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An Analysis of Environmental Value Losses as an Impact of a Palm Oil Mill in Rokan Hilir Regency

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Abstract*—This research aims to study and calculate the value of compensation for environmental damage resulting from palm oil mill effluent water in the Village of Sedingin and Teluk Mega Village, Tanah Putih District, Rokan Hilir Regency. The research location is in the vicinity of the Rokan River that passes through Teluk Mega Village and Sedingin Village, Tanah Putih District, Rokan Hilir. This research uses primary and secondary data. The calculation method used is a combination of Losses Due to Excess of Environmental Quality Standards calculation, Ecosystem value loss, and Foregone Income. Based on the results of the sum of several methods stated that the compensation value of Rp. 211,388,000.

***Keywords*—Environmental Value Losses, Ecosystem Value Loss, Foregone Income, Rokan Hilir**

I. INTRODUCTION

Ecosystem damage can have a negative impact on natural resources, biodiversity, and environmental services, and can cause harm to the country, society and each individual. In Indonesia, the estimated value of the loss is very large [1]. Environmental damage can occur due to logging, air pollution, river, and seawater pollution, as well as from industries that provide negative externalities.

This research focuses on water pollution, especially river water caused by the activities of palm oil mills or Crude Palm Oil (CPO) mills. The river is a natural channel on the surface of the earth that holds and channels rainwater from high areas to lower areas and finally empties into lakes or at sea. In the flow of water transported also sedimentary materials originating from the erosion process carried by the water flow and can cause siltation due to sedimentation where the water flow will lead to the lake or the sea [2]. Because of the growing number of population results in the development of industrial activities in general, making the river area vulnerable to change and damage [3]. Changes in land use are marked by increasing domestic, agricultural and industrial activities that will affect river water quality, especially waste [4].

Rokan River is one of the largest rivers in Riau Province. The river has a length of 350 km which is upstream in the Bukit Barisan and estuary in the marine waters of Rokan Hilir Regency. The river flows through Rokan Hulu Regency and Rokan Hilir Regency, and along with the flow, there are various rubber and oil palm plantations, rubber, and palm oil mills and community settlements. This river is very vulnerable to pollution due to various activities.

This research is motivated by the alleged pollution in the Rokan River as reported by online media [5]. The community suspects that pollution is caused by palm oil mill effluents in the Tanah Putih District of Rokan Hilir Regency. Furthermore, the Local Government under the Department of the Environment instructed them to conduct research and calculate the cost of economic losses due to environmental damage.

In accordance with the background and instructions from the government, it is necessary to calculate the economic losses due to water environment pollution from the activities of the palm oil industry.

II. METHODOLOGY

A. Data Set

The population in this research is determined based on the area affected by pollution in accordance with the input and information from the relevant government agencies. The population observed was the community/household heads who lived and made a living by using the Rokan River as a source of livelihood (fishermen, fishing business owners, and cage fishermen). The community of Sedingin Village and Teluk Mega Village hereinafter referred to as the Rokan River user community. The respondent's limit is the household head has lived for more than 5 years in location.

In determining the sample size of the study determined by limiting the number of populations in the community who use the Rokan River as a source of livelihood, if the population <100 then the entire population will be sampled, whereas if the population > 100 then a sample is drawn. The technique used to determine the size of the sample can be calculated using the Slovin formula [6]:

$$n = \frac{N}{1+Ne^2} \quad (1)$$

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Note: n = Total sample; N = Total Population; e^2 = margin error (10%)

Based on data monograph of Sedingin Village and Teluk Mega Village (2018) and calculations using (1), it is obtained a sample size of 89 respondents consisting of 74 respondents from Sedingin village and 15 respondents from Teluk Mega village.

B. The Estimated Economic Value of Environmental Losses

1) Losses Due to Excess of Environmental Quality Standards

Environmental pollution can occur due to non-compliance of companies or individual activities with the provisions of the legislation to treat waste and prevent environmental damage. Therefore, they are required to realize their obligations by building IPALs, IPUs, and other installations by operating optimally in accordance with the provisions of the law. If the person in charge of the company or activity does not carry out these obligations, it will cause harm to the environment and society. The loss value is calculated based on the minimum construction and operational costs. Furthermore, the calculation of pollution costs due to excess quality standards uses parameters of wastewater or liquid waste that are commonly used to calculate the cost of pollution along with the weight value per pollution unit of each parameter. This calculation refers to Ministry of Environment, *LH Regulation No. 7* [7].

The parameters of wastewater or liquid waste commonly used to calculate the cost of pollution along with the weight value per pollution unit of each parameter refer to Ministry of Environment, *LH Regulation No. 7* [7] adjusted to Ministry of Environment, *LH Regulation No. 5* [8] are COD, TSS, and Fatty oils. Next, the data used is sourced from the Company which is available during operations, and Environmental Department data that are relevant to the results of water quality measurements.

