The effect of economic factors on the level of disasters that occur in the area of West Sumatra

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Abstract. Environmental economics studies need to be developed nowadays, because they are increasingly aware of the scarcity of natural resources. Scarcity of natural resources can occur due to human activities in fulfilling their daily needs which sometimes over-consume natural resources. Humans are prioritizing more in economic growth targets, but ignore the consequences that occur during the process undertaken. Natural disasters are one of the consequent of the use of natural resources that do not pay attention to the sustainability of these old resources. Natural disasters that continue to occur will result in economic costs and scarcity of natural resources which ultimately threaten the sustainability of life. Complex empirical studies which link the impact of socio-economic variables of the many natural disasters that occur due to human activity is rare. This study aims to examine how the impact of socioeconomic variables on the level of disaster .Empirical studies using secondary data in the form of disaster data and macroeconomic indicators in the area of West Sumatra. The results of data processing using the generalized least squares model on models that affect the level of disasters due to the presence of macroeconomic factors are found as follows: the level of per capita income, labor force, number of industries. This study is expected to contribute to the study of environmental economics and macroeconomics.

1. Introduction

Human activities related to economic development processes often damage the environment, so that it has a negative impact on themselves. Environmental damage occurs because humans face the limitations of *natural resources*, resulting in excessive exploitation of natural resources. Exploitation of natural resources carried out sometimes exceeds the threshold of natural capacity itself [1]. Natural disasters are the further impact of excessive exploitation of natural resources and do not pay attention to environmental sustainability.

Disaster is an event or series of events that occur suddenly or slowly caused by nature, humans or both so that it can result in patterns of life and livelihood, disruption to the system of government and damage to ecosystems   [2]. United Nations Disaster Relief Coordinator (UNDRCO), [3] stress that disasters in the Sudden-onset disasters group (storms, earthquakes, floods) will mainly destroy productive capital and infrastructure. Meanwhile, disasters that fall into the category of Slow-onset disasters (droughts and floods) impact will be broader and longer-term, reducing the level of community savings, investment, domestic demand in aggregate and reducing productive capacity. Furthermore, climate change also triggers routine natural disasters, such as flash floods and landslides at this time almost every year and serious threats to various regions in Indonesia.

The opposite thing shows that the events of natural disasters on the regional economy not only have a negative impact, but can also trigger new economic growth in the region [4]. Then it can be understood that disasters and economic conditions have a close relationship.

According to data compiled in the Indonesian Disaster Information Data (DIBI) -BNPB, in the period 2005 to 2015 there were more than 1,800 disaster events. Of that amount, more than 78% (11,648) of these disasters were hydro meteorological disasters and only about 22% (3,810) were geological disasters. Disaster events in the hydro-meteorology group are in the form of floods, extreme waves, land and forest fires, droughts, and extreme weather. As for the geological disaster groups that often occur are earthquakes, tsunamis, volcanic eruptions,

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and landslides. The tendency of the total number of disaster events for the two types of groups is relatively increasing. The number of disasters caused by geological factors is not too significant compared to the number of disasters caused by hydro-meteorological factors. The influence of climate change also contributes to the increase of hydro-meteorological disasters. With a high frequency of occurrence, this disaster group also has a very large impact especially on the economic and environmental sectors, both direct and indirect impacts. Human activities also contribute to deteriorating environmental conditions, such as forest encroachment for plantations and settlements or development activities that affect ecosystems and ecology in buffer zones. [5].

West Sumatra is an area whose case is interesting to study, by examining how socioeconomic factors affect the level of natural disasters that occur in West Sumatra. West Sumatra is an area with high risk of disaster. Disasters that occur in West Sumatra tend to be more disastrous involving humans in their daily activities, as shown in the following picture below;
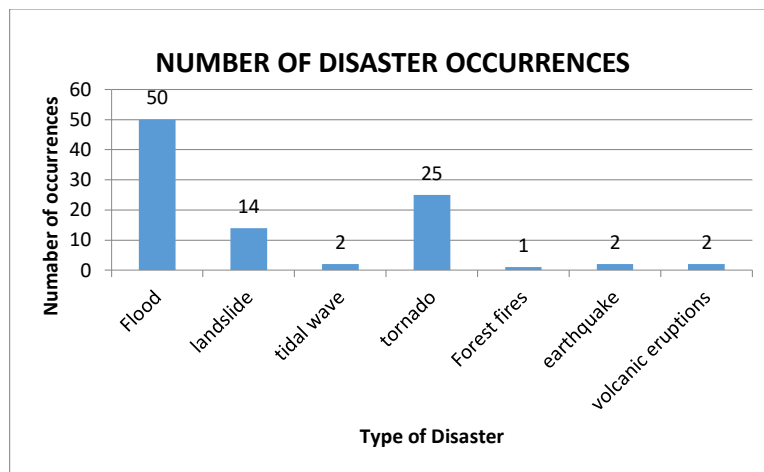
Figure 1. Disaster events in West Sumatra in 2000-2019
Source: Dibi, BNPB, 2019

