EMISSION REDUCTION REPORT
FOR THE INDONESIA-NORWAY PARTNERSHIP

MINISTRY OF ENVIRONMENT AND FORESTRY
REPUBLIC OF INDONESIA
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Preface

In pursuit of fulfilling the commitments outlined in The Paris Agreement, the Governments of the Republic of Indonesia and the Kingdom of Norway have agreed to further deepen their partnership in support of Indonesia's efforts to reduce greenhouse gas emissions from Forestry and Other Land Use (FOLU). This commitment was initially formalized through the signing of a Memorandum of Understanding (MoU) on 12 September 2022. Subsequently, a results-based Contribution Agreement under the MoU was signed on 19 October 2022.

The signed documents emphasize the importance of ensuring deliverable, tangible, direct and measurable benefits for communities while facilitating Indonesia's progress in this field. They uphold the prevailing standards of governance and promote transparency, accountability, inclusivity, and participation as key guiding principles.

In line with this, a comprehensive report was meticulously prepared based upon the existing Measurement, Reporting, and Verification (MRV) protocol, as agreed by the two governments under the aforementioned MoU and Contribution Agreement.

This report serves as a basis for determining a certain portion of the results-based contributions made by the Government of the Kingdom of Norway for the performance achieved by the Government of Republic of Indonesia in reducing greenhouse gas emissions from deforestation and forest degradation for the periods of 2017/2018 and 2018/2019.

In view of the constructive partnership fostered by both governments, I am confident that this report will continue to drive the process we are engaged in forward significantly. I am deeply appreciative of the partnership as a whole and would also like to acknowledge the crucial and indispensable roles played by relevant institutions and teams of experts in the preparation and development of the Emission Reduction Report for the Indonesia-Norway Partnership.

Jakarta, July 2023

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Table of Contents

List of Tables

List of Figures

1. Introduction

The bilateral partnership between the Government of the Republic of Indonesia and the Government of the Kingdom of Norway was formalized through the signing on **12 September 2022 of a Memorandum of Understanding (MoU)** on the "Partnership in support of Indonesia's efforts to reduce greenhouse gas emissions from forestry and other land use".

Under this MoU, the two governments subsequently signed a **Contribution Agreement on 19 October 2022** which was followed by the submission of a **contribution totalling USD 56 million** from Government of the Kingdom of Norway. This constituted the first results-based contribution for verified emissions reductions from forests and other land use **amounting to 11.2 million tonnes of CO_2e for the forest year 2016/2017**, based on the existing Measurement, Reporting, and Verification (MRV) protocol.

The figure of 11.2 million tonnes of CO_2e was reached after the deduction of a set-aside amount from the initially verified 17.2 million tonnes of CO_2e. Even this initial figure, while representing a significant amount, still accounts for only a minor portion of the total emissions reductions achieved by Indonesia during the forest year in question. Consequently, the first results-based contribution from Norway, though greatly appreciated, was relatively small compared to the overall scale of emissions reductions accomplished by Indonesia during that period.

As restated in the Contribution Agreement, results-based contributions for a portion of national level and third-party verified emissions reductions from forests and other land use for the years 2017/2018 through 2019/2020 will be based on the existing MRV protocol.

As agreed to in the documents, Indonesia duly developed an Emission Reduction Report which provides information on the reference emission level to be used to define the Baseline for Results-Based Payments and serves as the basis for determining a certain portion of the results-based contributions for the years of 2017/2018 and 2018/2019. This report was created using the existing MRV protocol for the Indonesia-Norway partnership on climate, forests, and peat.

Over time, Indonesia has made significant advancements in developing its systems and infrastructure. Alongside these improvements, Indonesia has also implemented a series of effective performance-enhancing policies and strategies. As a result of these combined efforts, **Indonesia achieved a remarkable reduction of over 286.4 million tonnes of CO_2e during the periods of 2017/2018 and 2018/2019**.

With reference to Norway's previous results-based contribution in 2016/2017, it is worth noting that its contributions for the 2017/2018 and 2018/2019 periods, if proportionally similar, would fall below the threshold of 10% of the total emissions reductions achieved by the Government of Indonesia. As such, while Norway's contributions are important and greatly appreciated within the spirit of this partnership, the contributions are still considered relatively minor in relation to the overall value of Indonesia's emissions reduction efforts.

The Results-Based Payment/Contribution (RBP/C) baseline used in this report differs from the National Forest Reference Emission Level for Deforestation and Forest Degradation (FREL), which was submitted to the UNFCCC and passed the technical assessment in 2016. The key distinction between FREL and the RBP/C baseline is in the reference period and the scope of activities involved. FREL applies to the period of 1990–2012 whereas the RBP/C baseline applies to the period of 2006–2016. Another difference between these two measurement benchmarks is that the emissions reductions from peat decomposition included in FREL are not incorporated in the RBP/C baseline.

2. Results-Based Payment/Contribution Baseline of the Indonesia-Norway Partnership

2.1 Definitions Used

The definitions used in this report are consistent with those in the first Indonesian FREL. The definitions restated in this report include, among others: the definition of forest, deforestation, forest degradation, and baseline for Results-Based Payment (RBP) which will serve as the basis for determining a certain portion of the Results-Based Contributions (RBC).

2.1.1 Forest

The Government of Indonesia through the Minister of Forestry Decree No. 14/2004 regarding A/R CDM, has set up the definition of forest as “Land with a minimum area of 0.25 hectares that contains trees with canopy cover of at least 30 percent that are capable of reaching a minimum height of 5 meters at maturity” (MoFor, 2004).

In this report, the term "**Forest**" refers to the "working definition" which is defined as follows: "a land area of more than 6.25 hectares with trees higher than 5 meters at maturity and a canopy cover of more than 30 percent." The delineation of forest areas is based on land-cover maps created by visually interpreting satellite images at a scale of 1:50,000. The minimum area for polygon delineation in these maps is 0.25 cm^2, which corresponds to the minimum mapping unit of 6.25 hectares.

Table 1. Land cover classes used in the RBP/C baseline

No	Land cover	Abbreviation	Category	IPCC
1.	Primary dryland forest	PF	Natural forest	Forest
2.	Secondary dryland forest	SF	Natural forest	Forest
3.	Primary mangrove forest	PMF	Natural forest	Forest
4.	Secondary mangrove forest	SMF	Natural forest	Forest
5.	Primary swamp forest	PSF	Natural forest	Forest
6.	Secondary swamp forest	SSF	Natural forest	Forest
7.	Plantation forest	TP	Plantation	Forest
8.	Estate crop	EP	Non-forest	Crop land
9.	Pure dry agriculture	AUA	Non-forest	Crop land
10.	Mixed dry agriculture	MxUA	Non-forest	Crop land
11.	Dry shrub	Sr	Non-forest	Grassland
12.	Wet shrub	SSr	Non-forest	Grassland
13.	Savanna and grasses	Sv	Non-forest	Grassland
14.	Paddy Field	Rc	Non-forest	Crop land
15.	Open swamp	Sw	Non-forest	Wetland

No	Land cover	Abbreviation	Category	IPCC
16.	Fishpond/aquaculture	Po	Non-forest	Wetland
17.	Transmigration areas	Tr	Non-forest	Settlement
18.	Settlement areas	Se	Non-forest	Settlement
19.	Port and harbor	Ai	Non-forest	Other land
20.	Mining areas	Mn	Non-forest	Other land
21.	Bare ground	Br	Non-forest	Other land
22.	Open water	WB	Non-forest	Wetland
23.	Clouds and no-data	Ot	Non-forest	No data

The Forest used as the basis for calculation pertains to natural forests, as classified in the Ministry of Environment and Forestry's land cover map (Table 1). These natural forests have been used in determining the Forest References Emissions Level. The classification comprises six distinct classes, encompassing primary dryland forest, secondary dryland forest, primary mangrove forest, secondary mangrove forest, primary swamp forest, and secondary swamp forest.

2.1.2 Deforestation

In this report, **deforestation** is specifically defined as the conversion of natural forest cover to other land-cover categories that occurs once at any given location. This definition encompasses scenarios where natural forest cover is transformed into plantation forests or non-forested lands.

