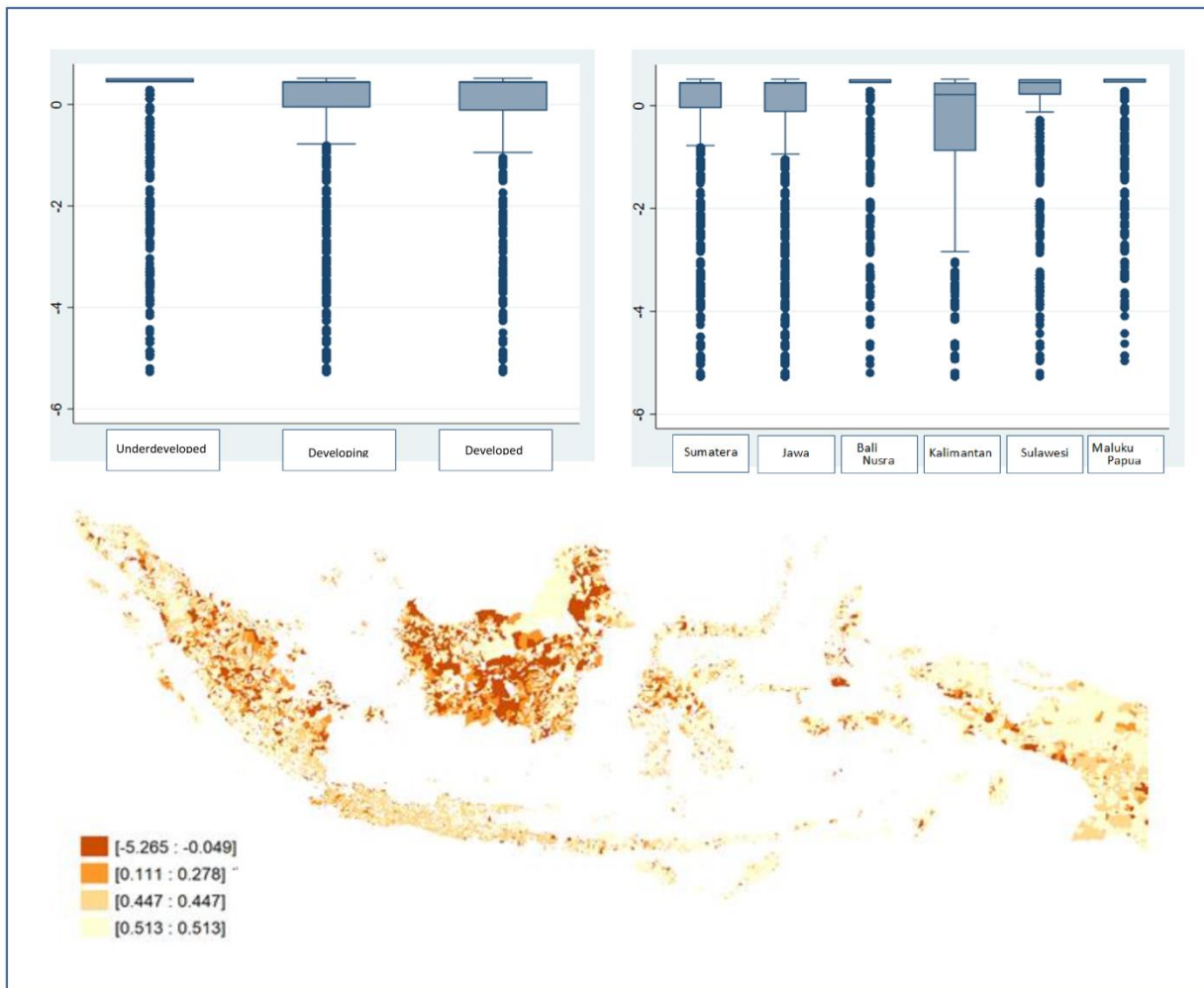


Figure 5. Distribution of Air Pollution Index



The air pollution index severity is in the independent village category. When viewed during the last 1 year, Kalimantan Island is the island that has the greatest severity index. This condition informs that, Kalimantan Island has experienced a sharp increase in pollution. People in Kalimantan Island feel that things have changed in the quality of their environment, so that the index formed is getting more negative. On the islands of Sumatra, Java and Sulawesi, the resulting index tends to be good.

