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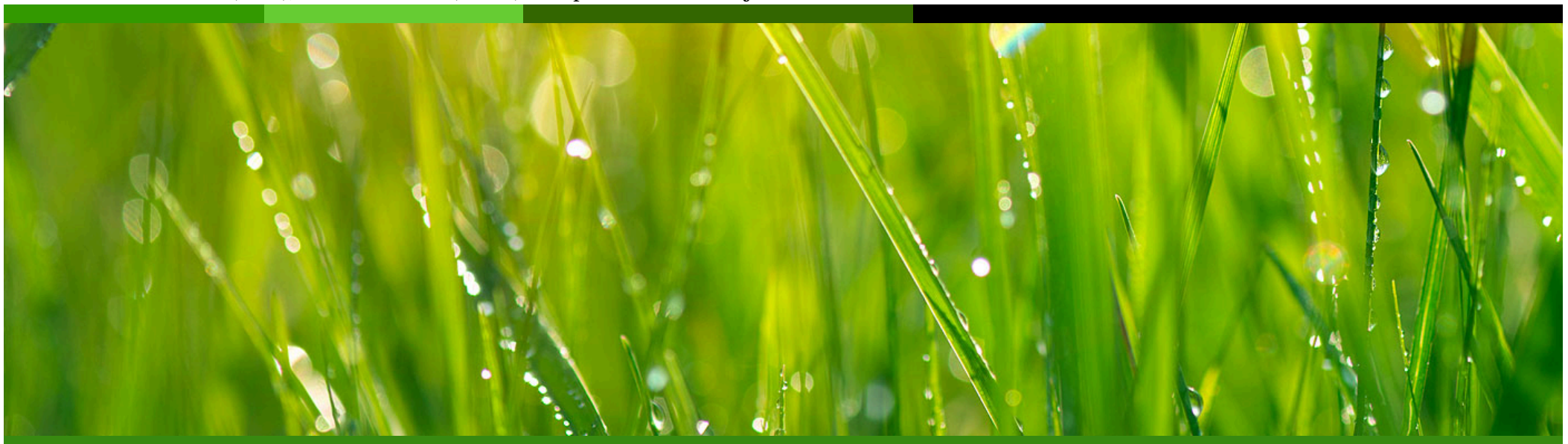

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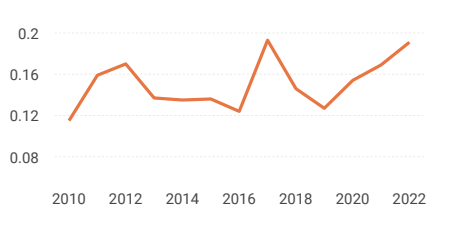

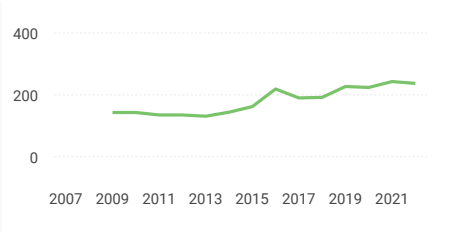

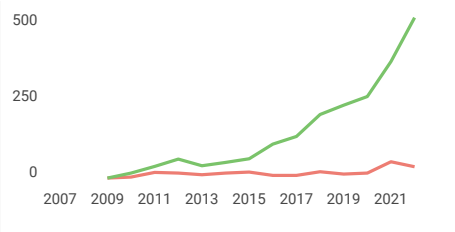

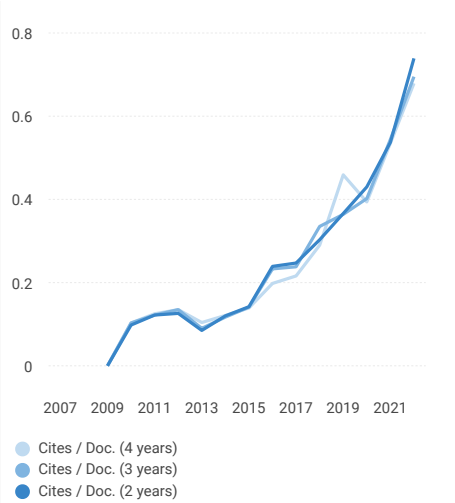

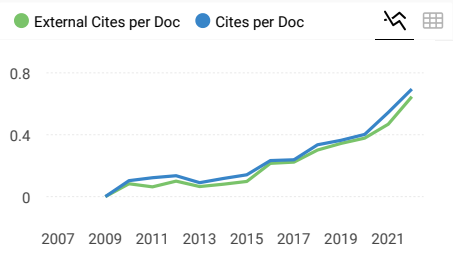

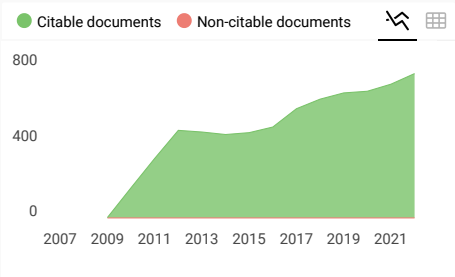

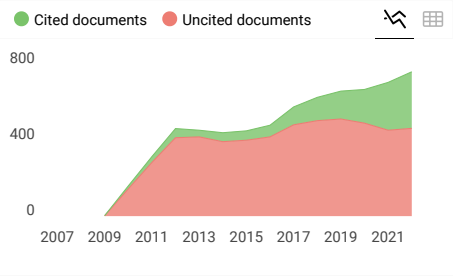

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Will Development and Temperature be Reconciled?