2.1.3 Forest Degradation

Forest degradation refers to the process of transforming from primary forest classes, which include primary dryland, primary mangrove, and primary swamp forests, to secondary forest classes. This transition leads to a reduction in the amount of carbon stocks within the forest due to human activities. The secondary forests that result from these transitions have undergone selective logging or experienced other disturbance events, such as fires and encroachment.

2.1.4 Baseline for Results-Based Payment/Contribution

The baseline for Results-Based Payment/Contribution (RBP/C), which has been constructed using historical forest dynamics data, is a benchmark for assessing Indonesia’s performance in implementing REDD+ under the framework of the Indonesia-Norway Partnership. The performance of emission reductions is expressed in tonnes of CO_2e per year. The technical definition of the RBP/C baseline adopted in this report is a projection of CO_2 gross emissions that is used as a reference to compare against actual emissions at a given point in time in the future. In accordance with the MRV protocol, the RBP/C baseline will be subject to periodic updates in an indicative manner every 5 years. These updates will consider any revisions made to Indonesia's FREL that have been submitted to the UNFCCC.

In order to be consistent with the first Indonesian FREL submitted to the UNFCCC, the definition of forests used in this report aligns with that provided in the aforementioned first FREL. The area of calculation was set to be limited to the extent of natural forest observed in 1990. However, it is important to note that the MRV Protocol document acknowledges the possibility of making certain modifications to this FREL. Any such modifications will be incorporated into the bilateral Results-Based Payment/Contribution framework.

2.2 Areas, Activities and Pools Covered

2.2.1 Areas Covered

RBP/C baseline calculation encompasses all natural forests in Indonesia, covering dryland, mangrove, and swamp forests from both primary and secondary classes.

2.2.2 Activities Covered

RBP/C baseline calculation includes activities related to deforestation and forest degradation. However, other REDD+ activities such as sustainable management of forests, role of conservation, and enhancement of forest carbon stock are not considered in the calculation. Additionally, emissions from peat decomposition are excluded in the calculation, in line with the Annex of MRV Protocol for the Indonesia-Norway Partnership on climate, forests and peat (see section “Activities, pools and gases included in the results-based payment/contribution”).

2.2.3 Pools and Gases

The RBP/C baseline calculation considers aboveground biomass (AGB) as the most significant carbon pool, and reports the greenhouse gas emissions associated with carbon dioxide (CO_2).

2.3 Data

2.3.1 Activity Data

The activity data used for the report were derived from the series of land cover maps created by the Ministry of Environment and Forestry (MoEF). These maps are part of the National Forest Monitoring System (NFMS) and are accessible through the NFMS[1] website or online map services[2]. The datasets of land cover maps from 2006, 2009, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, and 2019 were used to analyse historical land cover changes, and calculate emissions estimates. In order to ensure consistency with the definitions used, additional datasets from 1990, 1996, 2000 and 2003 land cover maps were also incorporated in the analysis.

[1] https://nfms.menlhk.go.id/

[2] https://geoportal.menlhk.go.id/server/rest/services/Time_Series

2.3.2 Emission Factors

For the RBP/C baseline calculation, the emission factors used are the same as those utilized in the first Indonesian FREL. These emission factors were derived primarily from data obtained through the National Forest Inventory (NFI), a national program initiated by the Ministry of Forestry in 1989. The NFI continuously updates and monitors national forest resources. To complement the NFI data and address any critical data gaps that were not available for analysis, research and published data collected from various Indonesian sites were used. Detailed emission factors used for deforestation and forest degradation can be found in Table 2 and Table 3, respectively.

Table 2. Deforestation Emission Factors

Forest Classes	Emission Factors for Deforestation ($tCO_2e.ha^{-1}$)						
	JAWA	KALIMANTAN	MALUKU	BALI -NUSA TENGGARA	PAPUA	SULAWESI	SUMATERA
Primary Dryland Forest	458.8	464.7	519.9	473.3	412.4	474.7	463.3
Secondary Dryland Forest	294.1	350.7	383.1	280.6	311.2	356.2	314.3
Primary Mangrove Forest	455.2	455.2	455.2	455.2	455.2	455.2	455.2
Secondary Mangrove Forest	347.9	347.9	347.9	347.9	347.9	347.9	347.9
Primary Swamp Forest	332.4	474.0	332.4	332.4	308.4	369.8	380.9
Secondary Swamp Forest	274.8	294.1	274.8	274.8	251.3	221.3	261.1

Note: In cases where specific data for the emission factors by individual islands is not available, the National Average is utilized instead.

Table 3. Forest Degradation Emission Factors

Forest Classes	Emission Factors for Forest Degradation ($tCO_2e.ha^{-1}$)						
	JAWA	KALIMANTAN	MALUKU	BALI -NUSA TENGGARA	PAPUA	SULAWESI	SUMATERA
Primary Dryland Forest	164.7	114.0	136.8	192.7	101.3	118.5	149.0
Primary Mangrove Forest	107.3	107.3	107.3	107.3	107.3	107.3	107.3
Primary Swamp Forest	57.6	179.9	57.6	57.6	57.1	148.5	119.7

Note: In cases where specific data for the emission factors by individual islands is not available, the National Average is utilized instead.

2.4 Methodology and Procedures

2.4.1 Forest Cover Change Analysis

The annual forest cover change analysis involved overlaying all of the land cover maps from 1990 to 2019. Based on the working definition provided, deforestation is identified as the transformation of natural forests into other land cover classes, and this change must have occurred only once at any given location during the entire period, which spans from 2006/2007 to 2018/2019.

Forest degradation refers to the transformation of primary forests into secondary forests in the subsequent year. The Land Cover (LC) dataset consists of a series of data points (T_1 to T_{1+n}). Degraded forest Is identified by comparing the LC of T_n (class of primary forests in the first period) to the LC of T_{n+1} (becoming class of secondary forests in the consecutive period). For a more in-depath understanding of the calculation process, please refer to Annex 1.

2.4.2 Reference Period

RBP/C baseline was determined using data from the reference period spanning from 2006/2007 to 2015/2016.

2.4.3 Baseline Calculation

The RBP/C baseline was calculated using the average annual emissions from deforestation and forest degradation during the period from 2006/2007 to 2015/2016. These historical emissions data served as the basis for establishing the RBP/C baseline.

2.5 Baseline Construction Results

2.5.1 Emission Estimates from Deforestation

The average annual emissions from deforestation during the period from 2006/2007 to 2015/2016 was 236.9 $MtCO_2e.yr^{-1}$ as shown in Figure 1.

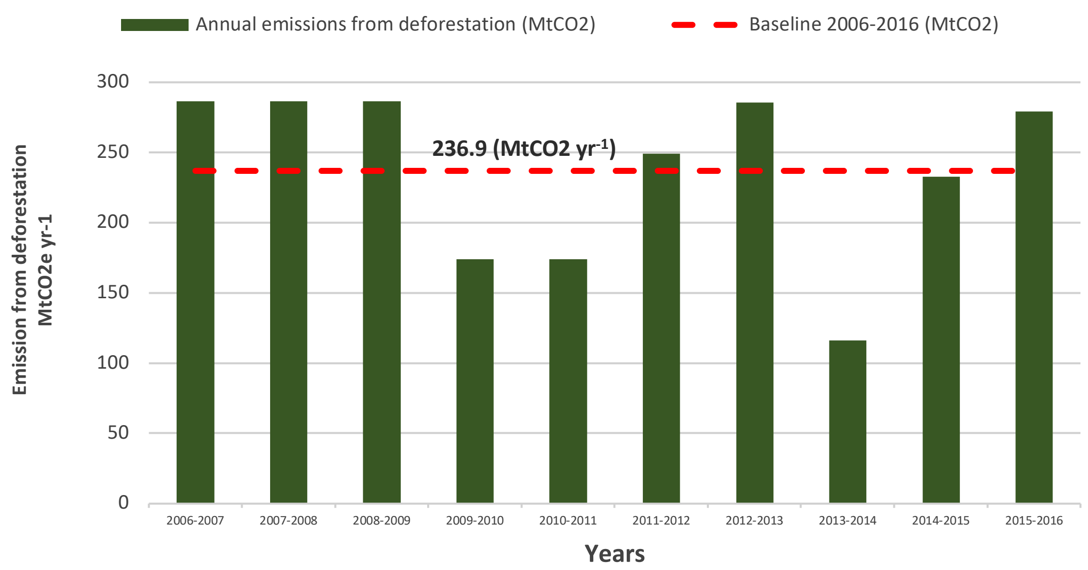

Figure 1. Average annual historical emissions from deforestation (millions tCO_2e).

