Environmental Quality in Sumatra Island in Economic and Spatial Perspective

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Abstract. This study aims to analyze the spatial relationship of the Environmental Quality Index (IKLH) of the provinces on the island of Sumatra in 2013–2019. Another objective of this study is to analyze the effect of the primary sector's Gross Regional Domestic Product (GRDP), population, and number of medium-sized industries on environmental quality on the island of Sumatra with a spatial concept and without a spatial concept. The analytical methods and tools used in this study include the Moran index to see the spatial relationship between the provinces on the island of Sumatra and the IKLH as a spatial weight. Panel data regression analysis was used to analyze the effect of economic factors on environmental quality. The results of the study indicate that there is no spatial linkage of IKLH between the provinces on the island of Sumatra.

Keywords: spatial autocorrelation · environmental quality · environmental quality index

1 Preliminary

Increased economic growth often ignores environmental aspects, including in its management, which causes natural resources to experience a rapid decline without being balanced with adequate substitutes. This causes the carrying capacity of nature to decrease which in turn risks damaging life support and disrupting the stability of the community's economic [1]. Grossman and Kruenger developed the concept of the Environmental Kuznet Curve (EKC) in 1991 [2]. Grossman and Kruenger applied the Kuznet hypothesis to determine the relationship between economic growth and environmental quality. The EKC hypothesis shows the contribution of economic growth to higher emissions but further economic growth will then be able to reduce environmental degradation. This is due to technological advances and the shift towards a service-based economy [3].

The Ministry of the environment has developed a measuring instrument that is used to see the value of the environmental quality of the region, which is known as the Environmental Quality Index (IKLH). Environmental quality index is an index that describes the condition of the results of environmental management nationally. The environmental quality index is used to describe environmental quality conditions nationally from various regions in Indonesia. Provincial IKLH is a measurable environmental management performance index of the districts/cities within it. The IKLH calculation is based

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on 3 indicators; Water Quality Index (IKA), Air Quality Index (IKU), and Land Cover Quality Index.

According to Indonesian Environmental Statistics (2020), in 2015 there were extensive forest fires in 3 provinces on the island of Sumatra. Forest fires occurred in South Sumatra with an area of 646,298.80 ha, Jambi 115,634.34 ha, and Riau 183,808.59 ha, this tragedy caused smoke haze to spread and pollute the air on the island of Sumatra, outside the island and even abroad. According to the BNPD report, Indragiri Hulu Regency in Riau Province became the area that burned the most, covering an area of 1200 ha and followed by Palalawan Regency with 1139.75 ha of burned land. This became a serious problem that year because the state and society suffered considerable losses, ecosystem damage and especially air pollution which affected health aspects,(Ahmad, 2018). The following is data on the average growth rate of GRDP and IKLH for provinces on the island of Sumatra [4].

Table 1 shows the data on the average growth rate of GRDP and IKLH in 2013–2019 on the island of Sumatra. West Sumatra Province is a province with the highest average GRDP growth rate of 5.47% and an average IKLH of 67.47 which is included in the fairly good category. The province with the lowest average GRDP growth rate is Aceh Province at 2.81% with an average IKLH of 75.1 which is included in the good category. This is not in accordance with the initial conditions in the EKC theory where high economic growth is also followed by a decrease in environmental quality (Table 2).

The island of Sumatra has provinces with a level of geographical proximity, so we will find out how the spatial relationship of the interactions between these areas is. According to inter-regional linkages are an important part in the development of an area as well as the impact of such development including environmental quality [5]. Economic analysis is usually only focused on the independence of a region without

Table 1. Average GRDP Growth Rate Based On 2010 Constant Prices, KPI, IKA, IKTL AND IKLH Provinces On Sumatra Island In 2013–2019 (Percent).

Province	**Avrg**	**Avrg**	**Avrg**	**Avrg**	**Avrg**
	GDP	***KPI***	***IKA***	***IKTL***	***IKLH***
Aceh		89.64	66.29	70.91	75.15
North Sumatra	5.30	86.00	65,90	49.30	65.29
West Sumatra	5.47	87,80	54.17	62.19	67.47
Riau	2.21	73.88	55,12	50.61	58.95
Jambi	5.22	87.48	59.92	51.01	64.62
South Sumatra	5.26	85.10	75.76	41.92	65.03
Bengkulu	5.27	89.84	72.37	54.42	70.43
Lampung	5.26	82.79	63.26	37.42	58,78
Kep. Bangka Belitung	4.33	89.68	73.32	41.48	65.45
Riau islands	5.18	90,30	66.59	55.54	69.28

Source: BPS Indonesia, 2021(processed)

Table 2. Moran Index Value of Environmental Quality Index 2013–2019 In Sumatra Island

Year	I	E(I)	Z(I)
2013	-0.0741	-0.1111	0.0796
2014	-0.1436	-0.1111	-0.3148
2015	0.0493	-0.1111	0.7309
2016	-0.0331	-0.1111	0.2938
2017	-0.0217	-0.1111	0.4285
2018	-0.2865	-0.1111	-1.0210
2019	-0.0499	-0.1111	0.1673
Average	**-0.0026**	**-0.1111**	**-0.5116**

Source: Geoda, data processed

considering the effects of space and the interactions that occur between one region and another, even though regional interactions are unavoidable, spatial and adjacency aspects are important factors that should be considered. The concept of a regional economy that incorporates a spatial element in economic analysis, to see economic growth is carried out with calculations that focus on each region [6].