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ABSTRACT

The country's advancement is fueled by regional growth. It frequently has many detrimental effects in its application, including contamination. Climate, notably temperature, is negatively impacted by the ensuing pollution. This study uses the Multiple Correspondence Analysis (MCA) method to measure the pollution index, followed by the instrumental variable (IV) method to calculate the effect of development on pollution and temperature. Rural data from Podes 2018 is among the data used in this investigation. The findings of this study show that developed and developing areas are where the negative pollution index forms the most frequently. The construction and the resulting pollution index have a negative impact on temperature. The development process should pay attention to environmental aspects to anticipate worse temperature changes in the coming period.

INTRODUCTION

The issue of global warming has become a tough task for implementation in fighting these problems. Apart from having to pursue measurable development achievements in socio-economic indicators, the government is asked to maintain the environmental conditions of the local area and those around it (Faradiba & Lodewik 2020, Wood & DeClerck 2015, Zhang et al. 2017). Global warming that has occurred has begun to be felt in various aspects of life, so the country has made efforts through various regulations to combat these problems (Bahrami et al. 2022, De Schryver et al. 2009, Houillon & Jolliet 2005, Peters et al. 2011).

The simplest global warming can be felt through weather conditions that are getting warmer every day. This phenomenon occurs because humans will compare the current temperature conditions with the conditions some time ago (Faradiba 2021, Foster & Rahmstorf 2011, Hansen et al. 2006, Li et al. 2011). To increase comfort in activities, people often take shortcuts by using an Air Conditioner (AC). Community use of air conditioning will disrupt the ozone layer and later will have a negative impact on global air temperature (Bolaji & Huan 2013, Busakhin 2022). On the other hand, without realizing it, the development carried out by the government will have an impact on the surrounding environment (Jalil & Feridun 2011). Exploration of natural resources will disturb the balance of the ecosystem (Mogborukor 2014, Wilkinson et al. 2013). Significant development accelerations can be achieved when the country's focus has shifted from primary economic activities to secondary and tertiary economies. It is known that the primary economy promotes sectors based on nature. The signal of a shift in economic activity is thought to be due to the lack of natural resources in the local area.

The transition of economic activity in developed regions tends to be based on the industrial sector. The industrial sector will have greater added value. However, the residual waste caused by industrial processes is also very worrying (Li & Randak 2009, Zhang et al. 2016). The waste disposal can be in the form of liquid, solid, and gas, all of which will disrupt the nature-based economic sector. This problem is usually resolved through the concentration of industrial areas located from residential areas and fields where agricultural businesses are located (Reni et al. 2022).

The phenomenon that occurs in Indonesia today is that many people have switched professions from the agricultural sector to the non-agricultural sector. This supports the

economic theory, which states that people will leave the primary sector and switch to other sectors (Inglehart 2018). Based on Fig. 1, it is known that economic progress, as measured by the rural development index, is still centered on the island of Java. This condition is in contrast to the areas in eastern Indonesia, which are still largely underdeveloped. The difference between Java Island and eastern Indonesia is not only visible from the conditions of development, but the consequences of natural ecosystems are also important. The natural ecosystems in eastern Indonesia tend to be well preserved compared to Java Island (Marshall & Beehler 2012, Sindhu 2017). The current condition shows that most of the villages are catching up, especially in areas that are left behind in developing areas.

Based on Fig. 2, natural conditions that are still natural can be seen from the temperature conditions in eastern Indonesia. The temperature in Indonesia is relatively low when compared to other regions. Extreme conditions can be seen in areas on the island of Java. Java Island has a relatively high temperature level in almost all regions (Kameswara & Suharjit 2023). Extreme conditions can also be seen in East Kalimantan Province. East Kalimantan Province is a province outside Java Island that has significant economic activity in supporting the Indonesian economy.

The phenomenon between development followed by pollution and having an impact on air temperature is like the two blades (Hamed et al. 2013, Senthilkumar 2019). On the one hand, the government wants socio-economic problems in the community through economic activities, but on the other hand, there are things that need to be sacrificed. Many studies have concluded that economic progress as measured by GDP will have an impact on temperature at both the country and provincial levels. This research will determine the impact of development instrumented with a pollution index and its impact on increasing air temperature. Additionally, the Multiple Correspondence Analysis (MCA) technique will be used to assess the pollution index in this study. This research makes use of many rural-level indicators, including