BNPB data also provides information that West Sumatra is the province with a high level of economic loss among other provinces in Indonesia [5], as shown in the table below,

Table 1. Losses due to disasters in Indonesia in 2019

Disasters	Number Of Disaster	Amount of Losses
ACEH	51	500100
NORTH SUMATRA	17	0
WEST SUMATRA	41	1614752581
RIAU	25	0
JAMBI	13	0
SOUTH SUMATRA	45	65011392
BENGKULU	4	0
LAMPUNG	15	0
BANGKA BELITUNG ISLAND	10	0
RIAU ISLAND	2	0
DKI JAKARTA	4	0
WEST JAVA	409	28469340

CENTRAL JAVA	558	954306661
DI YOGYAKARTA	20	0
EAST JAVA	264	8000636
BANTEN	13	0
BALI	24	0
WEST NUSA TENGGARA	28	0
EAST NUSA TENGGARA	9	0
WEST KALIMANTAN	12	0
CENTRAL KALIMANTAN	37	200
SOUTH KALIMANTAN	65	147080200
EAST KALIMANTAN	11	0
NORTH KALIMANTAN	4	0
NORTH SULAWESI	18	0
CENTRAL SULAWESI	7	0
SOUTH SULAWESI	81	1502032
SOUTHEAST SULAWESI	7	0
GORONTALO	4	0
WEST SULAWESI	6	0
MALUKU	14	0
NORTH MALUKU	4	0
WEST PAPUA	7	0
PAPUA	11	0

Source: BNPB, 2019

The environmental quality index for West Sumatra province actually shows a different thing, where West Sumatra has a high environmental quality index among other provinces, as shown in the table below.

Table 2. Results of 2017 IKA, IKU, IKTL and IKLH calculations

No	Province	IKU	IKA	IKTL	Environmental Quality Index (IKLH)
1	ACEH	89,84	80,00	66,87	77,70
2	NORTH SUMATRA	87,32	78,33	50,18	69,77
3	WEST SUMATRA	89,87	64,56	54,58	68,16
4	RIAU	90,90	65,23	54,51	68,64
5	JAMBI	89,39	57,50	52,29	64,98
6	SOUTH SUMATRA	88,88	77,62	48,08	69,18
7	BENGKULU	92,55	80,80	45,44	70,18
8	LAMPUNG	85,02	55,56	43,87	59,72
9	BANGKA BELITUNG ISLAND	94,97	72,50	44,01	67,85
10	RIAU ISLAND	95,47	66,67	54,24	70,34
11	DKI JAKARTA	53,50	21,33	33,32	35,78
12	WEST JAVA	77,85	29,00	45,50	50,26
13	CENTRAL JAVA	83,91	45,43	48,38	58,15
14	DI YOGYAKARTA	88,08	20,19	43,30	49,80
15	EAST JAVA	85,49	37,08	51,71	57,46
16	BANTEN	75,36	35,98	45,44	51,58

17	BALI	91,40	79,50	47,11	70,11
18	WEST NUSA TENGGARA	88,02	20,25	61,27	56,99
19	EAST NUSA TENGGARA	91,18	39,63	56,70	61,92
20	WEST KALIMANTAN	89,12	80,00	58,58	74,17
21	CENTRAL KALIMANTAN	92,25	62,35	62,72	71,47
22	SOUTH KALIMANTAN	89,02	73,57	51,50	69,38
23	EAST KALIMANTAN	88,87	73,33	67,48	75,65
24	NORTH KALIMANTAN	95,83	72,96	78,07	81,87
25	NORTH SULAWESI	94,32	57,69	63,02	70,81
26	CENTRAL SULAWESI	88,66	77,62	58,40	69,39
27	SOUTH SULAWESI	94,38	56,44	60,37	73,24
28	SOUTHEAST SULAWESI	91,04	64,67	60,37	70,86
29	GORONTALO	94,79	40,00	67,56	67,46
30	WEST SULAWESI	91,45	73,89	62,17	74,47
31	MALUKU	85,64	71,33	70,08	75,12
32	NORTH SULAWESI	96,00	63,64	66,65	74,55
33	WEST PAPUA	95,63	82,50	80,63	85,69
34	PAPUA	90,01	77,33	78,18	81,47
	NATIONAL IKLH	**87,03**	**58,68**	**56,88**	**66,46**