2.5.2 Emission Estimates from Forest Degradation

The annual emission from forest degradation during the period from 2006/2007 to 2015/2016 was 41.0 $MtCO_2e.yr^{-1}$ (*see* Figure 2).

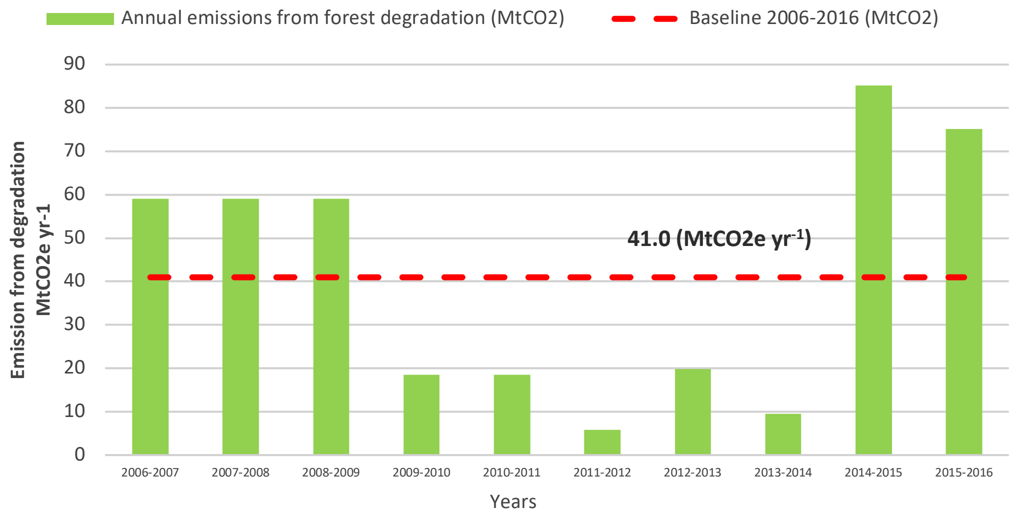

Figure 2. Average annual historical emissions from forest degradation (millions tCO_2e).

2.6 Constructed and Projected RBP/C Baseline

During the period from 2006/2007 to 2015/2016, the annual total emissions from deforestation and forest degradation amounted to 277.9 $MtCO_2e.yr^{-1}$ (*see* Figure 3).

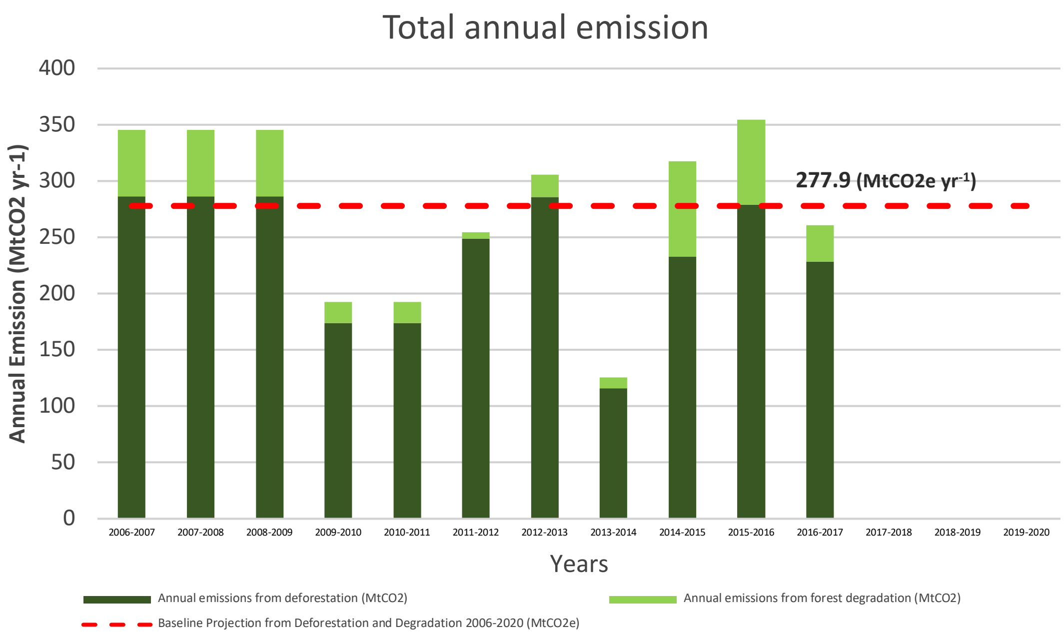

Figure 3. Average annual historical emissions from deforestation and forest degradation (million tCO_2e) from 2006/2007 to 2015/2016 and the projected emissions from 2016/2017 to 2019/2020.

Baseline emissions from deforestation and forest degradation were calculated using annual emissions data from the period of 2006/2007 to 2015/2016, as presented in Table 4. The total annual emissions during the baseline period varied between 116.1 million tCO_2e and 286.4 million tCO_2e. The average annual emission from deforestation and forest degradation, used for establishing the RBP/C baseline was 277.9 million tCO_2e.

Table 4. Historical (2006/2007 – 2015/2016) and projected (2016/2017 – 2019/2020) annual emissions from deforestation and forest degradation (tCO_2e), calculated using historical data of 2006/2007 – 2015/2016

Year	Deforestation	Forest Degradation	Total annual emission	
2006-2007	286,399,781	59,051,617	286,399,781	Historical
2007-2008	286,399,781	59,051,617	286,399,781	
2008-2009	286,399,781	59,051,617	286,399,781	
2009-2010	173,890,857	18,510,520	173,890,857	
2010-2011	173,890,857	18,510,520	173,890,857	
2011-2012	248,936,401	5,805,289	248,936,401	
2012-2013	285,586,539	19,833,885	285,586,539	
2013-2014	116,066,230	9,515,931	116,066,230	
2014-2015	232,677,053	85,190,736	232,677,053	
2015-2016	279,220,589	75,225,065	279,220,589	
2016-2017	236,946,787	40,974,680	277,921,466	Baseline
2017-2018	236,946,787	40,974,680	277,921,466	
2018-2019	236,946,787	40,974,680	277,921,466	
2019-2020	236,946,787	40,974,680	277,921,466	

3. Results

Emission reductions are calculated by deducting baseline emissions from actual annual emissions. Point 2.4.3 on the RBP/C Baseline mentions that the baselines for deforestation and forest degradation are 236,946,787 tCO_2e.yr^{-1} and 40,974,680 tCO_2e.yr^{1}, respectively.