Forest and land fires that occurred in the Kalimantan Region have had very serious impacts on local communities. The smoke that arises and forest and land fires will look like clouds that are grayish-white, brown and even blackish and the darker the smoke color will show the concentration of contaminants (SO<sub>2</sub>, NO<sub>2</sub>, O<sub>3</sub>, CO and PM<sub>10</sub>). The impact and the smog can cause losses in various fields such as health which can cause various diseases including ARI, bronchitis, pneumonia, asthma, and even eye irritation. The haze will also affect the disruption of air, land and sea transportation services as well as decrease business activities, tourism and also disrupt the teaching and learning process for school students. In addition, the smog will also disrupt relations between countries such as Malaysia, Singapore and Brunei Darussalam, because they are exposed to the haze and forest and land fires that have occurred in Indonesia and especially those that occurred on the island of Kalimantan.

#### 4. Conclusion

Pollution that occurs in the community needs to be the attention of the government and the people who live in the area. In the short term, the negative effects are not visible yet, but the bad effects will form on future generations. The distribution of the pollution index formed indicates that soil pollution is the most significant aspect in the formation of the overall pollution index. Participation from the central and local governments is needed to regulate regulations, in order to sustain the nature of the environment which can be disrupted due to the negative impacts of development.

#### References

- Abdi, H., & Valentin, D. (2007). Multiple correspondence analysis. *Encyclopedia of Measurement and Statistics*, 2(4), 651–657.
- Albertus, F., & Zalukhu, Y. (2019). Dampak dan pengaruh pertambangan batubara terhadap masyarakat dan lingkungan di Kalimantan Timur. *Legalitas*, 4(1), 42–56.
- Arnold, S. R., Law, K. S., Brock, C. A., Thomas, J. L., Starkweather, S. M., von Salzen, K., Stohl, A., Sharma, S., Lund, M. T., & Flanner, M. G. (2016). Arctic air pollution: Challenges and opportunities for the next decade. *Elementa: Science of the Anthropocene*.
- Asselin, L.-M., & Anh, V. T. (2008). Multidimensional poverty and multiple correspondence analysis. In *Quantitative approaches to multidimensional poverty measurement* (pp. 80–103). Springer.
- Beelen, R., Raaschou-Nielsen, O., Stafoggia, M., Andersen, Z. J., Weinmayr, G., Hoffmann, B., Wolf, K., Samoli, E., Fischer, P., & Nieuwenhuijsen, M. (2014). Effects of long-term exposure to air pollution on natural-cause mortality: an analysis of 22 European cohorts within the multicentre ESCAPE project. *The Lancet*, 383(9919), 785–795.
- Bruce, N., Perez-Padilla, R., & Albalak, R. (2000). Indoor air pollution in developing countries: a major environmental and public health challenge. *Bulletin of the World Health Organization*, 78, 1078–1092.
- Cachada, A., Rocha-Santos, T., & Duarte, A. C. (2018). Soil and pollution: an introduction to the main issues. In *Soil pollution* (pp. 1–28). Elsevier.
- Chen, B. H., Hong, C. J., Pandey, M. R., & Smith, K. R. (1990). Indoor air pollution in developing countries. *World Health Statistics Quarterly* 1990; 43 (3): 127-138.
- Chen, S. (2015). Environmental pollution emissions, regional productivity growth and ecological economic

