Peatland Non Use Value Survey In Siak Regency

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Abstract. Complementing the peatland depth survey using Ground Penetrating Radar di Siak Regency conducted by Pustekwil (Pusat Teknologi Sumberdaya Wilayah) BPPT, a Non-use Value survey was conducted in May 2017. Peatland is a natural resource whose value has long been underestimated. In order to correctly assign for peatlands’ value, a different approach, namely the Total Economic Value, must be used. The Total Economic Value (TEV) method comprises of Use Value and Non-Use Value. Whereas the Use Value component may use secondary data (and market price data), the Non-Use Value data must be gathered directly from the respondents using Contingent Valuation Method. Data gathered during a recent survey in Siak Regency, using stratified random sampling method, shows a Bequest Value of IDR/ha/year 1,413,647.95 (WTP based) dan IDR/ha/year 29,025,305.57 (WTA based). The same survey shows Existence Value of IDR/ha/year IDR 82,725 (WTP based) and of IDR/ha/year 9,472,281.78 (WTA based). While the gathered values seem small compared to Direct Use Value (of converting peatland for palm oil plantation), they need to be collected as part of the peatland’s Total Economic Value calculation.

Keywords: Siak peatland, WTP, WTA, total economic value, non-use value, existence value, bequest value

1. Introduction
Peat is a heterogeneous mixture of more or less decomposed plant (humus) material that has accumulated in a water-saturated environment and in the absence of oxygen. Its structure ranges from more or less decomposed plant remains to a fine amorphous, colloidal mass. The warmer the climate, the quicker the plant material will decompose. The rate of accumulating plant material is greatest in areas where the temperature is high enough for plant growth but too low for the vigorous microbial activity that breaks down the plant material. Such conditions are found more frequently in the northern hemisphere.

Indonesia has approximately 15 to 20 million hectares of tropical peatlands: the fourth-largest peatland area in the world (BRG, 2016). According to [1] Indonesia’s has 20.6 million ha peatlands area (10.8% of the country’s area), of which 7.2 million hectares (35%) is in Sumatera. The Indonesian peatlands represent 80% of SE Asian tropical peatlands and 50% of the world’s tropical peatlands [2]. Economically, an undisturbed peatland often considered as unproductive natural resources. Therefore, there have been pressures to use peatlands for commercial plantations purposes.

In Indonesia, the peat swamp forests vanishing at a critical rate (2.6%/year in Sumatra and Kalimantan) between 2007 and 2015 [3]. Growing demand for arable land especially for oil palm,
attractiveness in relation to their flat topography and non-active agricultural use have all led to intense conversion over past decades. In response to global market, oil palm has become one of the most economically attractive crops to cultivate in tropical regions. Indonesia is the leading global producer of crude palm oil with a production rate growing exponentially over time (Murdiyarso et al. 2010). The contribution of oil palm expansion to peatland deforestation also tends to follow an exponential pattern [3], even though oil palm development is not the sole driver of peat swamp forest disappearance.

Notwithstanding with first general impression that peatland is an unproductive natural resource, Wetlands/peatlands is a natural resource with multiple functions. They offer many services, namely in water resources protection, flood control, seawater intrusion defense, supporting biodiversity, climate control (through its ability to act as the carbon sink), and many more. Owing to this multi products nature of peatlands, peatlands’ value must not be judged in the conventional way, i.e. the products directly produced and sold at the market. A Total Economic Value approach must be used.

According to Plottu et al (2007), Total economic value (TEV) is a concept in cost-benefit analysis that refers to the value derived by people from a natural resource, a man-made heritage resource or an infrastructure system, compared to not having it. It appears in environmental economics as an aggregation of the (main function based) values provided by a given ecosystem. The value of an ecosystem can be distinguished as:

Use Value – Can be split into Direct and Indirect use values:
Direct use value: Obtained through a removable product in nature (i.e. timber, fish, water).
Indirect use value: Obtained through a non-removable product in nature (i.e. sunset, waterfall).

Non-use value – Values for existence of the natural resource. For example, knowing that tigers are in the wild, even though you may never see them.

Option value: Placed on the potential future ability to use a resource even though it is not currently used and the likelihood of future use is very low. This reflects the willingness to preserve an option for potential future use.
Bequest value or existence value: Placed on a resource that will never be used by current individuals, derived from the value of satisfaction from preserving a natural environment or a historic environment (i.e., natural heritage or cultural heritage) for future generations. Both Existence and Bequest Values are concerned with abstract benefits, which there is no actual market. Therefore, market prices cannot be used to measure the values respondents put on peatland. To alleviate this valuation problem, a contingent valuation method (CVM) is used for the survey.