Table 5 Emissions reductions from deforestation and forest degradation for periods of 2017/2018 and 2018/2019

Activity	2017/2018		2018/2019	
	Emission Reduction (tCO_2e)	Percentage from Baseline (%)	Emission Reduction (tCO2e)	Percentage from Baseline (%)
Deforetation	96,086,874	40.55	176,494,027	74.49
Forest Degradation	-19,827,946	-48.39	33,653,936	82.13
Total ER	76,258,928		210,147,963	
Total ER for 2 periods	**286,406,892 tCO_2e**			

Based on that baseline, the actual emissions from deforestation and forest degradation for the periods (2017/2018 and 2018/2019) are shown in Table 5. The emission reduction in 2017/2018 was 76.3 million tCO_2e, while in 2018/2019 was 210.1 million tCO_2e. **The total emission reductions for both periods ~~a~~mounted to 286.4 million tCO_2e.**

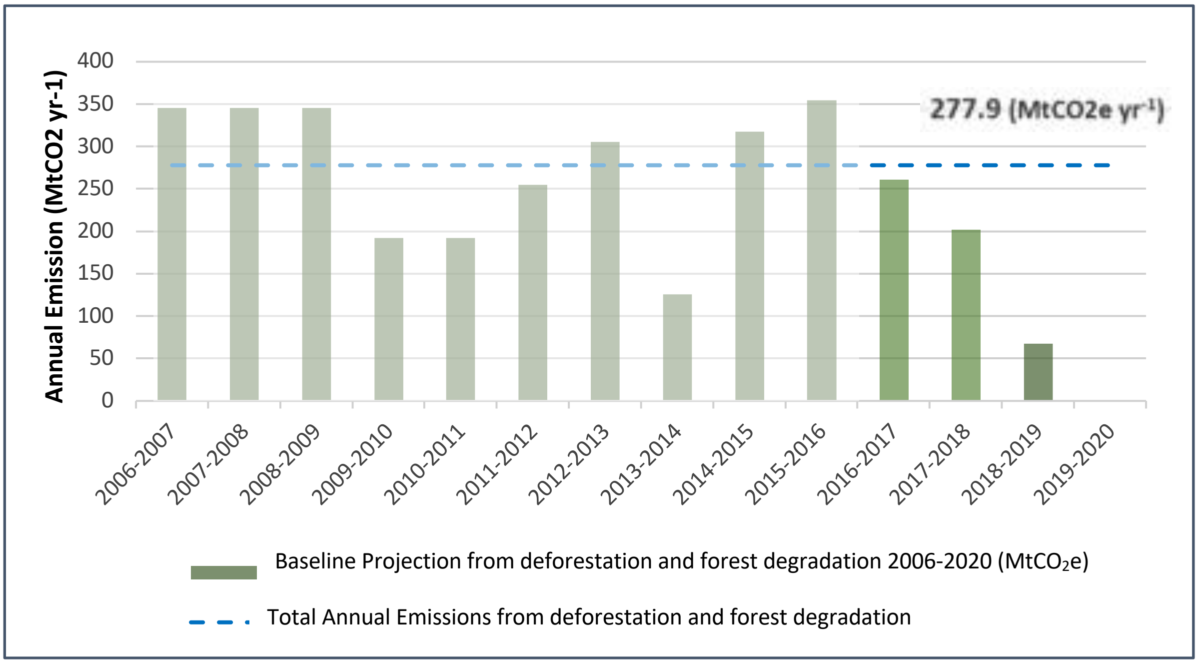

Figure 4. Annual emissions from deforestation and forest degradation. Pale colours depict historical emissions, while the green depicts emissions from 2017 to 2019.

4. National Forest Monitoring System (NFMS)

The NFMS has been established since 1989 by the Ministry of Forestry through the NFI project. This project was carried out over several years in collaboration with the Government of Indonesia (GOI) and the Food and Agriculture Organization (FAO).

The primary purpose of the NFMS is forest resources monitoring. During the NFI project, the system incorporated the use of satellite imagery, mainly from Landsat data, to create land cover maps. After the NFI project ended in 1997/1998, the responsibility for operational land cover mapping was transferred to the Forestry Planning Agency/Directorate General (DG) of Forestry Planning under the Ministry of Forestry.

The system evolved into the NFMS, which now produces land cover maps of Indonesia regularly. Initially, the land cover maps were generated every three years and later updated manually. These maps encompass 23 land cover classes, including categories for cloud cover and no-data. Figure 5 provides an example of Indonesia's land cover map. The NFMS is accessible online at https://sigap.menlhk.go.id/sigap/ for data display, viewing, and simple analysis.

Since the early 1990s, the main data sources for the NFMS in Indonesia have been the Landsat 5 Thematic Mapper (TM) and Landsat 7 Enhanced Thematic Mapper Plus (ETM+). However, using optical remotely sensed data, including Landsat, in tropical regions like Indonesia has its challenges due to clouds and haze.

Nevertheless, since 2008, the United States Geological Survey (USGS) changed its Landsat data policy, making Landsat data freely available over the internet. Although most of the data have been available online since around 2009, this policy shift has been beneficial for Indonesia, as it has increased the availability of data for the NFMS. Approximately 218 scenes of Landsat data are used to cover the entirety of Indonesia within selected year intervals for the NFMS.

At the end of 2014, the NFMS established an MoU with the National Space Agency (LAPAN) to ensure the data sustainability of the system. Under this agreement, LAPAN would provide mosaics of Landsat data covering Indonesia, primarily using Landsat 8 Operational Land Imager (OLI) and additional Landsat 7 Enhanced Thematic Mapper Plus (ETM+), on a regular basis. Initially, this data provision plan involved providing mosaics twice a year, starting from the year 2015 and onwards.

The 23 land cover classes in the NFMS were generated based on the physiognomy or appearance of bio-physical covers, which could be visually distinguished using Landsat remote sensing data at a 30-meter spatial resolution. The classification process primarily focused on the visual appearance of the land cover, rather than the probable land uses or covers. During the process of delineation several ancillary datasets were utilized as references to gather as much valuable information as possible for subsequent classification.

The visual classification process involved digitizing and interpreting key elements of the image on the screen. Using standard GIS software, features with distinctive existing appearances were carefully captured and manually delineated on the screen to create closed polygons and then assigned to designated land cover classes.

For the classification process, it is recommended to use a maximum scale of 1:100,000 when utilizing only multispectral bands (e.g., band 5-4-3) and 1:50,000 when using panchromatic bands for data registration. The minimum polygon unit size is 6.25 hectares, which is equivalent to 2.5 cm x 2.5 cm at the maximum zoom screen of a scale of 1:50,000, or 25 hectares at a scale of 1:100,000. At present, the national land cover map of Indonesia is provided at a minimum scale of 1:250,000.

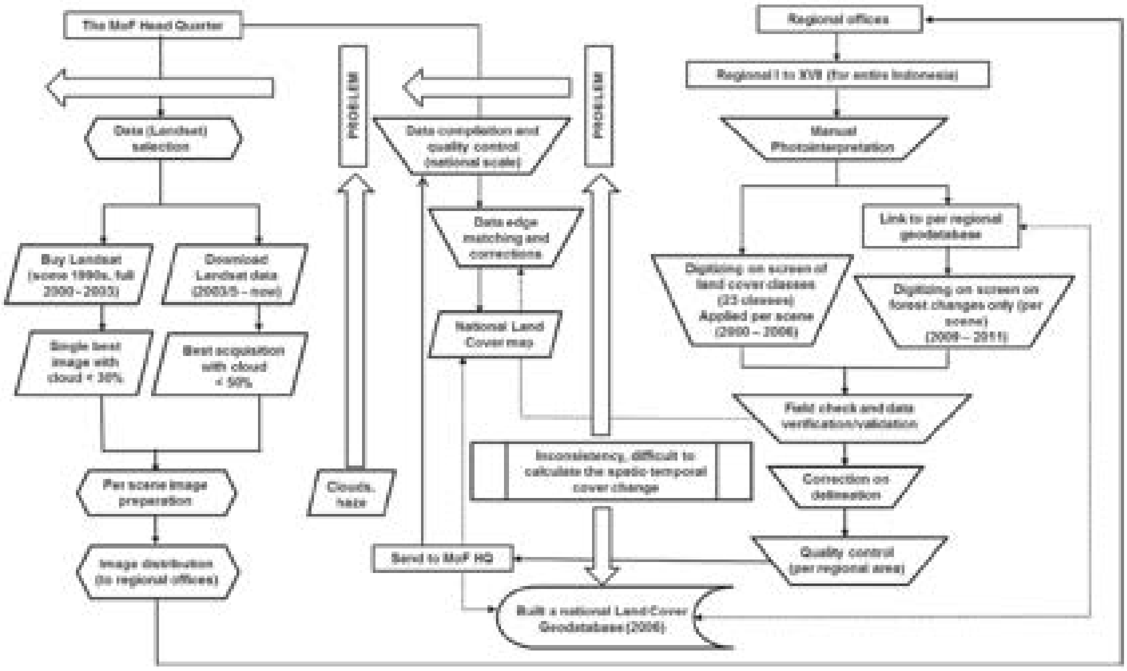

Figure 5. General Indonesian Land Cover map workflow

Quality control and quality assurance (QC/QA) for the land-cover data in the NFMS were carried out using ground-truth points distributed throughout Indonesia. Additionally, assessments of uncertainty in land cover changes utilized reference data based on a set of 10,000 of 30x30m grids corresponding to time series of Landsat satellite image pixels from 1990 to 2019. This validation approach has been implemented since 2018, as shown in Figure 6.