- development in China. *China Economic Review*, 35, 171–182.
- Curtis, L., Rea, W., Smith-Willis, P., Fenyves, E., & Pan, Y. (2006). Adverse health effects of outdoor air pollutants. *Environment International*, 32(6), 815–830.
- Desaigues, B., Ami, D., Bartczak, A., Braun-Kohlová, M., Chilton, S., Czajkowski, M., Farreras, V., Hunt, A., Hutchison, M., & Jeanrenaud, C. (2011). Economic valuation of air pollution mortality: A 9-country contingent valuation survey of value of a life year (VOLY). *Ecological Indicators*, 11(3), 902–910.
- Gulas, S., Downton, M., D'Souza, K., Hayden, K., & Walker, T. R. (2017). Declining Arctic Ocean oil and gas developments: Opportunities to improve governance and environmental pollution control. *Marine Policy*, 75, 53–61.
- Gurjar, B. R., Jain, A., Sharma, A., Agarwal, A., Gupta, P., Nagpure, A. S., & Lelieveld, J. (2010). Human health risks in megacities due to air pollution. *Atmospheric Environment*, 44(36), 4606–4613.
- Hamidiana, Z., Meidiana, C., & Heddy, S. (2016). Pengaruh karakteristik masyarakat terhadap kuantitas dan kualitas mata air (Studi kasus Desa Gunungsari Kota Batu). *Indonesian Journal of Environment and Sustainable Development*, 7(1).
- Hamuna, B., & Tanjung, R. H. R. (2020). Heavy metal content and spatial distribution to determine the water pollution index in depapre waters, Papua, Indonesia. *CURRENT APPLIED SCIENCE AND TECHNOLOGY*, 1–11.
- Hanim, L., & Noorman, M. S. N. (2018). Kebijakan kelautan dalam rangka menjaga dan mengelola sumber daya alam laut sebagai upaya mewujudkan Indonesia sebagai poros maritim dunia. *Legality: Jurnal Ilmiah Hukum*, 25(1), 1–12.
- Ishar, D. P. A., Sardini, N. H., & Astrika, L. (2017). Konflik antara pemerintah Provinsi DKI Jakarta dan pemerintah Kota Bekasi dalam pengelolaan sampah Bantar Gebang tahun 2015-2016. *Journal of Politic and Government Studies*, 6(04), 211–220.
- Islam, M. S., Ahmed, M. K., Raknuzzaman, M., Habibullah-Al-Mamun, M., & Islam, M. K. (2015). Heavy metal pollution in surface water and sediment: a preliminary assessment of an urban river in a developing country. *Ecological Indicators*, 48, 282–291.
- Kumar, P., Morawska, L., Martani, C., Biskos, G., Neophytou, M., Di Sabatino, S., Bell, M., Norford, L., & Britter, R. (2015). The rise of low-cost sensing for managing air pollution in cities. *Environment International*, 75, 199–205.
- Kusminingrum, N., & Gunawan, G. (2008). Polusi udara akibat aktivitas kendaraan bermotor di jalan perkotaan Pulau Jawa dan Bali. *Jurnal, Jakarta, Puslitbang Jalan Dan Jembatan*.
- Landrigan, P. J. (2017). Air pollution and health. *The Lancet Public Health*, 2(1), e4–e5.
- Lee, B.-J., Kim, B., & Lee, K. (2014). Air pollution exposure and cardiovascular disease. *Toxicological Research*, 30(2), 71–75.
- Li, Z., Ma, Z., van der Kuijp, T. J., Yuan, Z., & Huang, L. (2014). A review of soil heavy metal pollution from mines in China: pollution and health risk assessment. *Science of the Total Environment*, 468, 843–853.
- Mallongi, A., Indra, R., Arief, M. K. M., & Satrianegara, M. F. (2020). Environmental pollution and health problems due to forest fires with CO2 parameters. *Medico Legal Update*, 20(3), 888–892.
- Mayer, H. (1999). Air pollution in cities. *Atmospheric Environment*, 33(24–25), 4029–4037.
- Nisa, K., & Arthani, J. (2011). Kualitas air dan persepsi wisatawan di kawasan wisata alam Pulau Pinus Kalimantan Selatan. *Jurnal Hutan Tropis*, 12(31).
- Noor, M. (2001). *Pertanian lahan gambut, potensi dan kendala*. Kanisius.
- Nurbiantara, S. (2010). *Pengaruh polusi udara terhadap fungsi paru pada polisi lalu lintas di Surakarta*.
- Pospelov, B., Rybka, E., Meleshchenko, R., Borodych, P., & Gornostal, S. (2019). Development of the method for rapid detection of hazardous atmospheric pollution of cities with the help of recurrence measures. *Eastern-European Journal of Enterprise Technologies*, 1(10), 29–35.
- Pradhan, M., & Van Soest, A. (1995). Formal and informal sector employment in urban areas of Bolivia.