The contingent valuation method involves directly asking people, in a survey, how much they would be willing to pay for specific environmental services. In some cases, people are asked for the amount of compensation they would be willing to accept to give up specific environmental services. It is called “contingent” valuation, because people are asked to state their willingness to pay (WTP), contingent on a specific hypothetical scenario and description of the environmental service.

Other than WTP, in a CVM survey respondents are often asked their willingness to accept (hypothetical) financial compensation, in order to forgo for specific environmental services. Theoretically, both values (WTP and WTA) should not differ greatly. However, when asked to state their WTP and later their WTA for a specific hypothetical case, respondents often give very much different values. The WTA is almost always higher than WTP.

2. Objective
The survey’s objective is to evaluate the peat non-use values perceived by the Siak regency’s inhabitants. The non-use values are very important parameters to correctly evaluate natural resources value, together with the ‘traditional’ use value. Owing to the necessity to ask many respondents to collect this perceived values, non-use value survey is rarely conducted. This survey was part of combined studies in Siak regency’s peatland (including the peatland’s depth study using Ground Penetrating Radar and water level study using drone). Collecting the peatland’s non-use value, combined with previously collected use value of Siak Regency peatland, will provide a better calculation of the peatland’s total economic value. Other than that, as non-use values survey requires intensive human resources, it is
seldom conducted. Therefore the resulted non-use values may be used in another peatland total economic value study.

3. Methodology

The method used for this survey is Stratified proportional random sampling. A Stratified random sampling is a method of sampling that involves the division of a population into smaller groups known as strata. In stratified random sampling, the strata are formed based on members' shared attributes or characteristics. A random sample from each stratum is taken in a number proportional to the stratum's size when compared to the population. These subsets of the strata are then pooled to form a random sampling. The strata in this survey is the chosen districts. Out of 14 districts in Siak regency, seven districts have been chosen as the target area. Firstly, the districts are ranked according to their peatlands areas. Since this is a Non-Use value survey, the lesser the peatland area in a district, the higher the rank. Secondly, the districts are re-ranked according to their distance and accessibility from Siak city. Thirdly, and lastly, the districts are chosen until the required respondent numbers are met. To calculate the respondent requirement, a formula is used, namely:

\[ n = \frac{N}{1 + Ne^2} \]  

in which:
- \( n \) = the required respondents, representing a household
- \( N \) = populations (households)
- \( e \) = margin of error (%)

Having chosen the districts to be surveyed and the required respondents in those districts, the conducted survey follow the following algorithm. While the main survey objective is to gather Non-Use Values of peatland (namely the respondents’ WTP and WTA values concerning with peatland preservation), when the engaged respondent(s) is later known cultivating the peatland, Use Value data will be gathered from them, instead. This algorithm is used in order to quickly switch the survey questions, from the Non-use Value questionnaire to Use-value questionnaire. See attached survey questionnaires.

![Survey Algorithm](image)

Figure 1. Survey Algorithm

4. Result

4.1 Peatlands In Siak Regency

Geographically, the Siak regency lies between 10°16′30" — 00°20′49" North Latitude and 100°54′21" — 102°10′59" East Longitude. BujurTimur. Physically, the regency has a coastal area which shares borders with other ASEAN countries (Malaysia and Singapore). The Siak regency’s physical area mostly consists of lowland (in eastern region) and highland on the western side of the regency. The Siak regency’s soil structure generally consists of the yellow-red podsolic in rock and alluvial form, as well as organosol soil and gley humus in wetland and wet soil s. This area has a tropical climate with 25° -- 32° Celsius air temperature, and high humidity and rainfall.
Out of 869.72 hectares Siak regency area, 53.22 percent (459.193 hectares) is peatland, which is spread over 12 districts. Of this peatland area, 34.76 percent is wetland (302.291 Ha, with deep peat deposit), while the rest (18.47 percent or 160.615 Ha) is shallow peat wetland. Of those peat wetlands, mostly located on forest area, forest concession and plantation companies. Outside of those areas, the deep peat wetland lies in Koto Gasip, Dayun, Mempura and Sungai Apit districts. There are three small peat domes and four big peat domes. The small peat domes are Sungai Mandau, Buatan and Marempan domes.

