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Impact of Soil Pollution on Increasing Temperature in Indonesia

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The current increase in pollution is of great concern because it will have an impact on various aspects of life. The increase in pollution results in global warming in the form of earth's temperature. This study aims to examine the effect of soil pollution on increasing temperatures in Indonesia.The design of this study is descriptive quantitative. This study uses 2018 Village Potential (Podes) data sourced from the Central Statistics Agency (BPS). This study uses multiple linear regression by looking at soil pollution factors, temperature, and involving other factors as supporting factors. Temperatures in Indonesia range from 24.5^{o}C-28.3^{o}C. Due to soil pollution, the temperature increased by 0.05^{o}C and specifically on the island of Java, the temperature increased by 0.157^{o}C. The existence of land burning activities also increases the temperature by 0.07^{o}C and in Java by 0.144^{o}C. Soil pollution has a positive effect on increasing temperatures in the territory of Indonesia by 0.055^{o}C. Java Island as the center of government and economy has a big role in generating pollution. Pollution on the island of Java resulted in an increase in temperature of 0.157 ^{o}C. The addition of a control variable in the form of community behavior in burning fields, will affect the nutrients in the soil and also exposure to smoke will interfere with the health of living things, apparently contributing to an increase in temperature of 0.01^{o}C.

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Keywords: Soil pollution; temperature rise; Java island; land burning.

1. INTRODUCTION

Pollution of the environment can occur anywhere at a very fast rate, and the burden of pollution is getting heavier due to industrial waste from various chemicals including heavy metals. Environmental pollution occurs when the material cycle in the environment changes so that the balance in terms of structure and function is disturbed [1]. The imbalance in the structure and function of the material cycle occurs due to natural processes or also due to human actions.

There are five main types of pollution: air pollution, water pollution, soil pollution, noise pollution and light pollution [2,3]. Types of pollution that are closely related to industrial waste are soil and air pollution. Soil pollution or soil pollution is a condition where one or many chemical, physical, or biological substances enter the soil where these objects can damage the soil structure and make it difficult for plants to adapt [4,5]. This pollution usually occurs due to leakage of liquid waste or chemicals in industrial or commercial facilities. The main source of this soil pollution is the leakage of industrial chemical waste [6]. Usually in factories where chemical waste is disposed of in bunkers that are underground, it is very prone to leaks. If the bunker has leaked then what happens next is the entry of various chemicals into the soil and damage the structure of the soil itself. In addition, gas from industry will cause air pollution [7]. Mainly because the factory smoke is excessive and not accommodated properly. There is carbon dioxide gas, carbon monoxide, methane gas, and many more [8]. The carbon content produced by industrial activities is 412 parts per million in the last 150 years. The increase in the amount of industrial waste certainly opens up great opportunities for pollution. Both air pollution and soil pollution [9].

Pollution of the soil can be interpreted as the presence of a damaged top layer of soil. Soil pollution results in the loss of arable land for agriculture, reduced forest cover, and reduced fodder for grazing animals[10,11]. In general, soil temperature and humidity are important elements in the development of nutrients in the soil. According to the soil temperature will be influenced by the amount of absorption of solar radiation by the soil surface. Soil temperatures during the day and night are very different, during the day when the soil surface is heated by the sun, the air close to the ground surface gets a high temperature, while at night the soil temperature decreases [12]. Soil temperature affects water absorption [13]. The lower the temperature, the less water is absorbed by the roots. Soil moisture is the amount of water stored between the pores of the soil. Soil moisture is very dynamic due to evaporation through the soil surface, transpiration, and percolation [14]. Soil moisture has an important role for the government to know information such as potential runoff and flood control, soil erosion failure and slope, water resource management, geotechnical, and water quality. The factors that determine soil moisture are rainfall, soil type, and the rate of evapotranspiration [15], where soil moisture will determine the availability of water in the soil.

The existence of an imbalance in soil temperature and moisture, then worsens soil conditions. In addition to soil damage, soil pollution also causes loss of topsoil, toxic groundwater, and others. The effects of soil pollution are very dangerous, causing a loss of ecosystem balance. Polluted soil will directly or indirectly affect climate patterns. The problem at hand is the increase in temperature [16], weather activities that are not in season, acid rain and others.

Inappropriate weather activity and the increase in temperature that occurs cause global warming. Global warming now deserves attention. Not because the earth is getting old, but human activities are getting more and more arbitrary. The impact will damage the environment, because the cause of global warming will be out of control if it continues [17,18]. In addition to what was previously explained regarding the leak of chemical waste, this also contributes greatly to global warming. This arbitrary activity that causes global warming occurs because environmental awareness is still not understood. One form of activity that causes global warming is deforestation [19]. Deforestation causes tree cover to be disrupted and causes a steep imbalance in the rain cycle. The rain cycle will be disrupted by reduced green cover. Trees and plants help balance the atmosphere [20]. Disruption of this balance causes global warming, the greenhouse effect, irregular rainfall, flash floods and others.

