Linkage of Climate and Natural Disaster to Development Potential

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Climate analysis as the impact of natural disasters hampers development potential

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Abstract

The extreme climate change that occurred in Indonesia has an impact on increasing the frequency of natural disasters in almost all parts of Indonesia. The frequency of natural disasters that occur also affects the development potential of a region. This study uses 2018 Rural Potential data and the Rural Development Index. This study uses multiple linear regression by looking at the factors of natural disasters on development potential. Natural disaster factors in this study are landslides, flash floods and hurricanes. The results of this study indicate that natural disasters such as landslides, flash floods and tornadoes have an impact on decreasing development potential, respectively, namely 0.76%, 0.85% and 1.18%. Efforts are needed in disaster mitigation both from the government and the community as well as policies related to development by taking into account the frequency of natural disasters that occur.

Keywords: climate; natural disasters; development.

1. Background

The territory of Indonesia is located in a tropical climate area with two seasons, namely summer and rainy season with the characteristics of extreme changes in weather, temperature and wind direction. These climatic conditions and supported by relatively diverse surface topography and rock conditions, both physically and chemically, result in fertile soil conditions. On the other hand, this condition can cause several bad consequences for humans, such as the occurrence of disasters such as floods, landslides, forest fires and droughts (Adiyoso, 2018; Febryan, 2015). Climate change has been recognized as the cause of the increasing frequency of droughts, forest fires, hurricanes, and others (Dale et al., 2001; Faradiba, 2021a; Gamble et al., 2013).

The average annual temperature in urban areas is 3^{o}C higher than in rural areas. The minimum temperature is greater than 1 - 2 ^{o}C and the maximum temperature is 1 - 3 ^{o}C (Beattie & Landsberg, 1960; Karyono, 2005). This difference depends on the size of the function, the position of the city itself and also the macro-climate of the city. Differences in urban and rural temperatures are caused by differences in energy consumption, absorption of latent exchange, turbulence and turbulencei (Hagaback et al., 2005; Karyono, 2007).

Urban materials reflect more heat and most of the reflected radiation is also retained by the walls of buildings, roofs, etc. (Gago et al., 2013; Krayenhoff et al., 2014). Besides that, the conductivity of urban materials (concrete, stone, asphalt, etc.) has a very high heat capacity (Xu et al., 2021), So the sun's heat is stored during the day and released at night. On the other hand, in rural areas where the surface is mostly covered with vegetation which acts as a shield against the heat of the sun (Gago et al., 2013; Mas'at, 2009), at night and during the day the temperature is lower than in urban areas. This is due to the large number of water sources (in wet soil, puddles) so that a lot of heat is used for evaporation and evapotranspiration. The heat stored in the water vapor is known as latent heat (Mishra et al., 2015). The city is also a source of heat as a by-product of the activities of its inhabitants (industrial, transportation, household and others). In general, the temperature in the city is higher than in the village (Hermawan, 2015; Karyono, 2001), This difference is higher in calm wind conditions. For example, the contrast between the temperature in the city of London and the surrounding villages will appear when the wind speed is < 6 m/s and in sunny weather, the temperature difference can reach 6 ^{o}C but if the wind speed is > 11 m/s the temperature difference will disappear. (Hagaback et al., 2005).

One of the causes of natural disasters is its relation to extreme weather. Climate change is not something that can be taken lightly. There are many potential threats of disaster that haunt us if we do not make efforts to overcome them. Along with the development of time and increasing human activities, environmental damage tends to get worse and triggers an increasing number of incidents and intensity of floods, landslides and droughts that occur one after another in many areas in Indonesia. (Glantz & Glantz,

2001; Measey, 2010). Statistics related to natural disasters are simply unimaginable (Mani et al., 2003). Now every second someone is homeless. When compared, the number of people who have lost their homes due to natural disasters is 3-10 times greater than due to war and conflict. Each year, since 2016, an average of 26 million people have become homeless. This figure is equivalent to one person having to evacuate every second. In 2018 more than 17.2 million people were displaced by natural disasters in 125 countries and territories (Statistik, 2018).