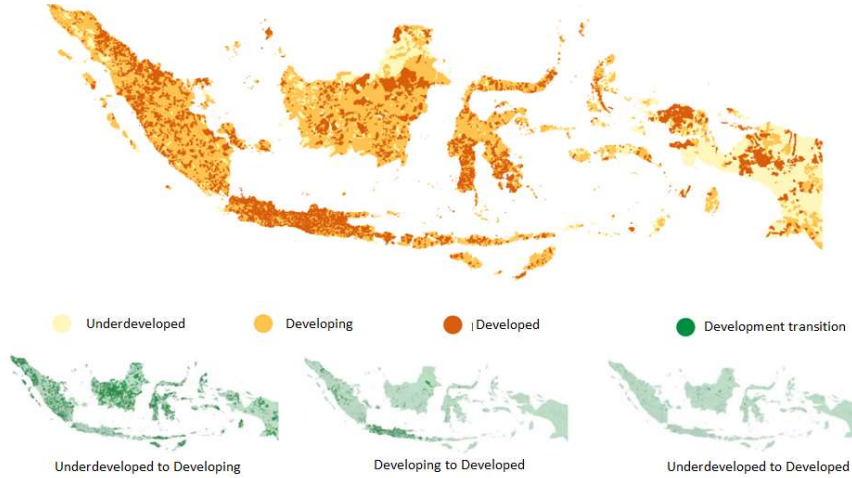


Fig. 1: Distribution of Rural Development Index and transition of development acceleration.

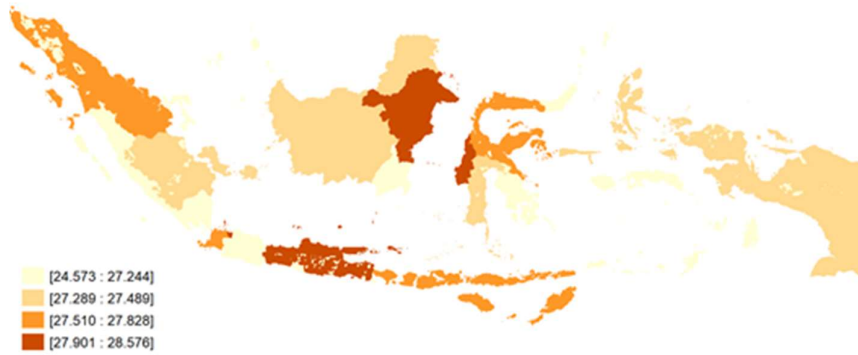


Fig. 2: Average temperature by Province 2018.

the development index and the pollution index. The village development index employed has taken into account a variety of factors, including government, economics, health, and education (BPS 2019). The pollution index built includes all pollution felt by rural communities.

MATERIALS AND METHODS

This research makes use of information from BPS-Statistics Indonesia's Village Potential 2018 findings, which include information on 75,436 villages. The pollution index will be created in this study to assess the level of pollution in rural regions. Additionally, this study makes use of data from the Rural Development Index that takes into account numerous features of a community. For this investigation, the BMKG-Meteorology, Climatology, and Geophysics Agency provided temperature data.

Multiple Correspondence Analysis (MCA)

Based on research findings from Yokota et al. (2017), the Multiple Correspondence Analysis (MCA) approach is used in this study (Yokota et al. 2017) to create the pollution index. By using this technique, category indices have been measured (Abdi & Valentin 2007, Asselin & Anh 2008, Rodrigues et al. 2016). Each of the *K* variables in the computation has a level of *Jk*, where *J* is the total of all *Jk*. Included are as many observations as *I* can count. The letter *X* stands for the $I \times J$ matrix. Two sets of factor scores will be generated by doing a correspondence analysis on the indicator matrix: one for the rows and one for the columns. Scaling the variance of these component scores to coincide with the relevant eigenvalues is a typical procedure. The breakdown of a single value in the following equation yields the factor score:

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

(Where an eigenvalue matrix is a diagonal matrix with a single value). The following equation is used to get the row and column factor scores, respectively:

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

The following equation may be used to indicate the distance squared between rows and columns:

$$d_r = diag\{FF^T\} \qquad d_c = diag\{GG^T\} \quad \ldots(3)$$

Instrumental Variable (IV)

The model has an endogeneity problem; hence, this inquiry will continue using the Instrumental Variable (IV) method. According to Wooldridge (2016), instrumental variable analysis provides a solution to the endogeneity problem. The Ordinary Least Square (OLS) estimator will be biased and inconsistent in the absence of a critical variable. Say there is a simple regression equation that appears as follows:

$$y = \beta_0 + \beta_i x + u \quad \ldots(4)$$

The relevance instrument is the name given to this supposition. The variable *z* is referred to as the instrument or instrumental variable for the variable *x*. Additionally, the so-called endogenous variable x elevates the subsequent regression equation:

$$x = \pi_0 + \pi_i x + z + v \quad \ldots(5)$$

The IV technique, according to Gujarati and Porter (2009), is completed in two steps. The first step is to use regression equation (2) to estimate the value of the variable *x*, represented by the symbol x. The next step is to insert the value of the variable x into equation (1) and run OLS regression. This second stage estimate is an unbiased and consistent estimator from the IV approach. These models will be developed for this study:

Preliminary model

$$Pollution_{index} = \alpha + \beta_1 rural\ development_{index} + \beta_2 GDRP_{per\ capita} + \beta_i X_i + \varepsilon \quad \ldots(6)$$

Temperature OLS model

$$Temperature = \alpha + \beta_1 pollution_{index} + \beta_i X_i + \varepsilon \quad \ldots(7)$$

