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Economic Valuation of the Loss of Peatland Fires with the Parameter Calculation of Education and Changes in Air Quality

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Abstract:- In 2015 there were forest fires covering an area of nearly 3 million hectares in the territory of Indonesia, which occurred not only dry land but also wet land such as peat. South Sumatra Province is the province with the largest burned area, where Ogan Komering Ilir (OKI) Regency is the largest burned area district. Peatland fires are mostly caused by human behavior. With the burning of peatlands, the functions and benefits of peat will be lost. We need to know that the benefits of the peatland ecosystem are numerous for the living things that grow around it as well as ecological benefits. Because of the large benefits of peatland ecosystems for the life of creatures on this earth, it is necessary to have an economic valuation to calculate losses due to damage to peatland ecosystems that are burned. On this occasion we calculated the economic valuation of losses due to peatland fires in Ogan Komering Ilir (OKI) Regency in 2015, due to the loss of the benefits of peat for education and the indirect consequence of peatland fires in the form of micro weather changes around OKI district so that many OKI people suffering from ARI due to inhaling toxic air from smoke. The amount of loss due to the loss of opportunities (Opportunity Cost) for teaching and learning for teachers and students in OKI district in 2015 amounted to Rp. 8,463,763,000 and the replacement cost of going to the puskesmas due to ISPA for OKI residents in 2015 due to peatland fires, amounting to Rp. 3,400,194,000,00. So the total loss is Rp. 11,863,957,000.00 or around 11.8 billion rupiah.

Keywords:- *Economic Valuation, Peatland Fires, Opportunity Costs of Education, Replacement Costs for Changes in Air Quality.*

I. INTRODUCTION

In 2015 around June – October around 2.6 million hectares of land and forests were burned (KLHK, 2016). The fires occurred not only in dryland forests, but also in wetland forests, especially peatlands. Fires on peatlands are much more difficult to extinguish than fires on mineral land forests. This is due to the spread of fire which does not only occur in the vegetation on the peat, but also occurs in the peat soil layer where it is difficult to know its spread.

The fires on peatlands are mostly caused by human activities in the framework of preparing agricultural land, Industrial Plantation Forests (HTI) and plantations and coupled with the natural phenomenon of El Nino Southern Oscillation (ENSO). In addition, the government has not enforced the law properly against the perpetrators of peatland burning which has resulted in losses both locally, regionally and internationally. Locally, the visible form of loss is the destruction of forest and land resources, as well as disruption to public health due to the effects of smoke and dust, resulting in loss of lives and forcing the closure of schools so that many residents lose the opportunity to obtain education and income. At the regional and national levels, the smoke disturbance is real, apart from disrupting health and the smooth running of transportation, it also has an impact on the economy. This loss covers several sectors, including: the agricultural sector, the forestry sector, the health sector, the trade sector, the transportation sector. As a result of the losses and negative impacts it causes in the form of smoke disturbance, damage and disruption of biodiversity, it has reached several neighboring countries such as Singapore, Malaysia and Brunei Darussalam, Thailand, the Philippines and Papua New Guinea, so now this problem has received serious attention from the international community, even until there was a threat of a boycott for the products of plantation companies (palm oil) and forestry (pulp and paper) which were accused of causing forest and land fires as well as their smoke.

Economic valuation to assess losses from environmental and ecosystem damage such as peatland fires is important for science and policy formulation (White and Heckenberg 2011). Economic valuation to assess environmental losses from fires on peatland ecosystems can also assist efforts to prosecute crimes involving forest and land burning, either peat or mineral land. When the perpetrators of crime are found, they must be held responsible for the damage caused, and the economic valuation of the loss, has the potential to strengthen prosecution, prevent the potential for further criminal acts,

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guarantee compensation to the aggrieved parties, and restore peatland natural resources that have been damaged by burnt.

In order to calculate the economic valuation of losses due to land fires in peat ecosystems, it is necessary to know the functions and benefits of natural resources in peat ecosystems and the natural resources above them which are disturbed or change or even disappear which are the focus of the calculation according to the objective of economic valuation. Based on the Regulation of the Minister of Environment of the Republic of Indonesia No.14 of 2012 concerning Guidelines for Economic Valuation of Peat Ecosystems, there are 19 functions of the benefits of peat ecosystems. As for what we analyze in this study only 2 functions, namely: 1). Education and 2) Change in Air Quality

II. STUDY AREA AND METHOD

➢ *Reseach Location*

The area of Ogan Komering Ilir Regency is located in the eastern part of South Sumatra Province, namely between 104°20' and 106°00' East Longitude and 2°30' to 4°15' South Latitude, with an area of 19,023.47 Km².