Pollution should be able to escape easily to the earth's surface. It's just that when global warming

occurs, these pollutants trap radiation and sunlight in the atmosphere [21]. When the causes of global warming are not immediately addressed, many disasters will occur [22]. Radiation and sunlight trapped in the atmosphere will make the earth's temperature rise to 1.1 degrees Celsius and has become the hottest on record [23]. Not without any impact, but can cause disasters such as storms, droughts, melting of the Arctic ice, fires, and floods.

The climate change is also related to the intensity or rainfall that occurred in the Jakarta, Bogor, Depok, Tangerang, Bekasi (Jabodetabek) and surrounding areas some time ago which caused flooding.[24,25]. The series of events that cause climate change begins with air pollution that causes urban warming or increases in temperature[26,27]. Air pollution occurs because it exceeds the existing environmental tolerance [28]. When the atmosphere continues to be at a high temperature, the earth also continues to rotate so naturally cold clouds will come to cool the heat.

In some parts of the world there has been an increase in temperature between 1.4 ° C - 5.8 ° C and a temperature increase of 4 ° C has occurred in Alaska, Siberia and parts of Canada even in New York the temperature has reached 14 ° C, in Manhattan on July 2000 was still 10° C and in January 2001 it had reached 18° C [29]. So global warming has hit in cold areas. Even at the North Pole and South Pole, chunks of ice have begun to melt. All this is due to the concentration of CO and CO_2 has increased greatly. Increasing thin and melting ice at the north and south poles and other ice areas, causing sea levels to rise [30,31]. Increasingly hot weather on earth which results in rapid evaporation of sea water so that rain occurs quickly [32]. The ferocity of the weather that causes very heavy rain, forest fires, sudden floods, sudden hurricanes [16] mass immigration/migration [33]. A place inhabited by traditional indigenous people moving from place to place due to natural disasters as well as animal migration which results in outbreaks of both human and animal diseases [34].

From the background that has been stated, it is deemed necessary to analyze the impact of pollution, especially soil pollution which can have an impact on other types of pollution. This study fills the gaps of previous research, which in this study uses data at the village level so that the results can be more representative. This study will also use control variables to ensure the strength of the model formed.

2. MATERIALS AND METHODS

The data used in this study is the 2018 Village Potential (Podes) data from the Central Statistics Agency (BPS). The data used specifically for soil pollution factors, temperature and control variables. This research uses multiple linear regression method. Multiple linear regression analysis is a linear relationship between two or more independent variables (X_1, X_2,….X_n) and the dependent variable (Y). In this study, the dependent variable is an increase in temperature, while the independent variable is soil pollution and the control variable is community activities such as land burning. Soil pollution data is obtained from data collection from each village in all parts of Indonesia related to soil pollution that occurs. The data used is usually an interval or ratio scale. The use of this method is to determine the effect of soil pollution on increasing temperatures in Indonesia.

3. RESULTS AND DISCUSSION

From the results of this study obtained the effect of soil pollution on the increase in temperature. From the results of this study, each relationship is presented in Table 1, namely the statistical description of temperature, Table 2, the effect of soil pollution on increasing temperature, Table 3, the effect of soil pollution on increasing temperature specifically in Java, Table 4, the effect of soil pollution on increasing temperature with the addition of variables control and Table 5 the effect of soil pollution on temperature increases, especially in Java with the addition of control variables.

Table 1. Statistics of Temperature Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
suhu	75,436	27.42243	.880811	24.5525	28.34193

Based on the descriptive analysis of the temperature variable in Indonesia as shown in Table 1, it was stated that the temperature degrees ranged from 24.5^{o}C -28.3^{o}C with an average of 27^{o}C. Indonesia's normal weather during the day in Indonesia is around 30 degrees Celsius. Based on these data, it can be interpreted that the temperature is still in normal conditions. However, this data represents the overall average temperature in the territory of Indonesia. But in fact, there are some areas in Indonesia that have temperatures above 30^{o}C. In general we almost always experience tropical weather conditions where the bright sun is mixed with heavy rain and thunderstorms. While the average temperature itself over the previous few decades in the observations of 91 BMKG stations, the normal air temperature for the 1981-2010 period in Indonesia was 26.6^{o}C and the average air temperature in 2020 was 27.3^{o}C. Overall in all regions of Indonesia in 2016 became the hottest year with an anomaly as high as 0.8°C throughout the observation period 1981 to 2020. While the second hottest year occurred in 2020 with an anomaly of 0.7°C, while the third hottest year occurred in in 2019 was with an anomaly value of 0.6°C.

Based on Table 2, information is obtained that pollution has a positive effect on increasing temperature. From these data, it can be seen that there was an increase of 0.05^{o}C. An increase in soil pollution in an area will result in an increase in temperature. The existence of dry conditions created by pollutants in the soil actually makes it easier for forest fires to occur. Fires can grow rapidly due to dry conditions and widening of polluted land. Polluted land is certainly not able to produce the nutrients needed by plants for their growth, resulting in a long vacancy of land. Empty land tends to have low temperature and humidity.