Temperature IV model

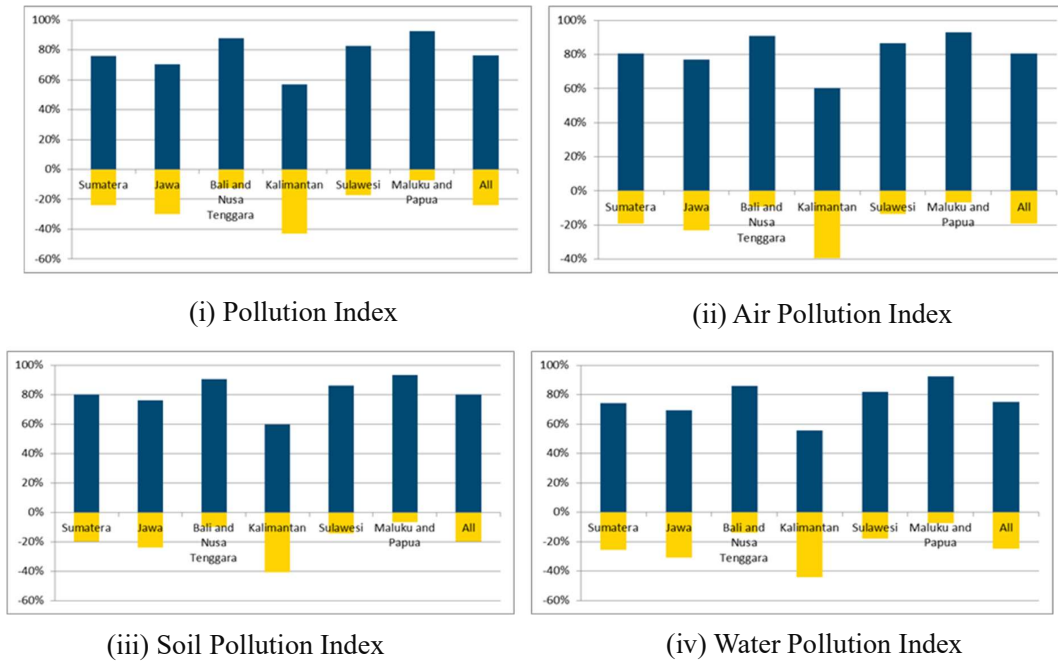
$$\text{Temperature} = \alpha + \beta_1 \widehat{pollution}_{\text{index}} + \beta_i X_i + \varepsilon \quad \ldots(8)$$

RESULTS AND DISCUSSION

Fig. 3 demonstrates that the number of villages on Kalimantan Island with a negative index as a percentage is larger than the number of villages on other islands. Pollution is a concern in the community, as shown by negative signs. The index value is more negatively skewed in areas where pollution is more pervasive. Pollution levels are quite low in the islands of Bali, Nusa Tenggara, Papua, Maluku, and Papua. This phenomenon is seen in almost every instance of pollution and pollution aggregation in general.

Based on Fig. 4, it is known that, in comparison to other development categories, villages with a negative index in the independent category have a comparatively large number. This tendency may be seen in the overall pollution index as well as the water, soil, and air pollution indices.

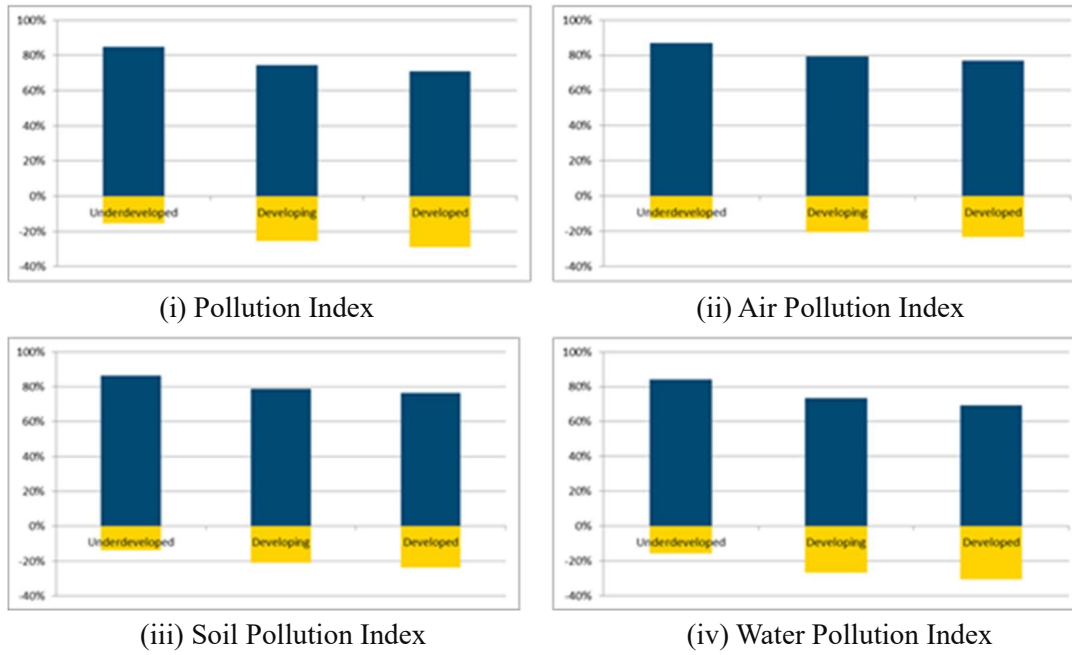
Based on Fig. 5, it is known that the soil pollution index has the highest level of severity when compared to the water



(i) Pollution Index (ii) Air Pollution Index

(iii) Soil Pollution Index (iv) Water Pollution Index

Fig. 3: Index Distribution by Island 2018.