Ogan Komering Ilir (OKI) District was the district with the largest burnt area in South Sumatra, namely 377,335 hectare. Where 98% of the burned land is peat land. In this paper we will calculate the economic valuation to assess losses from damage to peatland ecosystems due to fires in 2015.

➢ *Method*

With changes in biophysical conditions due to damage due to burning, it has an impact on changes in peatland resources and ecological functions which will result in direct or indirect economic impacts that are felt or borne by the community so that it affects the livelihood or welfare of the community. Such as the loss of opportunity costs for the community so that the benefits of peatland for education will be lost and the occurrence of losses due to health problems such as acute respiratory infections (ARI) due to changes in micro weather which is an indirect impact of peatland fires.

We have built an economic valuation model for losses due to peatland fires with education parameters and indirect impacts in the form of changes in micro-weather based on indicators of lost assets. Then we identify and inventory the work system process and the results of each asset indicator of the function and benefits and losses in peatlands. The results of the identification and inventory of each asset indicator both the function and benefits as well as the disadvantages of peatlands are in the form of dynamic calculation variables. Each dynamic variable for calculating the economic valuation of the peatland ecosystem will be defined so that it will have a unit with a quantitative value which will make it easier for us to calculate the economic valuation. This group of variables for calculating the economic valuation of peatland ecosystems will be built into a numerical formula. The numerical formula or calculation formula that we built for the functions and benefits of peat in the form of education due to lost teaching and learning opportunities (opportunity costs) and losses due to health problems such as acute respiratory infections (ARI) due to changes in microclimate are as follows:

➢ *Educational Facilities* $(P_{(7,2)})$

Formula:

$$\text{Val } P_{(7,2)} = \left\{ \begin{array}{c} \left(V_{(7,2,1)} \times V_{(7,2,4)}\right) + \left(V_{(7,2,2)} \times V_{(7,2,5)}\right) + \left(V_{(7,2,3)} \times V_{(7,2,6)}\right) \\ + V_{(7,2,19)}\left[\left(V_{(7,2,7)} \times V_{(7,2,13)}\right) + \left(V_{(7,2,8)} \times V_{(7,2,14)}\right) + \left(V_{(7,2,9)} \times V_{(7,2,15)}\right)\right] \\ + \left[\left(V_{(7,2,20)} + V_{(7,2,19)}\right)\left[\left(V_{(7,2,10)} \times V_{(7,2,16)}\right) + \left(V_{(7,2,11)} \times V_{(7,2,17)}\right) + \left(V_{(7,2,12)} \times V_{(7,2,18)}\right)\right]\right] \\ + V_{(7,2,21)} + V_{(7,2,22)} + V_{(7,2,23)} \end{array} \right\}$$

Where :

Val $P_{(7,2)}$ = The amount of loss due to the lost benefits of peat land for education with the calculation parameters of educational facilities

$V_{(7,2,1)}$ = How many Basic Education facilities (PD) are there in the burned area

$V_{(7,2,2)}$ = How many Upper Education facilities (PA) are there in the burned area

$V_{(7,2,3)}$ = How many Higher Education facilities (PT) are there in the burned area
$V_{(7,2,4)}$ = How much does it cost to build one PD facility (Rp)
$V_{(7,2,5)}$ = How much does it cost to build one PA facility (Rp)
$V_{(7,2,6)}$ = How much does it cost to build one PA facility (Rp)
$V_{(7,2,7)}$ = How many PD educators (person)
$V_{(7,2,8)}$ = How many PA educators (Person)
$V_{(7,2,9)}$ = How many PT educators (Person)
$V_{(7,2,10)}$ = How many PD students (person)
$V_{(7,2,11)}$ = How many PA student (person)
$V_{(7,2,12)}$ = How many PT student (person)
$V_{(7,2,13)}$ = How much is the honorarium of PD educators lost due to fire (Rp/person/month)
$V_{(7,2,14)}$ = How much is the honorarium of PA educators lost due to fire (Rp/person/month)
$V_{(7,2,15)}$ = How much is the honorarium of PA educators lost due to fire (Rp/person/month)
$V_{(7,2,16)}$ = How much is the cost of learning that has been spent by PD students due to fire (Rp/Person/Month)
$V_{(7,2,17)}$ = How much is the cost of learning that has been spent by PA students due to fire (Rp/Person/Month)
$V_{(7,2,18)}$ = How much is the cost of learning that has been spent by PT student (Rp/Person/Month)
$V_{(7,2,19)}$ = Long recovery so that peatlands can become a place re-teaching activities (month)
$V_{(7,2,20)}$ = The remaining time for students, both PD, PA and PT, has not been fulfilled by Education organizers due to fire (Month)
$V_{(7,2,21)}$ = The cost of living for PD students due to changing schools (Rp)
$V_{(7,2,22)}$ = The cost of living for PA students due to changing schools (Rp)
$V_{(7,2,23)}$ = The cost of living for PT students due to changing schools (Rp)