Source: Ministry of Environment and Forestry, 2018

Natural disasters have impacts on various socioeconomic systems. Scarcity of information and methodology is the cause of the impact of disasters cannot be measured universally. The European Commission for Latin America and Caribbean (ECLAC) proposed a methodology designed to assess the impact of disasters on the economy[6], which is divided into three groups:

1. Direct damages; including all damage to fixed assets, capital and inventory of finished and intermediate goods, raw materials and spare parts that occur simultaneously as a direct consequence. At this stage it will involve spending on emergency response assistance.
2. Indirect damages; the impact is more on the flow of goods that cannot be produced and services that cannot be provided after a disaster. This indirect damage also increases operational costs due to damaged infrastructure. This increase in costs lies in providing alternative services (alternative ways to produce, distribute and provide goods and services).
3. Secondary effect; covering the impact on overall economic performance as measured by the most significant macroeconomic variables. Relevant variables includes Gross Domestic Product (GDP), overall and sectorial, trade balance and balance of payments, the level of debt and monetary reserves, the state of public finances and gross capital investment. On the side of public finance such as decreasing tax revenues or increasing expenditure can be very important. This secondary impact will be greatly felt in the fiscal year in which the disaster occurs, but also may have an impact in the following the fiscal year

Furthermore AusAID [7], divides the macro economic impact from natural disasters in two groups, namely the real impact and the impact is not real. The two groups below will influence changes in macroeconomic variables.
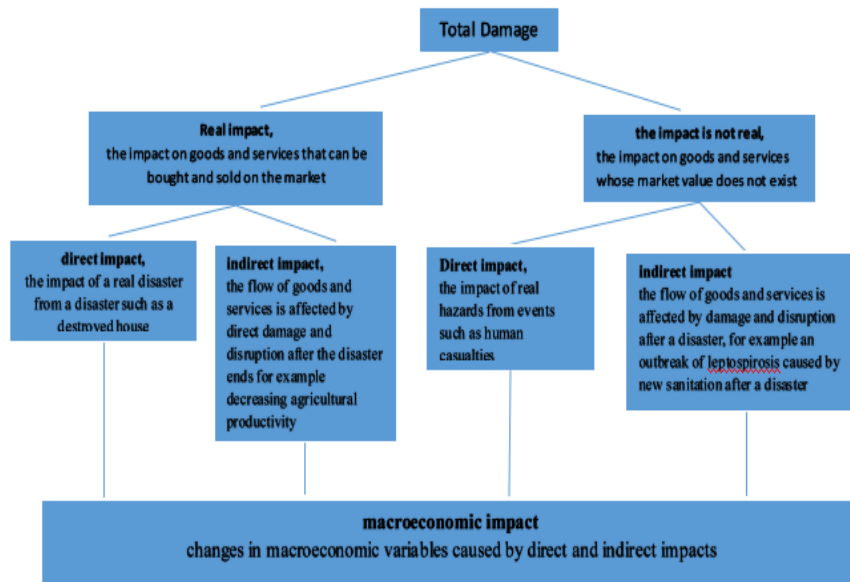
Source: AusAID, 2005

Figure 2. Macroeconomic impacts of natural disasters

Research on how economic factors affect the level of disasters is expected to contribute to the study of environmental economics and macroeconomics. Policies in macro and micro economy are expected to be in line with environmental preservation, so that environmental damage or natural disasters do not occur.

Expansion of Solow's classic economic growth model by incorporating environmental elements [8] and using the assumption that each production process has a negative externalization in the form of environmental damage. Output must be sacrificed to improve environmental conditions:

$$E = Pollutan\ created - Pollution\ Abated$$

Where E is the damage to the net environment, is the difference in the value of pollution produced by efforts to neutralize pollution. Every output produced causes environmental damage, pollution is a function of:

$$Pollution\ Created = \quad \Omega[F(K, BL)]$$

Higher production levels will result in high levels of pollution. Thus, economic activities and determinants of economic development determine the level of environmental damage.