Table 2. The Effect of Soil Pollution on Temperature

Linear regression	Number of obs	=	75,436
	F(1, 75434)	=	7.79
	Prob > F	=	0.0053
	R-squared	=	0.0001
	Root MSE	=	.88077

suhu	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
r513bk2	.0557162	.0199607	2.79	0.005	.0165932	.0948391
_cons	27.42096	.0032502	8436.73	0.000	27.41459	27.42733

Table 3. The Effect of Soil Pollution on The Temperature of Java Island

Linear regression	Number of obs	=	22,472
	F(1, 22470)	=	8.47
	Prob > F	=	0.0036
	R-squared	=	0.0003
	Root MSE	=	1.5524

suhu	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
r513bk2	.157279	.0540437	2.91	0.004	.0513496	.2632084
_cons	27.31008	.0105528	2587.93	0.000	27.2894	27.33077

Specifically, Table 3 shows the effect of soil pollution on temperature in Java. From the table, it can be seen that the increase is much greater, namely 0.157^{o}C. Java Island as the center of government and economy has a big role in generating pollution. Along with the increase in the industrial sector and population growth, this has the potential to have an impact on the environment, both directly and indirectly, one of which is the potential for climate change on the island of Java. One of the parameters to see the climate change is the surface air temperature (SUP). This result is in line with calculations from data from all BMKG stations showing a trend of increasing temperatures in Java for all regions. during the period 1990-2019. The annual temporal variation shows that there is an increase in air temperature over a 30 year period at all stations on the island of Java with a value range of 0.11-1.24^{o}C [35]. The impact of this pollution will have an impact on increasing temperatures on the island of Java.

Adding control variables to prove the strength of the model, the direction of the model does not change. So it can be explained that the independent variable has a strong effect on the dependent variable. The control variable used is the behavior of the community in burning fields. The phenomenon of the community in burning fields will affect the nutrients in the soil and also exposure to smoke will interfere with the health of living things. From the results of Table 4, it is found that the presence of pollution still has a positive effect on increasing temperature, with a value of 0.054^{o}C. This result is not much different from the results obtained previously in Table 2. The presence of a control variable that was added turned out to have a positive contribution to an increase in temperature of 0.07^{o}C. The control variable confirms that any field burning activity will result in an increase in temperature.

Land clearing by burning for industrial or mining areas causes a reduction in the number of trees that should be able to absorb carbon dioxide. Forests have an important function as an absorber and trap carbon dioxide which can prevent it from being trapped in the atmosphere [36]. The absorption of carbon dioxide can reduce the effects of global warming.

Table 5 is the same as Table 4, except that Table 5 is devoted to Java Island with the addition of a control variable in the form of community behavior in burning fields. The results that can be seen in Table 5 are that the presence of pollution still has a positive effect on increasing the temperature with a value of 0.158^{o}C. This result is not much different from the results obtained previously in Table 3, which is 0.157^{o}C. The added control variable also contributed positively to the increase in temperature of 0.144^{o}C. From these results, it can be interpreted that the model formed is fit, because the direction of the model does not change.

From Table 1 to Table 5 shows that there is an increase in temperature caused by soil pollution. the addition of a control variable, namely community activities in Field burning also gave a positive contribution in increasing the temperature degree. From these results, an equation model can be made

$$Y_{temp} = \alpha_{cons} + \beta_{coef} X_{soil\ pollution} + \beta_2 X_{land\ burning} \quad (1)$$

where Y is the increase in temperature, X_1 is soil pollution and X_2 is land burning. α value is a constant while for β_1 is the coefficient of soil pollution and β_2 is the coefficient of land burning.

Table 4. The Effect of Soil Pollution on Temperature With Control Variables

Linear regression	Number of obs	=	75,436
	F(2, 75433)	=	79.78
	Prob > F	=	0.0000
	R-squared	=	0.0016
	Root MSE	=	.88012

suhu	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
r513bk2	.054701	.0199705	2.74	0.006	.0155589	.093843
r515	.0708581	.0057485	12.33	0.000	.0595911	.0821251
_cons	27.39498	.0047053	5822.16	0.000	27.38576	27.4042

Table 5. The Effect of Soil Pollution on Temperature With of Control Variables In Java Island

Linear regression				Number of obs	=	22,472
				F(2, 22469)	=	16.70
				Prob > F	=	0.0000
				R-squared	=	0.0013
				Root MSE	=	1.5517

suhu	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
r513bk2	.1580702	.0540547	2.92	0.003	.0521193	.2640212
r515	.1447214	.0288391	5.02	0.000	.0881948	.201248
_cons	27.29025	.011417	2390.31	0.000	27.26788	27.31263

4. CONCLUSION

The results obtained in this study are soil pollution has a positive effect on increasing temperatures in the territory of Indonesia by 0.055^{o}C. Java Island as the center of government and economy has a big role in generating soil pollution. After being investigated regionally, pollution in Java Island increased by 0.157^{o}C when the area was polluted. The addition of a control variable in the form of community behavior in burning fields has an effect on the nutrients in the soil and also exposure to smoke will interfere with the health of living things, in fact it contributes to an increase in temperature of 0.01^{o}C. Cooperation of a number of parties is needed to anticipate worse conditions for living ecosystems.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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