- *Changes in Air Quality*

Formula :

$$\text{Val}P_{(21,2,3)} = \left(V_{(21,2,3,1)} \times V_{(21,2,3,2)} \right) + \left(V_{(21,2,3,3)} \times V_{(21,2,3,4)} \times V_{(21,2,3,5)} \right)$$

Where :

Val $P_{(21,2,3)}$ = The amount of loss due to peatland fires is indirectly in the form of changes in air quality
$V_{(21,2,3,1)}$ = How many people are sick and go to the hospital (RS)/ fire (person)
$V_{(21,2,3,2)}$ = How much does it cost to go to the hospital for treatment (Rp/person)
$V_{(21,2,3,3)}$ = How many sick people per Ha do not go to the hospital (person/hectar)
$V_{(21,2,3,4)}$ = How large is the area affected by changes in air quality (Ha)
$V_{(21,2,3,5)}$ = How much rupiah is lost per person due to changes in air quality Rp/person) (Replacement cost approach)

III. RESULT AND DISCUSSION

Based on data from the Ministry of Environment and Forestry and the World Bank, in June-October 2015 the Province of South Sumatera was the province with the largest burnt area of 608,000 hectares, and Ogan Komering Ilir (OKI) District was the district with the largest burnt area in South Sumatra, namely 377,335 hectare. Where 98% of the burned land is peat land. In this paper we will calculate the economic valuation to assess losses from damage to peatland ecosystems due to fires in 2015 in Ogan Komering Ilir (OKI) Regency, South Sumatra Province. The loss is calculated using the parameter of the loss of the benefits of peat for education and the indirect impact in the form of changes in air quality due to peatland fires.

Table 1 Area burned by Province, June-October 2015

Province	Tousand/ hectare	Precent (%)
Sumatera Selatan	608	23
Kalimantan Tengah	429	16
Kalimantan Timur	388	15
Kalimantan Selatan	292	11
Papua	268	10
Kalimantan Barat	178	7
Riau	139	6
Jambi	123	5
Lainnya	186	7
Total	**2611**	**100**

Source : Kementerian Lingkungan Hidup dan Kehutanan; Bank Dunia

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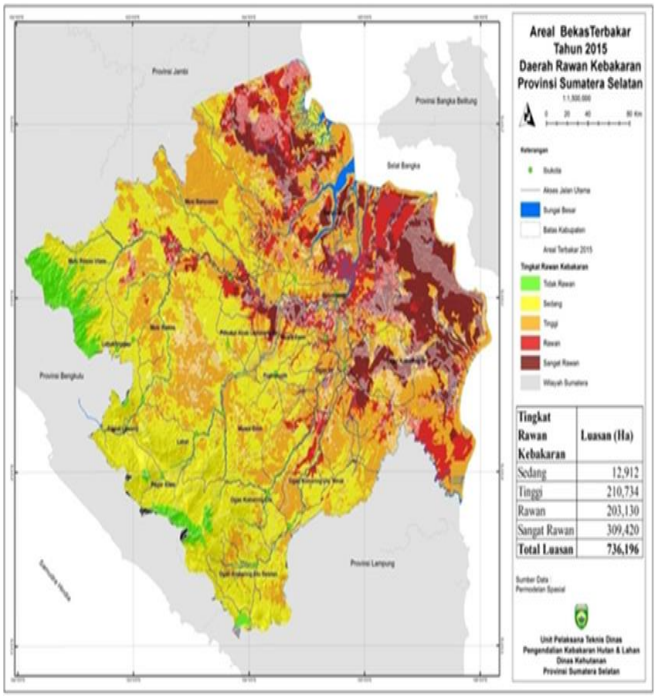