(i) Pollution Index (ii) Air Pollution Index

(iii) Soil Pollution Index (iv) Water Pollution Index

Fig. 4: Index distribution by development category 2018.

pollution index and air pollution index. From the index calculation results, it is known that the soil pollution index has a dominant negative contribution to the formation of the overall pollution index. A higher negative pollution index indicates a deeper level of severity.

If you pay attention in stages, the level of pollution is getting higher, starting from the category of underdeveloped development, developing, to being developed. Air pollution is the type of pollution that has the highest index level.

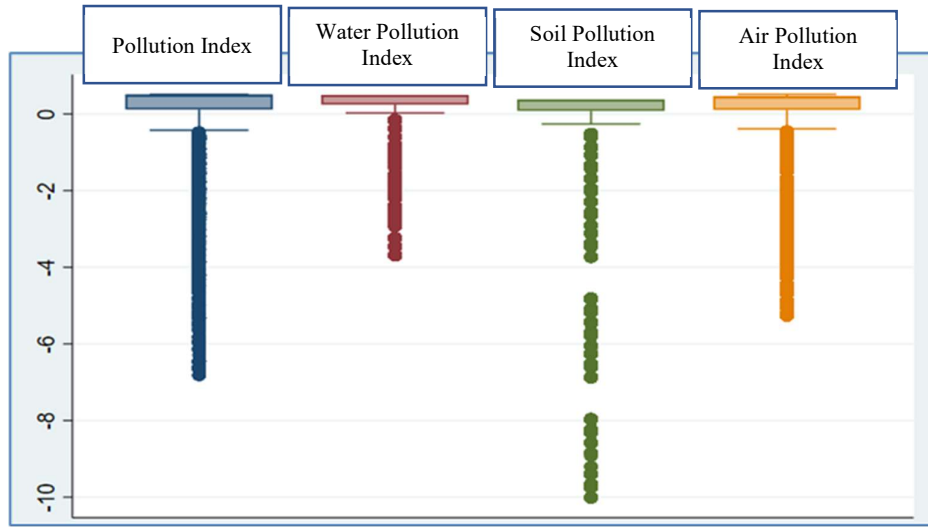


Fig. 5: Pollution Index by Type.

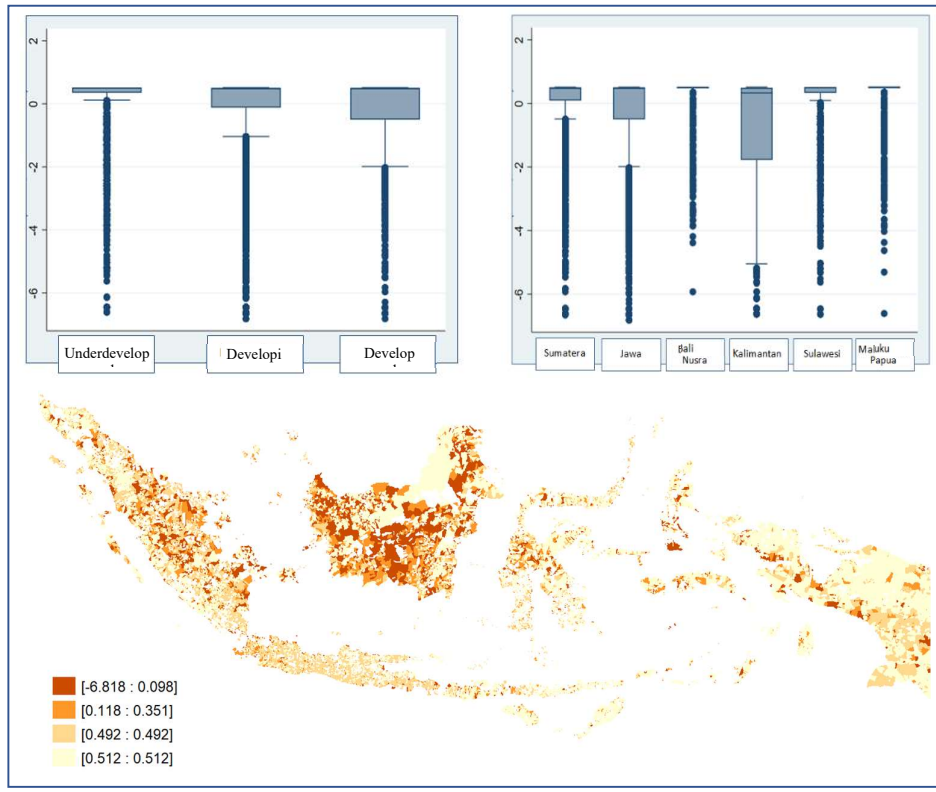


Fig. 6: Distribution of Pollution Index.