The selection of reference points throughout the country is done using a simple random sampling technique. Furthermore, the establishment of reference points is also correlated with other data sources, such as SPOT 6 and 7 satellite imagery from 2013 to 2016, minimum and maximum values of NDVI (Normalized Difference Vegetation Index), and very high-resolution satellite images from Google Earth.

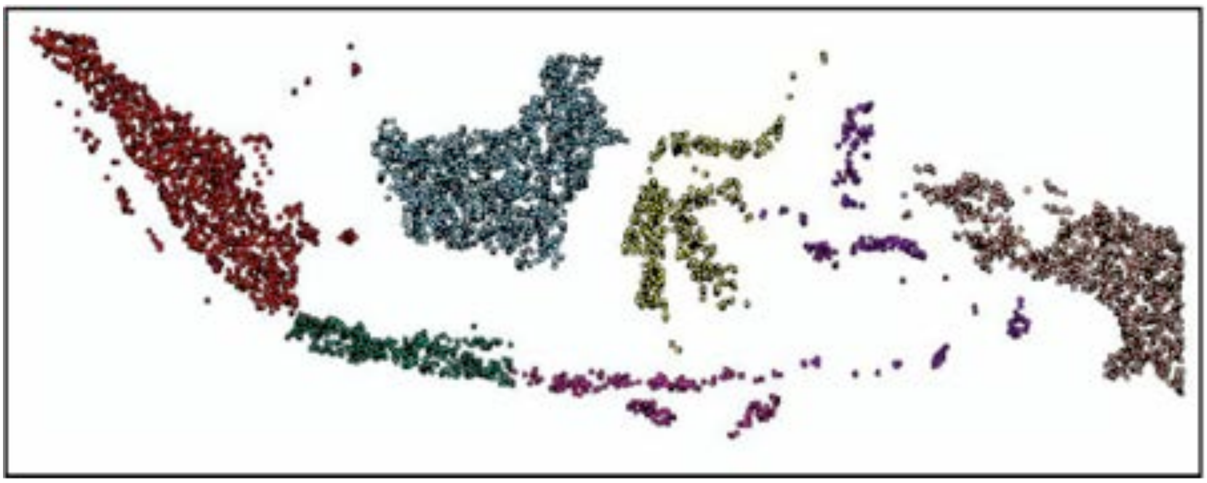

Figure 6. Random sample points were distributed across Indonesia for accurate assessment

A contingency table was developed to assess the error matrix by comparing the agreement and disagreement between interpretation results and the reference points. User accuracy and producer accuracy were calculated based on the matrix. From here, overall accuracy was subsequently calculated.

The NFMS portal is designed to integrate internet ability and forest resource information systems in a reciprocal manner to share information. The main objective is to promote good forest governance through transparency. The system ensures that uploaded information is kept up-to-date in real or near-real time, and it is maintained with completeness and correctness. Moreover, the NFMS encourages public participation by providing a facility for the public to access and benefit from the shared information.

5. Ensuring Methodologies Align with the RBP/C Baseline

The calculation methodology aligned with the development of RBP/C Baseline, ensuring consistency in the methodologies generating activity data, emission factors, assumptions, definitions, and procedures for estimating CO2e emissions from deforestation and forest degradation. The detailed components were as follows:

- REDD+ activities were considered, focusing on the most significant emissions from deforestation and forest degradation, in line with the RBP/C baseline development.
- Activity data was derived from the annual land cover map produced by the NFMS, in line with decision 4/CP 15. This map was generated using the same method as in the RBP/C Baseline.
- Emission factors were sourced from the data used in the RBP/C baseline and the first Indonesian FREL.
- The carbon pool presented is above-ground biomass, maintaining the consistency with the carbon pool used in the RBP/C Baseline.

6. Necessary Information that Allows for the Reconstruction of the Results

Data needed for the reconstruction of the RBP/C baseline and the REDD+ results were derived from the following sites:

1. Data on forest cover, deforestation and forest degradation derived from land cover maps (using Landsat imageries) through NFMS for the years 1990, 1996, 2000, 2003, 2006, 2009, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, and 2019. These are available online[3]
2. Other related information can also be accessed online at https://sigap.menlhk.go.id/sigap/.
3. Complete information (spatial data and tables) for the provision of data that allows for the reconstruction of the RBP/C baseline and results of the REDD+ can be accessed by request. *(See Annex 1 for detailed information related to the reconstruction of the RBP/C baseline and REDD+ results.)*

[3] https://geoportal.menlhk.go.id/server/rest/services/Time_Series or https://nfms.menlhk.go.id/

7. Uncertainty and Plans of Improvement

7.1. Uncertainty Analysis

Uncertainty (*U*) was determined in accordance with the IPCC 2006 Guidelines, specifically outlined in volume 1, Chapter 3. To calculate the combined uncertainty (Uj) for activity j, which takes into account the uncertainties from Activity Data (EA) and the emission factor (EE), Equation 1 is used:

$$Uij = \sqrt{EAj^2 + EEj^2} \quad \text{(Equation 1)}$$

Uncertainties related to deforestation and forest degradation activity data were obtained from the overall accuracy assessment of the land cover map.

The proportion of accuracy contribution (C_j) for activity j was calculated using Equation 2, which involves the uncertainty (Uj) associated with activity j, the total emissions that occurred in the corresponding activities (Ej), and the total emissions from the corresponding year (E):

$$C_j = (E_j * U_j)^2 / E \quad \text{(Equation 2)}$$

The total uncertainty of each year (*TU*) was obtained by taking the square root of the sum of the proportion of accuracy contribution (Cj) for all activities using Equation 3:

$$TU = \sqrt{\sum C_j} \quad \text{(Equation 3)}$$

The uncertainties of emission factor used in estimating carbon emissions were generated based on the standard error of carbon stock values from different forest types or classes in each major island or group of islands in Indonesia. The carbon stock values were estimated from NFI plots that have been established in seven major islands/groups of islands in the country.

Table 6. Calculation of Uncertainty for Emissions from Deforestation and Forest Degradation

Component		Unit	Year												
			2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Activity	Deforestation	MtCO2	286,40	286,40	286,40	173,89	173,89	248,94	285,59	116,07	232,68	279,22	228,35	140,86	60,45
	Forest Degradation	MtCO2	59,05	59,05	59,05	18,51	18,51	5,81	19,83	9,52	85,19	75,23	32,29	60,80	7,32
	Total emissions	MtCO2	345,45	345,45	345,45	192,40	192,40	254,74	305,42	125,58	317,87	354,45	260,64	201,66	67,77
Deforestation	AD uncertainty	%	12	12	11	11	11	11	10	10	10	10	10	10	10
	EF uncertainty	%	18	18	18	18	18	18	18	18	18	18	18	18	18
	Combined uncertainty	%	21,61	21,61	21,11	21,11	20,96	20,85	20,77	20,71	20,65	20,54	20,54	20,54	20,54
	Contribution to Variance by Category in Year Base Year	%	320,95	320,95	306,36	364,08	358,90	415,29	377,11	366,48	228,46	261,85	323,87	205,87	335,72
	Percentage uncertainty in total inventory	%	17,9	17,9	17,5	19,1	18,9	20,4	19,4	19,1	15,1	16,2	18,0	14,3	18,3
Forest Degradation	AD uncertainty	%	12	12	11	11	11	11	10	10	10	10	10	10	10
	EF uncertainty	%	25	25	25	25	25	25	25	25	25	25	25	25	25
	Combined uncertainty	%	27,92	27,92	27,72	27,72	27,61	27,53	27,46	27,42	27,37	27,29	27,29	27,29	27,29
	Contribution to Variance by Category in Year Base Year	%	22,79	22,79	22,46	7,11	7,06	0,39	3,18	4,32	53,82	33,55	11,44	67,72	8,69
	Percentage uncertainty in total inventory	%	4,8	4,8	4,7	2,7	2,7	0,6	1,8	2,1	7,3	5,8	3,4	8,2	2,9
Uncertainty	Percentage uncertainty in total inventory	**%**	**18,5**	**18,5**	**18,1**	**19,3**	**19,1**	**20,4**	**19,5**	**19,3**	**16,8**	**17,2**	**18,3**	**16,5**	**18,6**
	Uncertainty	MtCO2	64,05	64,05	62,64	37,07	36,81	51,94	59,56	24,18	53,41	60,92	47,73	33,36	12,58