The calculation method based on the accumulation of pollution unit values refers to Ministry of Environment, *LH Regulation No. 7* [7]. The value of the pollution unit for each waste parameter and the base cost per pollution unit are determined based on the amount of pollution impact on the environment. The parameters of wastewater or liquid waste commonly used to calculate the cost of pollution along with the weight value per pollution unit of each parameter are as follows:

TABLE I. POLLUTANT UNIT VALUES

Parameter	Value of 1 Pollution Unit
COD	50 Kg
TSS	50 Kg
Oil & Grease	3 kg

*The base cost per pollution unit is Rp. 24,750- [7]

In this method, the environmental burden and the danger level of various types of waste from various industries can be compared and understood. The total value of the pollution unit for each parameter in the waste can be summed in the same unit, the Pollution Unit (PU).

2) Ecosystem value loss

The method of valuing externalities is a function of environmental damage to economic impacts which states the added economic impact of each unit of environmental damage is called marginal loss [9]. Calculated components include the cost of biodiversity and the cost of genetic resources. The data collected is the base year price index of 2003 and the year price index of damage occurring in 2017. Data is obtained from the Central Bureau of Statistics.

Furthermore, the calculation formula is as follows:

$$CBD = BBDx\ \frac{IH_t}{IH_d}\ x\ LA \quad (2)$$

Note: CBD = Biodiversity Recovery Costs; BBD = Biodiversity Recovery Costs in Basic Years *(Rp 2,700,000/ Ha);* IH_t = Price index in the year of damage; IHd = Price index basic year (2003); LA = Land area damaged (Ha).

$$Cgen = Bgen_d x\ \frac{IH_t}{IH_d}\ x\ LA \quad (3)$$

Note: Cgen = Genetic Recovery Costs; $Bgen_d$ = Genetic Recovery Costs in Basic Years (Rp 410,000/ha)

By adding up (2) and (3), we get ecosystem value loss compensation.

3) Forgone Income

Forgone income is the loss of income and alternative income caused by changes in economic activity due to pollution or environmental damage. There are several methods that can be used to calculate forgone income [10]–[12], one with the Fee losses approach. Fee losses are loss of revenue that should be received by the community or local government due to the cessation of economic activities caused by changes in the environment.

Data is collected and grouped base on the livelihoods of communities in the Rokan River, the average amount of income of the community before pollution occurs, and the amount of average income of the community after pollution occurs. Data collection at this stage was carried out by direct interviews with community leaders and fisheries actors in the Rokan River within the study area, as well as the Focus Group Discussion (FGD).

Furthermore, a quantitative analysis is carried out to obtain conclusions about the number of costs that must be incurred for compensation in the implementation of environmental dispute resolution.

Fee Losses formula as follows:

$$FL = FPU \times NU \times TU \quad (4)$$

Note: FL = fee losses; FPU = fee per unit; NU = Reduced number of units; TU = the amount of time the unit was reduced.

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III. RESULT AND DISCUSSION

A. Costs for building and repairing IPAL

A discrepancy in the value of water quality that is treated at the IPAL Installation Company with quality standards set based on Ministry of Environment LH Regulation No. 5 [8], so far it is suspected to have caused pollution to the Rokan River water quality. This is due to the ability of wastewater management in IPAL unable to treat the large volume of wastewater produced, besides the incompatibility of IPAL structures so as to allow leakage or ineffective wastewater treatment. Therefore, the Company is obliged to carry out repairs and rebuild its IPAL facilities in such a way that wastewater that is treated and flowed into the environment from these facilities meets the quality standards set by the government. Through discussions with the Company, several repairs and improvements to the IPAL facility have been determined, which generally consist of improvements to the structure of IPAL pool, increasing the capacity of sewage capacity in each pool, adding aerator pumps and distribution pumps, increasing the number of IPAL treatment pool.

Since 2018, the Company has implemented an environmental impact control system with the need for additional effluent treatment pool. The area of land for the construction of new ponds for wastewater treatment is around ± 3 Ha with a total capacity of IPAL pool reaching + 70,000 m^3. Based on the calculation in Table 2, the cost to repair the IPAL installation is Rp. 1.12 billion.