The pollution index, based on Fig. 6, if classified according to the development category, the developing category has the largest average negative index when compared to other development categories. This phenomenon can be seen from the size of the squares in the negative area. Rural with underdeveloped categories have the smallest average negative index. If classified according to the major islands in Indonesia, Java, and Kalimantan have an average index range that dominates in negative areas. Good conditions can be seen in Maluku and Papua Islands.

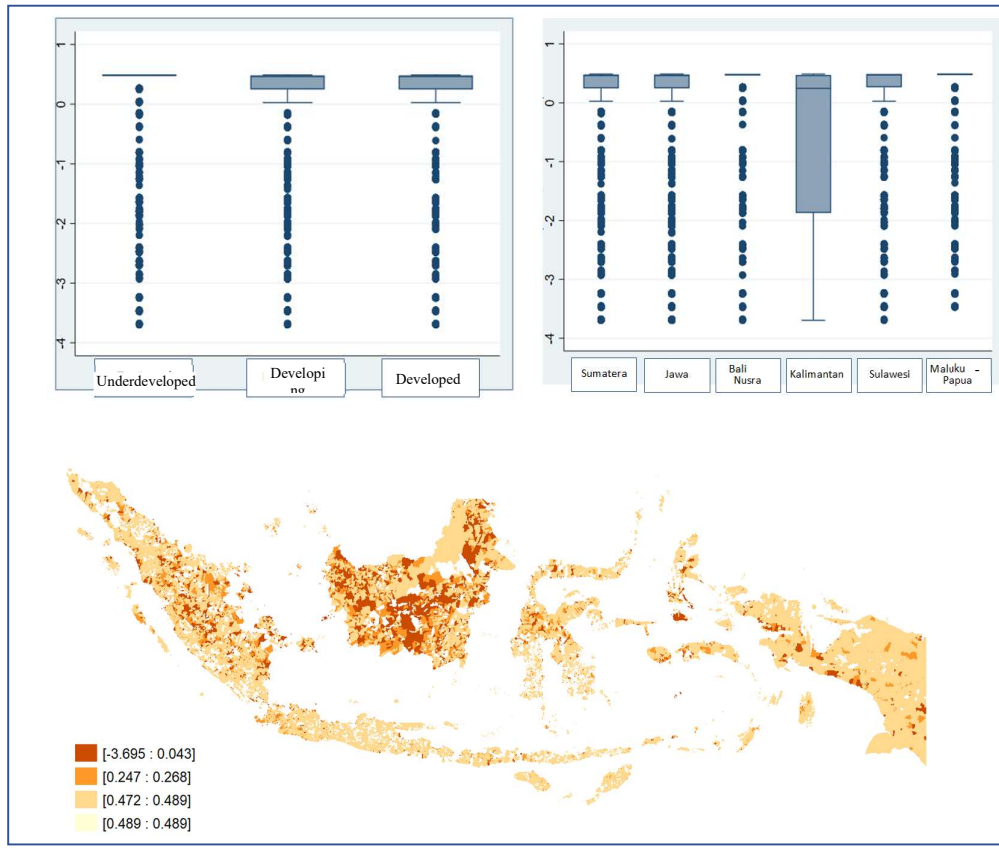


Fig. 7: Distribution of Water Pollution Index.

On the islands of Maluku and Papua, no average grouping is seen in negative areas. This phenomenon is because there is no domination box found in negative areas. If classified according to villages in Indonesia, Kalimantan Island has the largest negative index. The distribution of the negative index can be seen in areas that are, in fact, urban areas or areas close to the economic center or government center. The distribution of the created negative index totaled -6.818.

Based on Fig. 7, the water contamination index usually has positive index ranges across all development categories. The box size sees this in the area above 0. Comparing Kalimantan Island to the other major Indonesian islands, the average index range is mostly negative. Sumatra, Java, and Sulawesi are all in excellent condition.

The negative zones in the islands of Papua, Maluku, Nusa Tenggara, and Bali do not have an average grouping. Negative sections on these islands lack a dominance box, which accounts for this peculiarity. When classified as rural in Indonesia, Kalimantan Island has the highest negative index. The distribution of the negative index caused by water pollution has a maximum value of -3.695.

Based on Fig. 8, the soil contamination index usually has positive index ranges for all development categories. The box size sees this in the area above 0. Compared to the other major Indonesian islands, Kalimantan Island has an average index range that predominates in the negative zone. Sumatra, Java, and Sulawesi are all in excellent condition. The negative zones in the islands of Papua, Maluku, Nusa Tenggara, and Bali do not have an average grouping. Negative sections on these islands lack a dominance box, which accounts for this peculiarity. When compared to Indonesian communities, Kalimantan Island has the highest negative index. The water contamination-related negative index distribution achieves a value of -10.020.