The uncertainty for the parameter "activity data" (land cover) is approximately 10%-12% and is derived from the overall accuracy of forest and land cover mapping. On the other hand, the uncertainty for the parameter "emission factor" varies between 18% to 25% depending on the specific island/group of islands and land cover classes considered. The uncertainty of emission factors related to deforestation and forest degradation is determined from the sampling errors of the NFI from each forest cover class within each island/group of islands (Annex 4). Table 6, meanwhile, shows detailed results of uncertainty analysis for each assessment period.

Over the period from 2006 to 2017, the uncertainties in the emissions estimation showed improvement, declining from 18.5% in 2006 to 16.5% in 2017-2018. This improvement can be attributed to enhancements in the accuracy of activity data used in the estimation process. The uncertainties stemming from the activity data are often a result of potential misinterpretation of satellite imageries by the operators responsible for delineating the forest and land cover maps. However, efforts have been made to minimize these errors through various measures, including regular training and coordination, as well as the implementation of a robust Quality Assurance/Quality Control (QA/QC) process encompassing specific Standard Operating Procedures (SOPs) for data collection, processing, and mapping standardization.

The uncertainties from the emission factors remained constant over time because all available NFI plot data from 1990 to 2014 were used for estimating carbon stocks for all periods. The uncertainty from emission factors was generated from the sampling errors of the NFI data. It's important to note that the uncertainty analysis for the emission factors did not incorporate the errors associated with the allometric equation used for converting NFI measurement data into carbon stock values.

7.2. Plans of Improvement

The Indonesian national MRV system has significantly strengthened over the years. This progress is particularly evident as demonstrated in the Technical Assessment and Technical Analysis conducted by the UNFCCC for Indonesia's BUR (Biennial Update Report) 3 document (Nov 2022) which it duly verified and validated. To enhance all the activity data required for this report, remote sensing technology was utilized continuously to generate coverage for the total mainland area. Additionally, the emission factors for these activities are continuously updated through the compilation of existing research and by encouraging further research to anticipate any potential gaps.

Ongoing enhancement and improvement of the MRV system is crucial to prevent double counting and double reporting of emission reductions. To achieve this, the national registry system was developed and currently operates as one of Indonesia's main instruments to ensure good carbon governance. Furthermore, a web-based emission calculation monitoring system is currently under construction, with the objective of allowing robust, comprehensive, and consistent monitoring of emission reductions at all levels. In the meantime, an integrated information system is critical for preventing repetitive/redundant data entry and facilitating easy tracking of each actor's contributions to the country's climate action efforts.

Significant progress has also been achieved in establishing a legal framework for carbon-related activities and schemes in Indonesia. In this regard, the Government of Indonesia took a major step by issuing Presidential Regulation No. 98/2021 on the Arrangement of Carbon Economic Value. To support this regulation, the following implementing regulations have been enacted:

(i) Minister of Environment and Forestry Regulation No. 168/2022 on FOLU (Forestry and Other Land Use) Net Sink 2030.
(ii) Minister of Environment and Forestry Regulation No. 21/2022 on the Implementation of Carbon Economic Value.
(iii) Minister of Environment and Forestry Regulation No. 7/2023 on the Procedures for Carbon Trading in the Forestry Sector.

These ministerial regulations provide specific procedures and guidelines for carrying out carbon-related initiatives and policies. They focus on strengthening carbon governance and prioritizing the fulfilment of Indonesia's NDC targets. In particular, these regulations serve as the legal bases for ensuring that Indonesia will reach its FOLU Net Sink 2030 targets, which will contribute up to 60% of reductions in greenhouse gas emissions. Emissions reductions from deforestation and forest degradation are a major part of the FOLU Net Sink 2030 targets and will make a substantial contribution to overall emission reductions.

To this end, ongoing plans for improvement are in place to enhance the tools, methods, and infrastructure needed to ensure that **Indonesia's FOLU Net Sink 2030 climate goals** remain on track. This is crucial considering **its role as the primary contributor to achieving Indonesia's NDC targets**.

8. Potential Results-Based Payment/Contribution

The Results-Based payment/contribution baseline for this report was established using the annual historical average level of each of the two performance indicators: emissions from deforestation and forest degradation. The baseline was developed based on data from the reference period covering the years 2006/2007 to 2015/2016, and remains valid up to the year 2019/2020.

Based on the existing MRV Protocol of the Indonesia-Norway Partnership, both parties have reached an agreement on how to handle various risk factors related to Indonesia's emission reduction ambitions. These risk factors include statistical uncertainty and reversal risk, among other possible risk-related considerations.

To account for these risk factors and ensure a fair and transparent mechanism, a deduction of a set-aside amount is made from the initially verified amount of emission reductions achieved by Indonesia. This set-aside amount is an allocated portion of the verified emission reduction that is withheld or reserved to address the uncertainty and potential risks associated with the emission reduction measures.

As reported in Chapter 3. the total emissions reduced from deforestation and forest degradation in the periods of 2017/2018 and 2018/2019 amounted to **286,406,892 tCO_2e**. This total reduction was comprised of 76,258,928 tCO2e for the 2017/2018 period and 210,147,963 tCO2e for the 2018/2019 period.

Considering Norway's prior results-based contribution in 2016/2017, it is essential to highlight that if its contributions for the 2017/2018 and 2018/2019 periods are proportionally comparable, they would be less than 10% of the total emissions reductions accomplished by the Government of Indonesia. While Norway's contributions are significant and valued within the context of the partnership, they are still perceived as underwhelming in view of the comprehensive scale of Indonesia's own emissions reduction endeavor.

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Annex 1. Calculation of Emissions from Deforestation and Forest Degradation

Emission from deforestation and forest degradation was calculated using the following equation:

$$GE_{ij} = A_{ij} \times EF_j \quad (1)$$

Where:
GE_{ij} = CO_2 emissions from deforested or degraded forest area-*i* at forest change class-*j*, in tonnes of CO_2e (tCO_2e);
A_{ij} = deforested or degraded forest areas-*I* in forest change class-*j*, in hectares (ha);
EF_j = Emission Factor from the loss of carbon stock due to change of forest class-*j*, owing to deforestation or forest degradation, in tonnes carbon per ha (tC ha^{-1});
For emission factors from deforestation and forest degradation, see Table Annex 1.1 and Table Annex 1.2 respectively.

Emission from deforestation and forest degradation at period *t* (GE_t) was estimated using the following equation:

$$GE_t = \sum_{i=1}^{N} \sum_{j=1}^{P} GE_{ij} \quad (2)$$

Where:
GE_{ij} = emission from deforested or degraded forest area-*i* in forest class *j* expressed in tCO_2e
N = the number of deforested or degraded forest area units at period *t* (from t_0 to t_1), expressed without a unit.
P = the number of forest classes, which meet the natural forest criterion.