GRDP growth between provinces on Sumatra Island can occur due to socio-economic interactions, such as inter-regional trade, labor movement and migration, cross-capitalization, as well as the distribution of innovation between regions [8]. Regional aspects are important for economic development, spatial interactions between regions will lead to dependence, especially in meeting production factors which in turn trigger interactions between regions or we can call spatial interactions.(Irsyad & Syahnur, 2018). The distribution of different production factors in each of these areas causes variations in the value of environmental quality and GRDP in each region. This study aims to analyze the spatial interrelationships of the provinces on the island of Sumatra. The second objective of this study is to analyze the effect of primary sector GRDP, population, and the number of large and medium industries on environmental quality on the island of Sumatra.

2 Research Method

To analyze the spatial relationship in the provinces on the island of Sumatra using the method of calculating the Moran Queen Contingity Index with the IKLH variable used as a spatial weight (W). Moran's index is a method of spatial dependence test to see that observations in one place have an effect on observations of other locations. To perform calculations with the Moran index is to use the following formula:

$$I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \widetilde{x})(x_j - \widetilde{x})}{S_o \sum_{i=1}^{n}(x_i - \widetilde{x})}$$

where:
I: Moran's. index.
n: the number of observations.
w_{ij}: elements of the spatial weighting matrix of locations.
i and j.
x_i: attribute value at location i.
x_j: attribute value at location j.
$\overline{x}$: the average value of the attributes of n observation locations

Hypothesis:
H_0: $I = 0$ (No spatial autocorrelation/dependency spatial).
H_1: $I \neq 0$ (There is a spatial autocorrelation/spatial dependency)

The data used in this study is secondary data which is a combination of time series data from 2013 to 2019 and cross section data from 10 provinces on the island of Sumatra. The specifications of the model used in this study are as follows:

$IKLHi_t = 0 + 1PDRBSKTRit + 2JPDDKit + 3JINDit + \epsilon t.$

Where:
$IKLHi_t$ = Environmental Quality Index province i in year t.
GDPRit = Provincial Primary Sector GRDP i in year *JPDDkit* = Total Population of Province i in year t.
JINDit = Number of Industry Province i in year t.
0 = Constant.
1, 2, 3 = Coefficient.
ϵt = Error Term.

3 Results and Discussion

The spatial relationship of the Environmental Quality Index on the island of Sumatra can be determined using the Z (I) test. If the value of Z (I) > Zα/2, it can be concluded that there is a significant spatial relationship between regions at the significance level. In this study using of 5% or 1.960. Based on the results from the table, each year shows an insignificant value of Z (I) < Zα/2 or there is no spatial relationship between the Environmental Quality Index between regions on the island of Sumatra (Fig. 1).

Based on the LISA cluster map on the island of Sumatra, there is no spatial relationship, because none of the provinces on this island are significant, in fact there are

Fig. 1. Lisa Cluster Map Average Environmental Quality Index for the Island of Sumatra 2013–2019

2 provinces that are not neighbors, namely the Bangka Belitung Islands and the Riau Islands due to the absence of contact from the two provinces to other provinces.. Although there is no spatial relationship between IKLH, the fact is that the neighbor effect occurred in 2015 due to extensive forest fires in 3 provinces, namely South Sumatra with an area of 646,298.80 ha, Jambi with an area of 115,634.34 ha, and Riau with an area of 183,808.59 ha. Causing smog that spreads and pollutes the air of the provinces of Sumatra Island, outside the island and even abroad, the impacts such as narrowing the point of view for a long time [16] (Fig. 2).

Based on the Moran index test, the results show that there is no spatial relationship between regions on the island of Sumatra, this is thought to occur because the IKLH consists of three components, namely IKA, IKU, and IKTL, while environmental damage that affects each other or can affect between regions does not include these three components. Together, only air problems can affect other areas, while environmental problems related to water and land cover are usually experienced by each region without affecting other areas.