Based on Fig. 9, in the air pollution index, all development categories have an index range that is mostly positive in underdeveloped areas. This can be seen from the box size in the area above 0. In developing and developed areas, the grouping occurs in the negative area. This indicates that most of the indexes are in the negative range. If classified according to the major islands in Indonesia, Sumatra, Java, and Kalimantan have an average index range that dominates in negative areas. Good conditions can be seen on the island

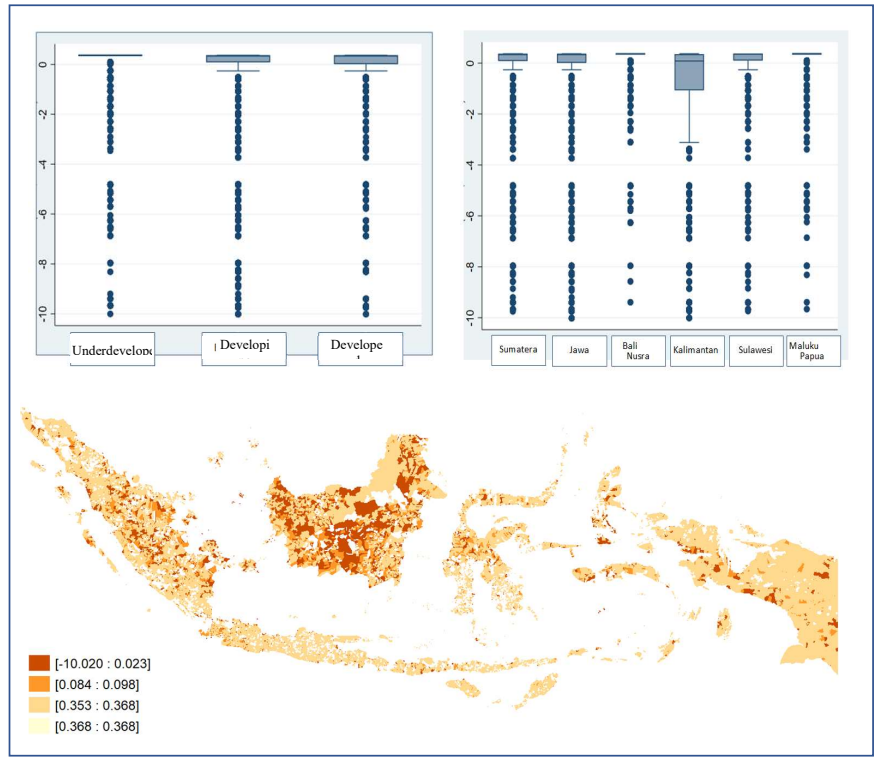


Fig. 8: Distribution of Soil Pollution Index.

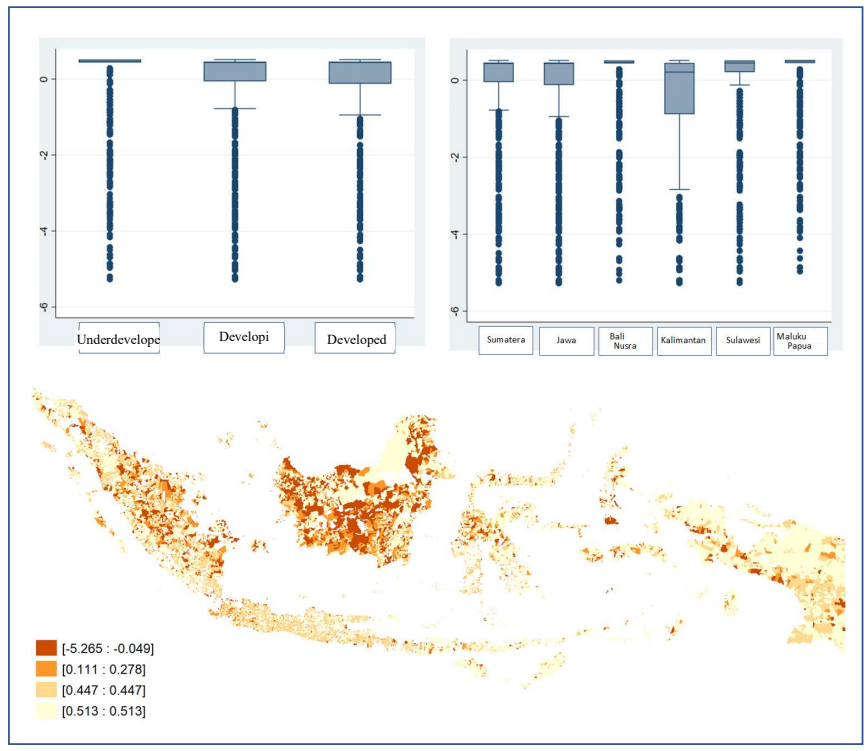


Fig. 9: Distribution of Air Pollution Index.

Table 1: General estimation results for first stage IV on the pollution index.

Variable	Country	Suma-tera	Jawa	Bali and Nusa Tenggara	Kali-mantan	Sulawesi	Maluku and Papua
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rural development index	-0.0088***	-0.0049***	-0.0030***	-0.0098***	0.0024	-0.0023**	-0.0016***
GRDP per capita	-0.2108***	-0.2536***	-0.1610***	-0.3492***	-0.1881	-0.1910***	-0.0957***
R^2	0.0189	0.0130	0.0029	0.0440	0.0047	0.0068	0.0087
Observation	75,436						

Source: Stata 16 (processed) processing results

Note: The dependent variable in the model is the pollution index. The instrument variables in the model are the village development index and GRDP per capita. Significance level notation *** p <1%, ** p <5%, and * p <10%.