Table Annex 1.1. Deforestation Emission Factors

Forest Classes	Emission Factors of Deforestation (tCO_2e)						
	JAWA	KALIMANTAN	MALUKU	BALI -NUSA TENGGARA	PAPUA	SULAWESI	SUMATERA
Primary Dryland Forest	458.8	464.7	519.9	473.3	412.4	474.7	463.3
Secondary Dryland Forest	294.1	350.7	383.1	280.6	311.2	356.2	314.3
Primary Mangrove Forest	455.2	455.2	455.2	455.2	455.2	455.2	455.2
Secondary Mangrove Forest	348.0	348.0	348.0	348.0	348.0	348.0	348.0
Primary Swamp Forest	332.5	474.0	332.5	332.5	308.4	369.8	380.9
Secondary Swamp Forest	274.8	294.1	274.8	274.8	251.3	221.3	261.1

*) In cases where specific data for the emission factors by individual islands is not available, the National Average is utilized instead.

Table Annex 1.2. Forest Degradation Emission Factors

Forest Classes	Emission Factors of Forest Degradation (tCO_2e)						
	JAWA	KALIMANTAN	MALUKU	BALI -NUSA TENGGARA	PAPUA	SULAWESI	SUMATERA
Primary Dryland Forest	164.7	114.0	136.8	192.7	101.3	118.5	149.0
Primary Mangrove Forest	107.3	107.3	107.3	107.3	107.3	107.3	107.3
Primay Swamp Forest	57.6	179.9	57.6	57.6	57.1	148.5	119.7

*) In cases where specific data for the emission factors by individual islands is not available, the National Average is utilized instead.

The estimation of emissions from deforestation and forest degradation, specifically from the loss of above-ground biomass, over a two-year period relies on the use of a land use transition matrix (LUTM). The LUTM is derived from a spatial analysis of a series of land cover maps, typically covering two consecutive years (e.g. 2012 - 2013). An example of the LUTM transition matrix for the period 2012 - 2013 is provided in Table Annex 1.4.

This matrix illustrates the changes between land cover classes from one year to the next, indicating how much land has changed from one class to another over the specified period. To calculate the emissions from the change of forest class-j to non-forest classes, Equation (1) is used. Similarly, the emissions from deforestation from primary dryland forest (class code 2001 (GE_{2001}) in tCO_2e can be calculated using Equation (3). The detailed class codes for the land cover data are provided in Table Annex 1.3.

$$GE_{2001} = AD * EF \quad (3)$$

Where:

AD = the change of primary dryland forests (code 2001) to non-forests in the period in hectares; and

EF = the emission factor for deforestation of the corresponding class in tCO_2e ha (see Table Annex 1.4 and 1.5 present examples of the emission matrix from deforestation of all forest classes in 2012-2013).

Table Annex 1.3. Land Cover Classes used in the Forest Reference Emission Level (FREL)

No	Land cover classes	Class Code	Abbreviation
1.	Primary dryland forest	2001	PF
2.	Secondary dryland forest	2002	SF
3.	Primary mangrove forest	2004	PMF
4.	Secondary mangrove forest	20041	SMF
5.	Primary swamp forest	2005	PSF
6.	Secondary swamp forest	20051	SSF
7.	Plantation forest	2006	TP
8.	Estate crop	2010	EP
9.	Pure dry agriculture	2009	AUA
10.	Mixed dry agriculture	20091	MxUA
11.	Dry shrub	2007	Sr
12.	Wet shrub	20071	SSr
13.	Savanna and Grasses	3000	Sv
14.	Paddy Field	20093	Rc
15.	Open swamp	50011	Sw
16.	Fish pond/aquaculture	20094	Po
17.	Transmigration areas	20122	Tr
18.	Settlement areas	2012	Se
19.	Port and harbor	20121	Ai
20.	Mining areas	20141	Mn
21.	Bare ground	2014	Br
22.	Open water	5001	WB
23.	Clouds and no-data	2500	Ot

Emissions from the deforestation of other forest classes use similar equations with corresponding emission factors. Therefore, the total emission from deforestation of all different forest classes are estimated using Equation (4):

$$GE_t = GE_{2001}+GE_{2002}+ GE_{2004}+GE_{2005}+ GE_{20041}+GE_{20051} \quad (4)$$

Table Annex 1.4. Example of Land Use Transition Matrix of Deforestation in the Period of 2017-2018 (hectares).

	LC Classes	**LC 2017 (ha) Region Kalimantan**						
		2001	2002	2004	2005	20041	20051	**Total**
Region Kalimantan LC 2018 (ha)	2006						35	**35**
	2007	1,392	19,463			122	529	**21,505**
	2010		10,083		68	403	25,538	**36,091**
	2012	2	168	3		144	77	**393**
	2014	346	22,364		20	664	8,094	**31,488**
	5001	0	131	3		76	341	**551**
	20071		82	11		1,777	10,642	**12,512**
	20091	18	445			863	284	**1,610**
	20092	831	11,531			157	948	**13,467**
	20093		9			176	843	**1,028**
	20094		85	140	52	9,175	188	**9,640**
	20141		3,726	17		214	1,357	**5,314**
	50011	4	1			1	39	**44**
	Total	**2,593**	**68,087**	**174**	**140**	**13,771**	**48,913**	**133,679**

Table Annex 1.5. Example of CO_2 Emission Matrix from Deforestation due to the Loss of Above-Ground Biomass (AGB) in the Period 2017-2018 (tCO_2e)

	LC CLasses	**LC 2017 (tCO2e) Region Kalimantan**						
		2001	2002	2004	2005	20041	20051	**Total**
Region Kalimantan LC 2018 (tCO2e)	2006						10,309	**10,309**
	2007	646,878	6,825,094			42,290	155,535	**7,669,798**
	2010		3,535,656		32,295	140,057	7,510,547	**11,218,555**
	2012	851	58,801	1,373		50,187	22,541	**133,753**
	2014	160,820	7,842,326		9,308	231,112	2,380,351	**10,623,918**
	5001	164	45,808	1,508		26,521	100,225	**174,226**
	20071		28,846	5,031		618,240	3,129,653	**3,781,770**
	20091	8,462	156,099			300,133	83,558	**548,250**
	20092	386,012	4,043,762			54,732	278,760	**4,763,266**
	20093		3,254			61,201	247,813	**312,268**
	20094		29,703	63,622	24,858	3,192,250	55,248	**3,365,681**
	20141		1,306,577	7,749		74,292	399,146	**1,787,764**
	50011	1,835	250			213	11,328	**13,625**
	Total	**1,205,022**	**23,876,178**	**79,283**	**66,462**	**4,791,228**	**14,385,012**	**44,403,184**

For calculation purposes, the LUTM presented in Table Annex 1.3 is summarized by islands, land cover classes, and year periods. For detailed information on the calculation of emissions from deforestation and forest degradation, refer to the respective tables in Annex 1.6 and Annex 1.9.