Fig 1 Map of Burnt Areas in 2015 and Map of South Sumatra Regional Boundaries

The burnt area map shows that the Ogan Komering Ilir area (brick red) is an area very prone to forest fires (377.355 hectar), the loss of which will be calculated as follows:

The amount of loss due to the lost benefits of peat land for education with the parameters of calculating educational facilities

For the variable $V_{(7,2,1)}$, $V_{(7,2,2)}$ $V_{(7,2,3)}$ did not exist in OKI District in 2015 or = 0, because the peatland fires in OKI in 2015 did not result in the burning of educational facilities for basic education, senior education and higher education, Since there were no schools burned, it means that there are no school building/repair costs $V_{(7,2,4)}$, $V_{(7,2,5)}$, $V_{(7,2,6)}$ = 0

For how many primary education educators (teachers) consisting of elementary school (SD) and junior high school (SMP) with the unit of person with variable code $V_{(7,2,7)}$ and how many senior education educators (PA) which consists of Upper Level Middle School with units of people with variable code $V_{(7,2,8)}$ can be seen in the table below :

Table 2 Number of Educators (teachers) for Basic Education (PD) in Ogan Komering Ilir (OKI) District in 2015

	Subdistrict	Teacher				
		SD	MI	SMP	MTA	Total
1	Lempuing	434	195	175	236	1,040
2	Lempuing Jaya	305	280	194	149	928
3	Mesuji	372	58	126	58	614
4	Sungai Menang	327	0	111	16	454
5	Mesuji makmur	376	0	150	52	578
6	Mesuji raya	262	47	141	46	496
7	Tulung Selapan	390	35	139	136	700
8	Cengal	263	39	107	28	437
9	Pedamaran	378	0	145	31	554
10	Pedamaran timur	129	8	64	33	234
11	Tanjung Lubuk	320	11	120	61	512
12	Teluk Gelam	220	23	126	36	405
13	Kayu Agung	620	10	303	81	1,014
14	Sirah Pulau Padang	457	0	108	0	565
15	Jejawi	431	9	125	35	600
16	Pampangan	394	12	75	74	555
17	Pangkalan Lampam	280	8	106	68	462
18	Air Sugihan	246	22	101	19	388
	Total	6,204	757	2,416	1,159	10,536

Based on the table above the total number of teachers at OKI in 2015 was 10,536 people consisting of teachers with Civil Servant (PNS) status and Honorary Teachers. Based on data from the OKI District Education Office in 2015 the number of teachers with honorary status totaled 2,223 people or around 21% of the total elementary education teachers at OKI. In this variable, the number of teachers/educators with Honorary teacher status will be calculated, on the grounds that when a peatland fire disaster occurs so that the smoke is so thick that it does not allow teaching and learning activities to be carried out, these honorary teachers will suffer losses because they will lose income because they do not teach, meanwhile teachers with Civil Servants (PNS) status usually, even if they do not teach, will still receive a salary from the government.

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Table 3 Number of Students and Teachers for Upper

No	Subdistrict	Student			Teacher		
		SMA	MA	Total	SMA	MA	Total
1	Lempuing	1,489	1,258	2,747	201	151	352
2	Lempuing Jaya	1,949	686	2,635	171	89	260
3	Mesuji	630	347	977	84	37	121
4	Sungai Menang	517		517	52		52
5	Mesuji makmur	541	192	733	73	61	134
6	Mesuji raya	2,758	120	2,878	94	33	127
7	Tulung Selapan	1,267	113	1,380	112	20	132
8	Cengal	374	97	471	27	20	47
9	Pedamaran	1,043	73	1,116	105	30	135
10	Pedamaran timur	417		417	48		48
11	Tanjung Lubuk	1,355		1,355	142		142
12	Teluk Gelam	584	238	822	49	54	103
13	Kayu Agung	5,542	113	5,655	632	33	665
14	Sirah Pulau Padang	749		749	105		105
15	Jejawi	1,104		1,104	113		113
16	Pampangan	718	130	848	64	25	89
17	Pangkalan Lampam	721		721	56		56
18	Air Sugihan	774	92	866	63	23	86
	Total	22,532	3,459	25,991	2,191	576	2,767

Based on the table above, the number of honorary teachers for upper education is not yet known, but the total number of teachers both honorary and civil servants for upper education (PA) is 2,767 people. It is assumed that the amount is the same based on the percentage of honorary teachers to PNS teachers for Basic education (PD), namely 21%, so the number of Honorary teachers for the upper education level is 582 people. As for the number of educators (lecturers) for higher education and students (students) for higher education with the variable How many are the number of higher education educators (PT) with the unit Person and variable code $V_{(7,2,9)}$ and how many students PT with unit Person with variable code $V_{(7,2,12)}$ and how much honorarium for PT educators lost due to fire with units of Rp/person/month and variable code $V_{(7,2,15)}$, How much is the cost of studying which have been issued by PT students due to fire (Rp/person/month) with the variable code $V_{(7,2,18)}$ the amount is zero (0). Because during the peatland fires at OKI Higher Education it was the end of semester break, so there were no teaching and learning activities.