The implementation of national development does not always run smoothly, because in its implementation there are many problems that become obstacles. In addition to human resources, there are several factors that hinder development, one of which is natural disasters. With the frequency of occurrence of natural disasters that occur more frequently, of course, development will be hampered. Although development in Indonesia has been designed and designed in such a way with minimal environmental impact, the development process still causes environmental and ecosystem damage (Faradiba, F., & Zet, 2020). Development that has been based on the exploitation of natural resources (especially on a large scale) has caused the loss of the carrying capacity of these resources to the lives of the people (Faradiba, 2021b). From year to year forest resources in Indonesia are decreasing, meanwhile the exploitation of mineral resources also causes damage to ecosystems which physically often causes an increase in disaster risk (Purba et al., 2020; Simarmata et al., 2021).

On the other hand, the pace of development has resulted in increased public access to science and technology (Morrar et al., 2017). However, due to the lack of precise technology implementation policies, technology failures often occur which have fatal consequences such as transportation accidents, industry and disease outbreaks due to higher human mobilization. (Muttarak & Lutz, 2014). Another potential disaster that is no less serious is the factor of demographic diversity in Indonesia (MacAndrews, 1978).

2. Methods and Data

The data used in this study are raw data from the 2018 PODES data collection and Rural Development Index data. 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,….Xn) with the dependent variable (Y). then the data used is usually an interval or ratio scale. The use of this method is to determine the effect of natural disasters: landslides, flash floods, and hurricanes/typhoons on development potential. The models that will be formed in this research are as follows:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n \qquad (1)$$

3. Results and Discussion

From the results of this study obtained the effect of natural disasters, namely landslides, flash floods and hurricanes / typhoons on development. From the results of this study, each relationship is presented in table 1, namely the effect of landslides on development, table 2, the effect of flash floods on development, and table 3 the effect of tornadoes on development.

Table 1. Effect of landslides on development

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	63,267	.0754874	.0005071	.1275392	.0744935	.0764812
1	8,969	.067874	.0012186	.1154063	.0654853	.0702627
combined	72,236	.0745421	.0004693	.1261205	.0736223	.0754618
diff		.0076134	.0014227		.0048249	.0104019

diff = mean(0) - mean(1) t = 5.3513
Ho: diff = 0 degrees of freedom = 72234

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 1.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 0.0000

In Table 1 it can be interpreted that the impact of landslides on development can reduce the potential for increased development by 0.76 percent. Factors that cause landslides naturally include the morphology of the earth's surface, land use, lithology, geological structure, rainfall, and earthquakes (Ramadhani & Idajati, 2017). The effect of rainfall in producing landslides is clear, although it is very difficult to explain precisely (Blong

& Dunkerley, 1976). This difficulty arises because rainfall only affects slope stability indirectly to pore-water conditions in the slope-forming material (Hasnawir, 2012). When the intensity of rainfall is high for a long time, causing rainwater to fall and seep into the ground, it will damage the compact and impermeable rock structure. Over time the rock will break and the rock fragments will be carried away by the flow of water so that landslides occur (Effendi, 2008).

In addition to natural factors, it is also caused by human activity factors that affect a landscape, such as agricultural activities, slope loading, slope cutting, and mining. (Mubekti, 2008). Mitigation of landslide risk in very risky areas is carried out by controlling development in accordance with the carrying capacity of the environment. Development control basically aims to avoid a greater risk in the event of a landslide. Land use is also one of the parameters in the calculation of landslide risk. Uncontrolled land use change is a form of human intervention that can increase the risk of landslides. The increasing need for land for settlements, economic activities, or infrastructure due to an increase in population can also increase the risk in the event of a landslide.