The big peat domes are the Siak Kecil dome (which lies in Siak and in Bunga Raya districts), the Zamrud dome (lies in Siak and Pelelawan regencies), the Bukit Batu dome (lies in Siak and Bengkalis regencies) and the Kandisdome (lies is Siak, Rokan Hulu and Bengkalis regencies). Of the utilized peatlands, the largest is used for industrial woods plantation (HTI, HutanTanamanIndustri) in Zamrud dome (46.920 Ha) and in Sungai Mandau dome (29.487 Ha), planted with acacia for pulp industry. The deep dome utilization has resulted in peatland subsidence, decreasing peatland biodiversity, as well as introducing new pests for the flora. The following table show peatland distribution among the Siak Regency’s districts.

| Peatland Depth (metres) | 1-2 | 2-4 | >4 |
|------------------------|-----|-----|----|
| Siak District          | 44.76 | 221.65 |
| Mempura Dist           | 134.13 | 82.52 | 135.33 |
| Dayun Dist             | 30.95 | 59.27 | 911.45 |
| Kerinci Kanan Dist     | 1.03 | 16.65 |
| Bunga Raya Dist        | 43.84 | 58.57 |
| Lubuk Dalam Dist       | 7.04 |  |
| Koto Gasib Dist        | 48.78 | 26.25 | 99.01 |
| Total 7 districts (ha) | 302.45 | 169.07 | 1,449.70 |
| Total                  | 192,123.00 |

Source: Peta LahanGambut Indonesia, BBSDLP, 2014

From the original 14 districts Siak peatland map (from which the above table is calculated), it shows that while the Sungai Apit district has the largest area of peatland, the Siak and Bunga Raya districts have the big peat domes. This 192,123 ha peatland area figure will be used throughout the analysis. The following map shows peatland distribution in the Siak districts.
Figure 2. Peatland Thickness of Siak District

From the above map can be noted that soil or peat located at Siak has two Subclasses of the thickness of the peat moss. Peat with a thickness of 1 meter to 2 meters and peat with a thickness of more than 4 meters. For the distribution of peatland in peat thickness with Siak over 4 meters is located in the northern part, central part, and the southern part. For peat with a thickness of 1 meter to 2 meters is located in the central part with a little part towards the East area. The extensive peat with a thickness of 1 meter to 2 meters in sub-district of Siak around 44,762 km², while the area of peat with a thickness of more than 4 meters in sub-district of Siak covering an area of 221,647 km². The red circle appears on the image map above is showing the area of the site survey team in finding the respondents. Other districts’ peatland map is attached at the end of this paper.

4.2 Number of Respondents Requirement

For the Non-use Value Survey purpose, out of 14 Siak regency’s districts, 7 districts have been chosen as the survey areas. The selection is based on the methodology used (see Ch III). The following table summarises the required data and the resulting sample requirement for each selected district.

There area 116,950 households in the Siak Regency. The chosen margin of error is 2.5%. Entering the data into the formula (see Methodology in Ch III) resulting in 1,578 households respondents requirement. As result of limitation (budget, time, manpower), it was decided to take only 25% of the required samples, namely 400 respondents. Therefore, each respondent representing 265 populations.

Table 2. Number of Respondents In Siak Regency’s Selected Districts

| Districts | Area (km²) | Population | Pop Density | Households | Sample |
|-----------|------------|------------|-------------|------------|--------|
| 8. TUALANG | 343.60     | 126,442    | 367.99      | 30,548.00  | 115    |
| 2. KANDIS  | 1493.65    | 82,349     | 55.13       | 19,711.00  | 74     |
| 10. DAYUN  | 232.24     | 32,591     | 140.33      | 8,371.00   | 32     |
| 1. MINAS   | 346.35     | 31,939     | 92.22       | 7,647.00   | 29     |
| 4. SUNGAI APIT | 1346.33 | 30,929    | 22.97       | 7,808.00   | 29     |
### Districts

| Districts       | Area (km²) | Population | Pop Density | Households | Sample |
|-----------------|------------|------------|-------------|------------|--------|
| 3. SIAK         | 894.17     | 27,548     | 30.81       | 6,940.00   | 26     |
| 11. BUNGA RAYA  | 15.10      | 26,192     | 173.46      | 6,979.00   | 26     |
| 6. KERINCI KANAN| 128.66     | 25,827     | 200.74      | 6,737.00   | 25     |
| 9. KOTO GASIB   | 704.70     | 23,488     | 33.33       | 5,963.00   | 23     |
| 7. LUBUK DALAM  | 155.09     | 20,800     | 134.12      | 5,206.00   | 20     |
| 12. MEMPURA     | 437.45     | 16,323     | 37.31       | 4,187.00   | 400    |
| 13. SABAK AUH   | 73.38      | 12,789     | 174.28      | 3,231.00   |
| 5. SUNGAI MANDAU| 1705.00    | 7,445      | 4.37        | 1,885.00   |
| 14. PUSAKO      | 544.47     | 6,668      | 12.25       | 1,737.00   |
| Total           | 8556.09    | 471,330    |             | 116,950.00 |        |

### Survey Results

The survey conducted in 8 days and has met the required 400 respondents. Not all the gathered data are good for analysis purposes. There are incomplete data, too low or too high WTP and/or WTA values. For data analysis purpose, the complete data must also be cleaned from outliers. Outliers are data values which are too low or too high compared to data’s mean.