TABLE II. ESTIMATED COST OF REPAIRING IPAL INSTALLATION

No	Description	Job volume	Unit	Unit Price (Rp)	Total Cost (Rp)
1	Repair of IPAL Pool Structure, pool no 1-7	40.000	M^3	5,000	200,000,000
2	Add a new WWTP Pool, pool 8-9	27.000	M^3	25,000	675,000,000
3	Extra machines aerator pump, the pipes support, and electrical installations 7 units	7	unit	35,000,000	245,000,000
	Total				1,120,000,000

B. The cost of pollution load of COD, TSS, and Oil

From Table III, it can be seen that the average quality of wastewater treatment results from IPAL treatment still exceeds the quality standards for COD and TSS. These two parameters are used as parameters for the calculation of compensation due to exceeding government quality standards. The amount of compensation costs due to exceeding the government quality standard for the COD parameter is Rp 6,623,000. As for the TSS parameter of Rp. 352,000. Furthermore, oil and fat do not cause losses because they do not exceed quality standards. Thus the total cost of compensation due to exceeding the quality standard is Rp. 6,975,000.-

TABLE III. ANALYSIS OF THE AVERAGE COD, TSS, OIL & FAT WASTEWATER FROM IPAL DURING JUNE 2017-AUGUST 2018

No	Parameter	Unit	Test result	Reference
1	COD	mg/L	515,6	350
2	TSS	mg/L	258,8	250
3	Minyak & Lemak	mg/L	12,9	25

C. Value of Compensation for Ecosystem Losses

TABLE IV. VALUE OF COMPENSATION FOR ECOSYSTEM LOSSES

Variable	LA	IHt / Ihd	Costs of Recovery Basic year (2003)	Cost of Recovery for Damage Year (2017)
Biodiversity Recovery (CBD)	60	1,10	2.700.000	178.097.061,16
Genetic Recovery (Cgen)	60	1,10	410.000	27.044.368,55
Total Compensation for Ecosystem Losses				205.141.429,71

Based on these calculations, the total value of ecosystem losses due to pollution is Rp. 205,000,000. Furthermore, in accordance with the administrative sanctions imposed by the local government to carry out fish restocking, the company has restocked fish in the Rokan River in the Sidingin Village and Teluk Mega Village on August 28, 2018, with details: (1) For Sedingin Village, 17,000 tails have been given fish seeds, consisting of 8,000 catfish, 5,500 tilapia, 3,500 tail gourami. (note: two bags (2,000) of dead catfish); (2) For Teluk Mega Village, 5,000 Fish, consisting of 2,000 catfish, 1,000 tilapia, and 2,000 tail catfish (of which 2,000 tails have been given to Pak Ijeh cages as a group of fishermen in Teluk Mega village); (3) Costs incurred by the company for the procurement of fish restocking activities are Rp. 64,000,000.

Thus the value of ecosystem losses due to pollution from companies that still have to be paid to the government is Rp. 205,000,000 less the cost of fish restocking that has been done in the amount of Rp. 64,000,000, so that the remaining is Rp. 141,000,000.

D. Value of community losses

The community losses that are counted are only the fishermen category, the choice of this category is based on work directly related to the Rokan River. The loss calculation is done in two steps.

Step 1, the calculation focuses on the number of fishermen from the field observations around the Rokan River, Sedingin Village, and Teluk Mega Village, which make fishermen the main livelihood, and totaling 45 fishermen, with an average monthly income of Rp. 2,076,667. Step 2, using a filter with the criteria of fishermen who have side income other than fishing and

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is more valuable than fishing in one month, there are 37 fishermen with side jobs not exceeding the main income, with an average monthly income of Rp. 2,285,135, - and average income per week Rp. 571,284.

For the calculation of the fee losses period, it is used one month after the pollution, assuming that the Rokan River is an open channel and the water always flows. Then the calculation is used with a periodic reduction in time, which in the first two weeks of pollution results in disruption to the catch or does not get fish at all in other terms this condition results in a loss of 100% income. Meanwhile for the next two weeks using a calculation of 50% loss of normal income. The use of periodic calculations is consistent with the results of deep interviews conducted in the field.

Based on the above steps and the results of deep interviews in the field, the calculation of fee losses in detail is presented below:

TABLE V. FEE LOSSES CALCULATION RESULTS

No	Description	Result
1	Fee Loss for the first 2 weeks	FL = Rp. 571,284 × 37 × 2 week FL = Rp. 42,275,000
2	Fee Loss last 2 weeks (weeks 3 & 4)	FL = Rp. 571,284 × 37 × 2 week × 50% FL = Rp. 21,137,500
3	Sum of Items 1 + 2	FL = Rp. 63,412,500.- = Rp. 63,413,000 (rounded off)

IV. CONCLUSION

Based on the results and discussion, conclusions can be drawn from this research.

1. The value of the loss is caused by passing the environmental quality standard in the form of COD, TSS, and Oil pollution costs worth Rp 6,975,000.
2. Thevalue of ecosystem losses due to pollution for the cost of Biodiversity Recovery (CBD) and Genetic Recovery (Cgen) of Rp. 141,000,000.
3. The value of community losses with foregone income with fee losses is Rp. 63,413,000. Therefore, the total value of environmental compensation is Rp. 211,388,000.

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