Table 2. The effect of flash floods on development

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	70,579	.0747365	.0004764	.1265757	.0738027	.0756704
1	1,657	.0662593	.0025698	.1046083	.0612188	.0712998
combined	72,236	.0745421	.0004693	.1261205	.0736223	.0754618
diff		.0084772	.0031343		.002334	.0146205

diff = mean(0) - mean(1) t = 2.7046
Ho: diff = 0 degrees of freedom = 72234

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.9966 Pr(|T| > |t|) = 0.0068 Pr(T > t) = 0.0034

Based on Table 2, it can be interpreted that the impact of banjir bandang natural disasters on development can reduce the potential score increase by 0.85 percent. Floods can be caused by static natural conditions such as geography, topography, and river

channel geometry. Dynamic natural events such as high rainfall, damming from the sea/tidal on the main river, land subsidence and siltation due to sedimentation, as well as dynamic human activities such as inappropriate use of land in floodplains, namely: by establishing settlements on the banks rivers, lack of flood control infrastructure, land subsidence and sea level rise due to global warming (Sastrodihardjo, 2010).

The intensity of rainfall is an important factor to consider when checking the rain conditions during banjir bandang. Rainfall with very high intensity is usually found in convective rainfall. The duration of high-intensity rainfall is another major factor determining flood risk (Zhai et al., 2018). Floods become a problem during the rainy season, because the carrying capacity of the watershed against the rain that falls is not capable. Climate change that can increase the intensity of rain and changes in land use add to the risk that occurs. Every time we enter the rainy season, several regions and cities in Indonesia experience flooding problems.

Table 3. The effect of hurricanes/typhoons on development

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	66,027	.0755518	.0004995	.1283535	.0745727	.0765308
1	6,209	.0638048	.0012524	.0986874	.0613496	.06626
combined	72,236	.0745421	.0004693	.1261205	.0736223	.0754618
diff		.011747	.0016736		.0084668	.0150272

diff = mean(0) - mean(1) t = 7.0191
Ho: diff = 0 degrees of freedom = 72234

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 1.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 0.0000

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Based on Table 3, it can be interpreted that the impact of natural disasters such as hurricanes/ hurricanes/ typhoons on development can reduce the potential score increase by 1.18 percent. A hurricane or tornado is a vortex of strong winds with wind speeds of 120 km/hour or more that often occurs in tropical areas between the north and south, except in areas very close to the equator, rotating with a longer scale of about 3 – 7 day,

it always happens at sea with destructive power reaching thousands of km (Naing, 2016). Tornadoes are considered as one of the most dangerous types of wind because they can destroy anything in its path.

Extreme weather that occurs on land includes hurricanes, strong winds, heavy rain, heavy rain accompanied by strong winds or lightning, hail, extreme horizontal visibility or extreme air temperatures. Moderate extreme weather that occurs at sea includes tropical cyclones, strong winds, waterspouts, extreme ocean waves, tidal waves, heavy rains, heavy rains accompanied by strong winds and/or lightning, or extreme horizontal visibility.

An increasing trend of tornadoes as the earth's temperature warms. Global warming increases the temperature of sea water so that water vapor is abundant and clouds grow bigger. There is also a change in the atmosphere where the cloud height grows higher. Several locations in Indonesia show an increasing trend of increasing temperatures. The temperature of the earth's surface is increasing, increasing the contrast of warming in some places. This is the cause of the increasing trend of tornado occurrences. Tornadoes occur because there is a temperature contrast at the change of seasons. Densely inhabited areas tend to heat up faster than green areas.

There are six climatic phenomena that cause extreme weather. These include the La Nina phenomenon, the Asian Monsoon wind phenomenon, the Madden-Jullian Oscillation phenomenon, the Kelvin and Rossby phenomenon, the phenomenon of warming sea surface temperatures and the phenomenon of cyclone seeds..

4. Conclusion

Extreme climate change results in high intensity of rainfall with a long duration, causing the impact of natural disasters such as landslides, flash floods and tornadoes. the impact of landslides on development can reduce the potential for increased development by 0.76 percent. The impact of banjir bandang natural disasters on development can reduce the potential score increase by 0.85 percent. The impact of hurricane/cyclone/hurricane natural disasters on development can reduce the potential score increase by 1.18 percent. Efforts are needed in disaster mitigation both from the government and the

community as well as policies related to development by taking into account the frequency of natural disasters that occur.

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