Based on Fig. 3 Primary Sector GRDP showed a significant increase during 2013–2019 along with the rise and fall of IKLH which illustrates the environmental quality on the island of Sumatra. The sectoral GRDP increase was not always accompanied by an increase in IKLH in 2014 of 63.20, 2016 of 65.79, and 2019 of 65.08, the average IKLH of which was below the average for that period, which was 66.62%, this caused

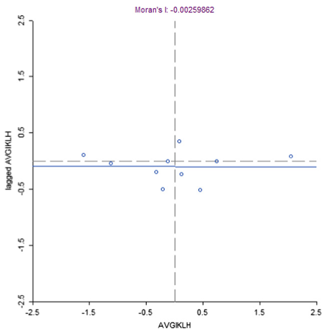

Fig. 2. Moran Scatterplot Average Environmental Quality Index on Sumatra Island 2013–2019

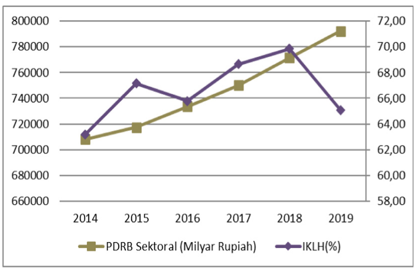

Fig. 3. Comparison of IKLH and GRDP of the Primary Sector of Sumatra Island

a decline in environmental quality caused by every 1 billion increase in GRDP in the primary sector is only 0.000256%.

The decline in environmental quality caused by the increase in GRDP in the primary sector does not always show a decline based on Fig. 3,the ups and downs of environmental quality are not accompanied by this increase in the GRDP of the primary sector. According to [9] This is due to comparative advantage as well as the policy and strictness of environmental regulations in each region, and is the reason for the change from the increase in the sectoral GRDP of the area to a decrease in environmental quality, so that the overall increase in GRDP in the primary sector of the provinces on the island of Sumatra has a significant negative effect on the IKLH of the island of Sumatra [18].

Total Population (X2) shows a significant positive effect whose coefficient is 0. 011844, when the total population increase a thousand people, the Environmental Quality Index increases by 0.011844 percent. The results of this study are not in accordance with the theoryand research conducted by highlighting how the loss of land cover and the occurrence of fires intentionally due to the policy of the Indonesian government in carrying out efforts to transmigrate the population so that they can have a place to live, the results of the study show that an increase in population reduces the quality of the environment, especially land cover and air pollution [20, 24].

The increase in population followed by an increase in environmental quality was due to an increase in the Human Development Index during that period. The Human Development Index describes the quality of Human Resources (HR) of an area which is formed from three basic indicators, namely longevity and healthy living, knowledge and standard of living. This means that the increase in population is accompanied by an increase in the quality of the population. Residents have the awareness to be wiser in maintaining and preserving the environment both around it and elsewhere.

Population increase accompanied by an increase in HDI will increase IKLH, also with its founding indicators, residents have awareness and knowledge of the importance of the environment will change the pattern of environmental damage that has been happening so far, reduced waste disposal in rivers will increase regional IKA, or reduce the use of private vehicles also the construction of green open spaces will increase the regional KPI.

Based on Fig. 4, the Population in Sumatra Island showed a significant increase from 2013 to 2019 with IKLH which also rose and fell in that period, the results of the study of the relationship between Population and Environmental Quality Index showed a significant positive result, meaning every increase in population the quality of the environment will also increase.

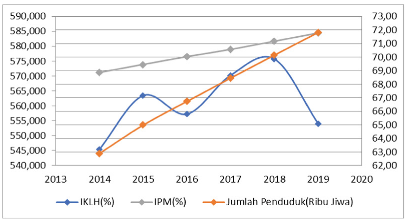

Fig. 4. Comparison of IKLH and Total Population of Sumatra Island

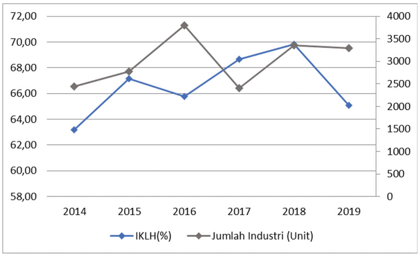

Fig. 5. Comparison of IKLH and Number of Industries on Sumatra Island

Variable Number of Industries (X3) in Sumatra Island has no significant positive effect with a confidence level of 95 percent, has a coefficient value of 0.004452 Number of Industries has no effect on IKLH. These findings are not in line with the hypothesis that was built, where it is suspected that the number of industries reduces the quality of the environment, meaning that the number of industries cannot measure the quality of the environment because the number cannot describe the amount of industrial output produced in an area.

Based on Fig. 5, the number of industries increased from 2013–2016 before finally dropping in 2017 and rising again in the following year, when compared to IKLH in the same period in 2013–2017 it has a negative relationship, where when the number of industries increases or decreases, the IKLH the opposite will happen, until 2018 and 2019 have a positive relationship.

The increase in the number of industries has no significant effect on the Environmental Quality Index for the island of Sumatra, this can be caused by two things, according to(Gallagher, 2005)the comparative advantage of a region still tends to produce low pollution, or it can occur due to improvements in indicators and policies carried out by both the central and regional governments that regulate environmental quality in order to create sustainable development and an EKC pattern can be formed [24, 25].

4 Conclusion

There is no spatial relationship between the provinces on the island of Sumatra. Primary Sector GRDP has a significant negative effect on the Environmental Quality Index, the population has a significant positive effect on the Environmental Quality Index, and the number of industries has no significant effect on environmental quality on the island of Sumatra.

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