For the variable how many students or Basic Education students (PD) with units of people with the variable code $V_{(7,2,10)}$ can be seen in table 4 below.

Table 4 The number of students in Basic Education at OKI in 2015

No	Subdistrict	Total Student						
		SD	MI	Total SD & MI	SMP	MTs	Total SMP & MTS	Total PD
1	Lempuing	7,391	1,998	9,389	2,131	2,070	4,201	13,590
2	Lempuing Jaya	4,808	3,391	8,199	2,035	1,394	3,429	11,628
3	Mesuji	5,225	196	5,421	1,370	287	1,657	7,078
4	Sungai Menang	7,528	0	7,528	236	165	401	7,929
5	Mesuji makmur	7,298	0	7,298	1,665	534	2,199	9,497
6	Mesuji raya	4,303	564	4,867	1,698	220	1,918	6,785
7	Tulung Selapan	6,344	624	6,968	1,414	1,052	2,466	9,434
8	Cengal	5,480	540	6,020	1,293	149	1,442	7,462
9	Pedamaran	5,937	0	5,937	2,088	132	2,220	8,157
10	Pedamaran timur	2,998	44	3,042	798	86	884	3,926
11	Tanjung Lubuk	3,722	198	3,920	1,126	361	1,487	5,407
12	Teluk Gelam	2,826	138	2,964	1,105	326	1,431	4,395
13	Kayu Agung	8,865	85	8,950	4,337	451	4,788	13,738
14	Sirah Pulau Padang	5,209	0	5,209	1,399		1,399	6,608

Based on table 4 above, the number of students for basic education at OKI in 2015 was 137,832 people. Meanwhile, how many students or students of Upper Education (PA) with units of Persons and variable code $V_{(7,2,11)}$ can be seen in table 3 above, namely 25,991 people.

The magnitude of the variable is how much the honorarium of PD educators is lost due to fire with the unit Rp/Person/Month and the variable code $V_{(7,2,13)}$ and How much is the honorarium of PA educators lost due to fire with the unit Rp/Person/Month and the variable code $V_{(7,2,14)}$based on the results of interviews with a number of honorary teachers in Ogan Komering Ilir (OKI) Regency of IDR 1,500,000.00 / person / month. Because the variable remaining time for students, both PD, PA and PT, has not been fulfilled by education providers due to fire with units of months and variable code $V_{(7,2,20)}$ of 15 days or 0.5 months, honorary teachers will lose income of Rp. 500,000/person/month.

Variables What are the learning costs incurred by PD students as a result of the fire in units of Rp. Month with variable code $V_{(7,2,17)}$, we assume how much BOS (School Operational Assistance) fees the School receives from the Government every year. With BOS assistance, school students, both Basic Education and Higher Education, were no longer subject to SPP (Education Development Contributions). With peatland fires and teaching and learning activities being closed due to environmental pollution due to smoke, students or students will lose out, because BOS funds are still being disbursed by the government but students and students will lose the

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opportunity to get an education (opportunity cost). The amount of lost BOS funds for elementary school children is Rp. 66,000/month/person, junior high school children are Rp. 83,000/month/person (elementary education) and high school or senior education children are Rp. 116,000/month/ org.

For the long recovery variable so that peatland can become a place for teaching and learning activities again with units of months and the variable code $V_{(7,2,19)}$ equals 0 because once the peatland fires can be extinguished, the community can carry out teaching and learning activities again as usual .

Meanwhile, for the variable cost of living for PD students due to moving schools, the unit is Rp. (variable $V_{(7,2,21)}$). The unit cost of living for PA students due to moving schools is IDR with the variable code $V_{(7,2,22)}$, and the living cost for PT students due to moving schools is IDR with the variable code$V_{(7,2,23)}$ the sum is zero (0), because with the peatland fire disaster, the people in OKI Regency did not experience moving their school places due to the fact that their school was burned down or could no longer be used.