- Labour Economics*, 2(3), 275–297.
- Rahim, A., & Soeprbowati, T. R. (2019). Water pollution index of Batujai Reservoir, Central Lombok Regency-Indonesia. *Journal of Ecological Engineering*, 20(3).
- Rodrigues, L., Grave, R., de Oliveira, J. M., & Nogueira, C. (2016). Study on homophobic bullying in Portugal using Multiple Correspondence Analysis (MCA). *Revista Latinoamericana de Psicología*, 48(3), 191–200.
- Sabiham, S., Lahan, S., & Sukarman, S. (2012). *Pengelolaan lahan gambut untuk pengembangan kelapa sawit di Indonesia*.
- Schraufnagel, D. E., Balmes, J. R., Cowl, C. T., De Matteis, S., Jung, S.-H., Mortimer, K., Perez-Padilla, R., Rice, M. B., Riojas-Rodriguez, H., & Sood, A. (2019). Air pollution and noncommunicable diseases: A review by the Forum of International Respiratory Societies' Environmental Committee, Part 2: Air pollution and organ systems. *Chest*, 155(2), 417–426.
- Siddharthan, T., Grigsby, M. R., Goodman, D., Chowdhury, M., Rubinstein, A., Irazola, V., Gutierrez, L., Miranda, J. J., Bernabe-Ortiz, A., & Alam, D. (2018). Association between household air pollution exposure and chronic obstructive pulmonary disease outcomes in 13 low-and middle-income country settings. *American Journal of Respiratory and Critical Care Medicine*, 197(5), 611–620.
- Simandjuntak, A. G. (2013). Pencemaran udara. *Buletin Limbah*, 11(1).
- Sudrajad, A. (2006). Pencemaran udara. *Majalah Inovasi*, 52.
- Suriadikusumah, A., Mulyani, O., Sudirja, R., Sofyan, E. T., Maulana, M. H. R., & Mulyono, A. (2020). Analysis of the water quality at Cipeusing river, Indonesia using the pollution index method. *Acta Ecologica Sinica*.
- Suryanto, D. A. (2012). Analisis tingkat polusi udara terhadap pengaruh pertumbuhan kendaraan studi kasus DKI Jakarta. *UG Journal*, 6(12).
- Swamee, P. K., & Tyagi, A. (1999). Formation of an air pollution index. *Journal of the Air & Waste Management Association*, 49(1), 88–91.
- Tahmasbi, B., Mansourianfar, M. H., Haghshenas, H., & Kim, I. (2019). Multimodal accessibility-based equity assessment of urban public facilities distribution. *Sustainable Cities and Society*, 49, 101633.
- Tanjung, R. H. R., & Hamuna, B. (2019). Assessment of water quality and pollution index in coastal waters of Mimika, Indonesia. *Journal of Ecological Engineering*, 20(2).
- Thahir, M. T., & Lagoa, Y. (2018). Analysis of seawater pollution index based on Cu and Pb parameter in tourism area of Raja Ampat West Papua. *Jurnal Sumberdaya Akuatik Indopasifik*, 2(2), 113–118.
- Wang, H., & Wheeler, D. (2003). Equilibrium pollution and economic development in China. *Environment and Development Economics*, 451–466.
- Wang, X.-K., & Lu, W.-Z. (2006). Seasonal variation of air pollution index: Hong Kong case study. *Chemosphere*, 63(8), 1261–1272.
- Wasis, B. (2013). Dampak kebakaran gambut terhadap ketersediaan unsur hara dan keracunan unsur hara mikro di kawasan pertanian, Lokasi PU I Desa Bukit Batu, Kecamatan Bukit Batu, Kabupaten Bengkalis, Provinsi Riau. *Departemen Silviculture Fakultas Kehutanan IPB Bogor*. ResearchGate DOI, 10.
- Wheeler, D. (2001). Racing to the bottom? Foreign investment and air pollution in developing countries. *The Journal of Environment & Development*, 10(3), 225–245.
- Widyati, E. (2011). Kajian optimasi pengelolaan lahan gambut dan isu perubahan iklim. *Tekno Hutan Tanaman*, 4(2), 57–68.
- Yanuarti, S. (2016). Kemiskinan dan konflik Papua di tengah sumber daya yang melimpah. *Jurnal Penelitian Politik*, 9(1), 14.
- Yokota, K., Watanabe, K., Wachi, T., Otsuka, Y., Hiramata, K., & Fujita, G. (2017). Crime linkage of sex offences in Japan by multiple correspondence analysis. *Journal of Investigative Psychology and Offender Profiling*. <https://doi.org/10.1002/jip.1468>

- Yuwono, A. S., Wardiatno, Y., Widyastuti, R., Wulandari, D., & Natali, M. (2021). Development of ecosystem health index in rural areas of Java Island: Preliminary results. *IOP Conference Series: Earth and Environmental Science*, 622(1), 12020.
- Zulfiah, N., & Aisyah, A. (2016). Status trofik perairan rawa pening ditinjau dari kandungan unsur hara (No3 Dan Po4) serta Klorofil-A. *Bawal Widya Riset Perikanan Tangkap*, 5(3), 189–199.