Having been cleaned and smoothed (outliers deleted), the following steps are taken to get the Non-Use Values result.

- Step 1, calculate the average Existence/Bequest WTP/WTA values from original data
- Step 2, multiply with 7 districts’ population (172,769.00) to get 7 districts’ Existence/Bequest WTP/WTA values
- Step 3, multiply with 12 to get total annual figures
- Step 4, divide with 7 districts peatland area to get IDR/ha/year value. This step is required as the Use Value components (of TEV, Total Economic Value) also using IDR/ha/year unit.

The resulting Step 1 – Step 4 is shown in the following tables.

**Table 3. Existence Value Results (WTP)**

|                          |             |
|--------------------------|-------------|
| Total WTP as surveyed (IDR/month) | 8,186,000   |
| Average WTP as Surveyed (Rp/mo/person) | 91,977.53   |
| Rata-rata WTP Survei (IDR/thn/orang) | 98,232,004  |
| Total WTP in 7 Districts (mi IDR/annum) | 15,893      |
| WTP in 7 Kec (IDR/ha/annum) | 82,725      |

**Table 4. Existence Value Results (WTA)**

|                          |             |
|--------------------------|-------------|
| Total WTA as surveyed (IDR/month) | 78,987,667.00 |
| Average WTA as Surveyed (Rp/mo/person) | 877,640.74   |
| Rata-rata WTA Survei (IDR/thn/orang) | 10,531,688.93 |
| Total WTA in 7 Districts (mi IDR/annum) | 1,819,833.72  |
| WTA in 7 Kec (IDR/ha/annum) | 9,472,281.78 |
The above tables show that when asked to state how much the respondent will ask for a compensation, in return of his/her willingness to accept the peatland disappearance, the answer is almost 10 times (877,640/91,977) as much as their willingness to pay to prevent the peatland disappearance.

| Table 5. Bequest Value Results (WTP) |
|-------------------------------------|
| Total WTP as surveyed (IDR/month)   | 14,931,666.67 |
| Average WTP as Surveyed (Rp/mo/person) | 130,979.53 |
| Rata-rata WTP Survei (IDR/thn/orang) | 1,571,754.39 |
| Total WTP in 7 Districts (mi IDR/annum) | 271,592.87 |
| WTP in 7 Kec (IDR/ha/annum)        | 1,413,647.95 |

| Table 6. Bequest Value Results (WTA) |
|-------------------------------------|
| Total WTA as surveyed (IDR/month)   | 306,580,000.00 |
| Average WTA as Surveyed (Rp/mo/person) | 2,689,298.25 |
| Rata-rata WTA Survei (IDR/thn/orang) | 32,271,578.95 |
| Total WTA in 7 Districts (mi IDR/annum) | 5,576,399.76 |
| WTA in 7 Kec (IDR/ha/annum)        | 29,025,305.57 |

Similar with Existence Value data, when asked to state how much the respondent will ask for a compensation, in return of his/her willingness to accept the peatland disappearance, the answer is more than 20 times as much (2,689,289/130,979) as their willingness to pay to prevent the peatland disappearance.

5. Conclusions
When compared with Direct Use of converting peatland for palm oil plantation (which can produce 19,64-25,53 tonnes of fresh fruit bunch/ha/year, [4] the survey result shows lower values of (WTP) Existence and Bequest Values in peatland. However, when the respondents are asked the compensation values (WTA), the resulting Non-Use Value are much higher than the Direct Use Value of palm oil plantation in peatland. Notwithstanding with this mixed result, a Non-Use value survey has to be conducted in peatland conversion, to catch as much as value as possible.

References
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Attachments
Survey Questionaires

1 Existence Value
Q1: How much will you pay per month in order to preserve the peatland in your district from being converted to oil palm plantations?
Q2: How much will you agree to be compensated per month to allow the peatland in your district to be converted to oil palm plantations?

2. Bequest Value
Q1: How much will you pay per month in order to preserve the peatland in your district from being converted to oil palm plantations, so that your future generations can see the peatland?
Q2: How much will you agree to be compensated per month to allow the peatland in your district to be converted to oil palm plantations, such that your future generations may not be able to see the peatland?

Figure 3. Peatland Thickness Distribution and Survey Locations Map of Lubuk Dalam District
Figure 4. Peatland Thickness Distribution and Survey Locations Map of Bunga Raya District

Figure 5. Peatland Thickness and Survey Locations Map of Siak District
Figure 6. Peatland Thickness Distribution and Survey Locations Map of Mempura District

Figure 7. Peatland Thickness Distribution and Survey Locations Map of Koto Gasib District
Figure 8. Peatland Thickness Distribution and Survey Locations Map of Dayun District

Figure 9. Peatland Thickness Distribution and Survey Locations Map of Siak District