From the value of each existing variable, it will be entered into the numerical formula Val Val $P_{(7,2)}$ = Total Losses due to the lost benefits of peatland for education with the parameters for calculating educational facilities, so that the total amount of losses due to lost community opportunities (opportunity cost)) teaching and learning activities in Ogan Komering Ilir (OKI) Regency in 2015 amounted to Rp. 8,463,763,000.

- *The Amount of Loss Due to Peatland fires is Indirectly in the form of changes in Air quality*

With the peatland fires, the air in Ogan Komering Ilir Regency contains toxic gases which, if inhaled by humans, will cause people with unfit bodies and people at a disease-prone age such as toddlers, pregnant women and the elderly to become sick. Diseases suffered by residents due to peatland fires are ARI (Acute Respiratory Infection) cough and flu. There are people who are sick who go to the hospital for treatment, so the calculation of the economic valuation of losses due to changes in air quality due to peatland fires uses the replacement cost method for people going to the hospital. While people who are sick but do not go to the hospital for treatment and people who are not sick but seek treatment for prevention, the calculation of the economic valuation of the loss uses a replacement cost for buying drugs other than in the hospital until they recover from their illness. Below is a table of the number of patients with the 10 largest types of disease who seek treatment at the health centers in OKI districts in 2015.

Table 5 Number of Patients and Percentage with the 10 Largest Types of Disease who seek Treatment at the Health Centers in OKI Districts in 2015

No	The Type of Disease	Number of people	Precent (%)
1	Other acute infection of the upper respiratory tract	77,630	21
2	Infectious diseases of the intestines	6,575	18
3	Diseases of the muscular system and memory tissues	43,354	12
4	skin and tissue diseases	37,743	10
5	high blood pressure diseases	28,962	8
6	diseases of the oral cavity	19,884	5
7	Other diseases of the lower tract	16,321	4
8	Diseases of the eye and andexa	8,052	2
9	Accident and Poisoning	7,842	2
10	Diseases of the Ears	6,437	2
11	Other diseases	59,743	16
	TOTAL	371,713	84

Source :OKI Distric Health Office in 2016

Based on the table above, ISPA was the type of disease with the highest percentage for patients who went to health centers in OKI in 2015, which was around 21%. For the variable the number of people who are sick and go to the hospital (RS) or health center due to fire with the unit of person and the variable code $V_{(21,2,3,1)}$ we assume that the patients with ISPA have an influence from the peatland fires, namely the number 77,630 people. As for the variable, how much does it cost to go to a hospital or health center with the unit Rp./person and variable code $V_{(21,2,3,2)}$ which is Rp.43,800 including outpatient fees, laboratory examinations, and drug costs. This fee is a replacement fee incurred by the BPJS (Health Insurance Organizing Agency) for the treatment of ISPA patients, because in OKI all people affected by the peatland fires are borne by the government through BPJS.

For Variable How many sick people /hectare do not go to the hospital or health center with units of person/Ha and variable code $V_{(21,2,3,3)}$, variable how wide is the area affected by changes in air quality with units of Ha with variable code $V_{(21,2,3,4)}$, and variable how many rupiah losses per person due to changes in air quality with units of Rp/person, replacement cost approach and variable code $V_{(21,2,3,5)}$ the number is zero (0) due to the unavailability of data on the number of people who are sick but do not go to the hospital for health centers in OKI District in 2015.

From the value of each existing variable, it will be entered into the numerical formula. Valuation P Val $P_{(21,2,3)}$ = Total losses due to peatland fires indirectly in the form of changes in air quality, so that the total amount of losses due to changes in air quality in OKI in in 2015 due to peatland fires Rp. 3,400,194,000,00. So the total loss due to peatland

fires in Ogan Komering Ilir (OKI) Regency in 2015 due to the loss of educational benefits and indirect consequences in the form of changes in air quality is Rp. 11,863,957,000.00 or around 11.8 billion rupiah

IV. CONCLUSION

- Losses due to lost opportunities (Opportunity Cost) for teaching and learning for teachers and students in OKI district in 2015 amounted to Rp. 8,463,763,000
- The replacement cost of going to the health center due to ARI for OKI residents in 2015 due to peatland fires is Rp. 3,400,194,000,00.
- The total loss due to peat fires to teaching and learning activities and the cost of replacing drugs to the Puskesmas because they were exposed to ARI is Rp. 11,863,957,000.00 or around 11.8 billion rupiah.

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