Table 2: Estimation results of OLS and IV in general at temperature.

Variable	Bali and Nusa Tenggara		Kalimantan		Sulawesi	
	OLS	IV	OLS	IV	OLS	IV
(1)	(8)	(9)	(10)	(11)	(12)	(13)
Pollution index	0.0295***	0.3410***	0.0042**	1.1144***	0.0035	-0.0190
R^2	0.0779	< 0.0001	0.0009	< 0.0001	0.0001	0.0065
Observation	75,436					

Variable	Country		Sumatera		Jawa	
	OLS	IV	OLS	IV	OLS	IV
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Pollution index	0.0605***	0.5810***	0.0059**	-0.0587	0.1230***	2.6880***
R^2	0.0047	< 0.0001	0.0003	< 0.0001	0.0078	< 0.0001
Observation	75,436					

Variable	Maluku and Papua	
	OLS	IV
(1)	(14)	(15)
Pollution index	0.0302***	0.2688***
R^2	0.0108	< 0.0001
Observation	75,436	

Source: Stata 16 (processed) processing results

Note: The dependent variable in the model is temperature. The independent variable in the model is the pollution index. The instrument variables in the model are the village development index and GRDP per capita. Significance level notation *** p <1%, ** p <5%, and * p <10%.

of Sulawesi because there is a grouping of positive index ranges. There is no average grouping in negative regions in the islands of Bali, Nusa Tenggara, Maluku, and Papua. This anomaly is caused by the absence of a domination box in negative areas on these islands. The biggest negative index is seen on Kalimantan Island when compared to Indonesian communities. Water contamination creates a distribution of the negative index that reaches a value of -5.265.

The impact of the instrument factors on the relevant variable is shown in Table 1. From these findings, it may be inferred that growth in Indonesia has a detrimental effect on pollution in general, both nationally and throughout the archipelago. Additionally, the direction and importance of per capita GRDP as a control variable are the same. The islands of Bali and Nusa Tenggara saw the highest development effect, whereas Maluku and Papua experienced the least.

Table 2 shows how the pollution index affects temperature. According to the calculations, pollution has a beneficial effect on temperature both nationally and throughout the Indonesian archipelago. The island of Java is where development has had the most impact, whereas Bali and Nusa Tenggara have witnessed the least change.

As a factor for the success of a region, development is often used as an indicator that can be compared between regions. However, development turns out to have bad impacts, especially on environmental aspects and indirect impacts on climate change. Climate change that has occurred has prompted environmental experts to urge the public and the government to continue to maintain the purity of nature as a legacy for future generations. The climatic impact that is most felt is the higher temperature in the last decade.

From this research, it is known that the greatest pollution is seen in developed and developing areas, followed by underdeveloped areas. Underdeveloped areas tend to be still natural, so the pollution index formed for all types of pollution tends to be good. This is different from the developed and developing regions, which have a relatively large negative index. The negative index that is formed can be described as the developed and developing regions having more pollution than the underdeveloped areas. According to earlier studies' findings, pollution levels in developed regions would be greater than those in undeveloped ones. (Hoffmann 2019, Kumar et al. 2015, Mayer 1999).

When linked to the development that occurs, the entire region confirms that development will cause significant pollution. This Indonesian phenomenon is consistent with studies done in other nations and is seen in rural regions (Brauer et al. 2002, Gan et al. 2020, Gehring et al. 2010). The development carried out by each region often explores the natural resources that are around it so that it has an impact on the ecosystem. In the short term, the most felt is the progress of the area and the welfare of the surrounding community. However, in the long term, this will be eroded by the negative impacts that arise, especially on environmental factors.

Pollution that occurs in developed areas is often found in several countries. The government must anticipate the bad impacts caused by the development that occurs. The government can endeavor to reinforce the rules relating to the exploration of natural resources that have an impact on the environment. Thus, in practice, the progress of an area is not only measured through development alone but through the environmental impacts that occur.

From the results of the regression calculation in this study, it is known that development has a negative impact on temperature conditions. These results are visible both nationally, as well as on most islands in Indonesia. This result reaffirms that the recent climate change is the impact of development. The results of this study are in line with several previous studies that have linked development with temperature (Ding et al. 2007, Horne et al. 2019, Melicher et al. 2019). The global warming that occurs will certainly have a negative impact on human life, especially the livelihoods of most Indonesians as farmers. The yields were no longer as expected due to the long drought.

It takes coordination between the government, investors, and the community to be able to anticipate the negative impacts of development on pollution and temperature. It is hoped that with good coordination, the development process can run, and the environmental ecosystem can be maintained. This study still uses temperature data at the provincial level. In further research, temperature data at the village level are needed to produce more representative research results.

CONCLUSION

Environmental activists and the government are always trying to control climate change that is happening. The climate change that most people feel is increasing global warming. This phenomenon adversely affects various community activities. Through research, it is known that the development that occurs has a negative impact on the temperature in Indonesia. This result occurs in most archipelagic regions in Indonesia. It takes various efforts from the government and society to anticipate worse events because development often takes precedence over environmental aspects.

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