Study of economic growth by taking into account the concept of environment or scarcity of resources continues to grow with the emergence of new variables. The existence of labor as an economic variable in the study of environmental damage is clearly seen in the model [9], reinforced by a study of the role of labor in the green Solow model [10]. The variable of population growth and technology are the variables studied determine net pollution [11], the higher the level of population growth the higher the amount of labor available in the economy. The high population growth will provide the high workforce.

Several models of economic growth state that pollution reduction can occur along with the increase in per-capita income, if there is a high increase in environmental technology. This is clearly seen in the green economy model [11] which is used as the basis for the green GDP model (Gross Domestic Product). Based on the consideration that this model is a variant of the Solow model that is able to adopt the concept of a green economy with a GDP calculation formulation that includes depletion and environmental degradation. Statistical results show that CO_2 emissions have a negative relationship with GDP and a statistically

significant positive relationship with population size. However, there is a weak and insignificant relationship between CO_2 emissions and foreign investment [12].

Many theories and literature say that investment is a determinant of industrial value that is closely related to environmental conditions. Foreign investment sometimes has an adverse effect on environmental quality. There is research that looks at the effect of economic structure, development strategies, and regulations on the environment in the form of the Kuznet Environmental Curve in urban areas of China [13]. The research is further strengthened by the findings that state the positive influence of foreign investment on environmental quality. Investment reduces emissions levels and increases economic optimization and enhances technology so that investments have a positive effect on the economy and environment [14]. Investment is a catalyst in increasing capital accumulation and encouraging the export of high-tech products. Investment can increase efficiency in the pollution reduction process [15]. More specific things are found in the agriculture industry, for example in the palm oil industry. The results show that oil palm development produces externalities such as water pollution, soil erosion and air pollution [16].

This research becomes urgent to do because the existing disaster studies are limited to disasters related to human activities and their relationship with socioeconomic variables. Such studies have not been found in previous disaster studies. Previous disaster studies are only on the topic of general disasters, where some of the disasters that occur are caused by nature and not due to human activities in exploiting natural resources

2. Method

The disaster has a close relationship with the level of community income and macroeconomic conditions. in this case, the number of major disasters that occur turns out to have a strong relationship with economic conditions [17], [18].

The level of income in a country will determine the severity of the disaster experienced by a country,[19]. The study of the level of loss of natural disasters with economic development includes several influencing factors, namely economic, socioeconomic and demographic factors, in a simple logical framework this study can be seen as shown below
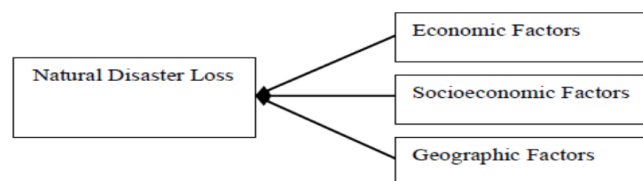
Source; Karnjana Songwathana, 2018
Figure 3. Conceptual Framework, disaster loss and economic development

The study of natural disasters and economic development using data panels from 168 countries during 1990-2016, found that the total population has a relationship with natural disasters that occurred [19]. In the study found a positive relationship between income and the level of disaster losses. Some economic variables influence the level of environmental damage that causes disasters. The economic variables used by researchers in environmental pollution studies include gross domestic product, trade openness, industrial output, urbanization, financial development, population density and foreign direct investment, [20]. More specifically, it was found that there was a significant relationship between economic variables and environmental quality. This study states that the workforce has a significant relationship with environmental quality. [21].

Research on the role of the industrial sector in natural disasters can be strengthened by studies that suggest that there is a significant positive relationship between capital production and the level of environmental pollution. This condition explains that globalization capital has a bad effect in the form of loss of habitat and *species*[22]. This confirms that the production sector in industry is able to influence the occurrence of environmental damage or, furthermore,

natural disasters. Environmental impacts of palm oil industry is water pollution, soil erosion and air pollution [16]

Based on the literature study conducted [16], the model that will be analyzed in this study can be derived using Generalized Least Squared (GLS) for data analysis. The least squares estimation form of GLS, is a form of estimation that is used when the classical assumptions required by the OLS method (homokedastic and nonautocorrelation) are not met. The use of OLS in such conditions will result in estimation of regression parameters that are no longer efficient and can lead to misleading conclusions (conclusions). GLS has the ability to maintain the efficiency of its estimator without losing its unbiased and consistent nature. The research model that will be analyzed in this research is:

$$y = \alpha_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon$$

where   y = a lot of disasters
        x1 = population
        x2 = per capita income
        x3 = labor force
        x4 = number of industries

Variable, the number of disasters (y) is limited to disasters for which human activity is considered to be the cause. Number of Industries (X4) is a sum of all small and big industry. This study uses secondary data in the form of social economic development indicators and disaster data. The research location covers all districts and cities in West Sumatra, namely 19 districts and cities.

3.   Results and Discussions

Disaster level factor assessment in the West Sumatra region Model factors that affect economic losses are carried out by Generalized Least Squared. Model. Generalized Least Squared can explain disaster level variables with variables that affect the independent variables of population, income level of Decapitator, Labor Force, Number of Industries. The results of the processed data found are as follows:

Table 1. Results of Generalized Least Squared data processing

Dependent Variable/ Disasters		
Independent Variable	Coefficients	Significant
Log labor force Zstatc	32.31931	(5.99)***
Log per capita income Zstatc	30.46836	(2.44)***
Log industries Zstatc	-12.84411	-(3.65)***
Constant	-358.3066	-(3.27)
Wald Chi2(2)		38.01
Prob>Chi2		0.0000

From the processed data in the table above, it can be seen that the level of disaster is determined significantly by the Workforce, the level of income per ca-pita, the number of industries. It was found that the produced value Prob> Chi2 0.0000 and Wald Child2 (2) 49.61 was quite good, which means the ability of five predictors to explain variable variations can be accepted statistically.

The workforce involved in the development process sometimes does not get a good place in the labor market, because of the increasing number of workforce. Finally, some are in the informal workers sector, trying to work alone with makeshift capital and technology. The informal sector is a place for the workforce that does not get the expected place in the labor market. Low production technology will only rely on the availability of natural resources and production that do not care about recycling waste that is environmentally friendly, oriented towards production and low-cost profit tends to be the cause of environmental damage and

natural disasters. However, conditions of excessive exploitation of the environment and endanger the environment can change with the improvement of the level of education, with a better quality of community education, making the community able to carry out environmentally friendly activities, discovering waste management technology, the concept of living back to life that is more concerned with natural life, awareness of the importance of protecting the environment for environmental sustainability. To anticipate disasters, it requires mobility and flexibility of workers. Each region will have different specifications to reallocate workers after a disaster, and this will determine how much impact the disaster has [23]

In this study it was found that the industrial sector has a negative relationship with the level of disaster, capital production or capital in the industrial sector showing the effect of technological diffusion or environmental efficiency [24]. Investment can improve environmental efficiency by increasing the capacity of local innovation through technology diffusion.

In this study also found that the level of income has a positive relationship, this shows that the economic development policies undertaken have not supported environmental sustainability. The orientation of chasing the target of economic growth by ignoring the quality of the environment is still happening. Expansion of development by opening new land, burning land and changing land functions from forest management to commercial land that does not pay attention to environmental ethics increases the level of disaster.

4. Conclusions
It is undeniable that environmental problems are getting heavier and more difficult, especially considering that natural resources are used, to carry out development aimed at meeting and improving people's welfare, is limited. This condition causes a deterioration in the quality of the environment, followed by an increase in the intensity of natural disasters. Policies that regulate the management of natural resources and the environment. Policies including support for environmental law enforcement and resource and environmental management systems are needed to protect environmental conditions from disasters.

It needs to be studied how development policies for the environment and economic growth are in line. Pursuing economic growth with per capita income indicators should not sacrifice the environment. The government in economic development policy needs to examine how existing workers can get decent jobs by opening new jobs, improving education, providing production facilities and education about the environment and strict environmental law enforcement needs to be done. Economic policy should be taken after conducting studies through a measurable environmental economic model, so that the impact of each policy is measured and can be evaluated.

5. Discussions
In addition to disaster reduction program policies, orders should also pay attention to other aspects that are also in the community in the form of existing socio-cultural forces that are able to become disaster mitigation forces. Existing social and cultural forces such as utilizing environmental resources, cultural respect for environmental forces. It was found that households that adopt climate risk management strategies have higher income levels [25]. The natural disaster preparedness field needs to transform its traditional knowledge into sustainable actions [26]

So it is expected that in handling disasters the government has a clear and measurable program so that the impact experienced by the community can be minimized. Policies in the form of insurance schemes with government funds to ensure rapid recovery from the effects of natural disasters for all categories of people[27].

So the need for a predictive model for landslides is very important for life safety and environmental and economic protection of the region   [28]

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