Table Annex 1.6. Activity Data for Deforestation

Island/Soil/ Land Cover	Deforestation (ha)									
	2006-2009	2009-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
SUMATERA	**1,420,549**	**502,062**	**367,706**	**307,579**	**151,461**	**210,212**	**213,258**	**152,982**	**71,496**	**56,204**
PEAT	**433,076**	**204,652**	**108,510**	**82,362**	**65,608**	**90,962**	**32,841**	**28,392**	**10,935**	**6,446**
Primary Dryland Forest							613	24		
Secondary Dryland Forest	14,920	2,708	3,691	512	314	986		228	366	37
Primary Mangrove Forest	0					10	15	1	2	
Secondary Mangrove Forest	751	1,087	547	50	38	421	654	262	1,118	522
Primary Swamp Forest	37,901	10,757	5,678	5,163	1,110	9,949	10,712	703	1,830	56
Secondary Swamp Forest	379,503	190,100	98,595	76,637	64,146	79,596	20,846	27,174	7,620	5,832
MINERAL	**987,473**	**297,410**	**259,195**	**225,217**	**85,854**	**119,250**	**180,417**	**124,591**	**60,561**	**49,758**
Primary Dryland Forest	8,063	7,871	7,300	7,479	8,628	2,429	22,229	14,231	6,446	6,505
Secondary Dryland Forest	752,153	181,813	202,431	188,383	57,801	83,576	128,923	91,871	48,542	31,887
Primary Mangrove Forest	1,043	110	715	145	4	1,400	1,316	901	547	205
Secondary Mangrove Forest	24,441	2,906	5,485	1,894	1,508	4,865	11,195	6,893	2,584	8,281
Primary Swamp Forest	5,001	236	134	492	23	1,044	3,983	155	74	2
Secondary Swamp Forest	196,772	104,473	43,130	26,823	17,889	25,935	12,771	10,539	2,369	2,878
KALIMANTAN	**1,021,058**	**458,046**	**292,796**	**494,080**	**154,089**	**348,008**	**423,404**	**315,302**	**133,679**	**70,974**
PEAT	**234,606**	**99,684**	**52,164**	**127,764**	**23,146**	**172,957**	**90,678**	**24,439**	**27,437**	**6,979**
Primary Dryland Forest					16		367			
Secondary Dryland Forest	5,580	1,407	2,054	3,973	184	322		415	248	50
Primary Mangrove Forest		213					0			
Secondary Mangrove Forest	341	19	66	159	20	106	19	210	24	7
Primary Swamp Forest	3,837	2,058	339	4,556	503	3,446	9	333	74	14
Secondary Swamp Forest	224,847	95,987	49,704	119,076	22,423	169,082	90,282	23,480	27,092	6,907
MINERAL	**786,452**	**358,362**	**240,632**	**366,317**	**130,944**	**175,051**	**332,726**	**290,863**	**106,241**	**63,995**
Primary Dryland Forest	2,968	362	6,968	11,088	1,967	1,870	5,504	1,632	2,593	1,828
Secondary Dryland Forest	584,102	273,274	194,914	262,861	106,896	113,193	241,082	256,555	67,839	53,736
Primary Mangrove Forest	493	133	164	593	10	116	452	244	174	212
Secondary Mangrove Forest	22,061	3,608	8,768	5,791	3,828	5,674	11,547	7,608	13,747	1,666
Primary Swamp Forest	3,237	7	600	122	28	516	577	170	66	
Secondary Swamp Forest	173,591	80,977	29,219	85,863	18,214	53,682	73,563	24,654	21,821	6,554
PAPUA	**115,232**	**31,876**	**43,003**	**23,880**	**22,309**	**81,321**	**17,323**	**51,129**	**87,037**	**18,472**
PEAT	**11,987**	**1,729**	**1,039**	**590**	**1,556**	**4,201**	**1,459**	**2,240**	**3,097**	**561**
Primary Dryland Forest	48	229	590		75	254	98	364	286	200
Secondary Dryland Forest	1,848	1,359	298	304	473	1,490	740	1,006	980	37
Primary Mangrove Forest	52		37	22		18	0	42	52	
Secondary Mangrove Forest	212	10	49			0	0	40	4	1
Primary Swamp Forest	4,911	105	66	264	642	1,309	271	788	716	31
Secondary Swamp Forest	4,916	25			366	1,130	350		1,060	292
MINERAL	**103,246**	**30,147**	**41,964**	**23,290**	**20,753**	**77,121**	**15,863**	**48,889**	**83,940**	**17,911**
Primary Dryland Forest	17,442	14,118	9,116	3,892	5,654	19,268	4,820	14,659	30,157	7,672
Secondary Dryland Forest	69,499	9,952	22,597	16,312	11,243	34,274	9,438	32,327	34,973	6,627
Primary Mangrove Forest	49	88	173		599	1,276	0	134	2,049	131
Secondary Mangrove Forest	372	339	238	106	31	165	0	201	544	155
Primary Swamp Forest	8,403	4,974	1,532	1,931	1,129	4,859	1,422	1,513	6,804	695
Secondary Swamp Forest	7,481	677	8,308	1,049	2,097	17,279	183	56	9,413	2,631
SULAWESI	**140,533**	**74,658**	**19,448**	**46,192**	**16,950**	**56,839**	**91,981**	**77,842**	**69,013**	**14,709**
MINERAL	**140,533**	**74,658**	**19,448**	**46,192**	**16,950**	**56,839**	**91,981**	**77,842**	**69,013**	**14,709**
Primary Dryland Forest	4,327	18,996	1,892	6,782	1,729	6,727	17,285	6,417	6,166	4,247
Secondary Dryland Forest	121,052	54,885	17,268	38,410	14,080	47,488	68,042	65,222	49,010	9,927
Primary Mangrove Forest	193	116		60	200	60	619	270	1,102	65
Secondary Mangrove Forest	3,722	556	223	860	708	2,221	5,131	4,247	10,520	382
Primary Swamp Forest						91		3	35	
Secondary Swamp Forest	11,239	105	65	80	233	251	904	1,683	2,180	88
JAWA	**13,244**	**6,100**	**1,294**	**4,349**	**12,976**	**4,495**	**5,015**	**29,863**	**6,497**	**1,925**
MINERAL	**13,244**	**6,100**	**1,294**	**4,349**	**12,976**	**4,495**	**5,015**	**29,863**	**6,497**	**1,925**
Primary Dryland Forest	84	150				81		7	1,457	89
Secondary Dryland Forest	6,377	5,943	1,294	3,068	12,950	4,414	5,008	29,812	3,748	1,804
Primary Mangrove Forest							8		15	22
Secondary Mangrove Forest	6,783	7		1,280	26		0	43	1,263	11
Primary Swamp Forest										
Secondary Swamp Forest									14	
BALI NUSA	**4,877**	**3,612**	**55,092**	**906**	**1,308**	**18,630**	**30,394**	**9,332**	**27,452**	**11,482**
MINERAL	**4,877**	**3,612**	**55,092**	**906**	**1,308**	**18,630**	**30,394**	**9,332**	**27,452**	**11,482**
Primary Dryland Forest	190	146	1,409		12	729	3,437	623	12,012	1,421
Secondary Dryland Forest	4,687	3,194	52,111	864	1,288	17,512	24,493	8,664	10,501	9,882
Primary Mangrove Forest		157	1,569			302	779	10	1,866	45
Secondary Mangrove Forest		115	3	42	9	87	1,684	34	2,767	135
Primary Swamp Forest										
Secondary Swamp Forest									306	
MALUKU	**25,965**	**24,687**	**6,713**	**7,001**	**3,962**	**16,780**	**44,391**	**37,388**	**14,593**	**3,584**
MINERAL	**25,965**	**24,687**	**6,713**	**7,001**	**3,962**	**16,780**	**44,391**	**37,388**	**14,593**	**3,584**
Primary Dryland Forest	309	1,732	10	10	0	599	4,476	1,033	100	34
Secondary Dryland Forest	25,371	21,911	6,590	6,607	3,864	15,903	36,478	33,612	14,249	3,486
Primary Mangrove Forest	188	1	112	60	75	11	782	650	39	5
Secondary Mangrove Forest	48	22		324	22	225	2,522	1,449	171	38
Primary Swamp Forest						41	63	23		
Secondary Swamp Forest	50	1,021					70	622	34	21
Grand Total	**2,741,459**	**1,101,040**	**786,052**	**883,986**	**363,056**	**736,285**	**825,766**	**673,838**	**409,767**	**177,350**
Annual Rate	**913,820**	**550,520**	**786,052**	**883,986**	**363,056**	**736,285**	**825,766**	**673,838**	**409,767**	**177,350**

Table Annex 1.7. Emissions from Deforestation

Island/Soil/ Land Cover	Emission from deforestation (CO2e)									
	2006-2009	2009-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
SUMATERA	**420,882,182**	**144,191,518**	**109,810,531**	**92,745,264**	**44,656,358**	**61,928,920**	**70,204,885**	**48,624,595**	**23,228,223**	**18,499,222**
PEAT	**118,492,743**	**54,970,845**	**29,260,718**	**22,158,417**	**17,286,313**	**25,036,717**	**10,042,386**	**7,538,496**	**3,191,540**	**1,737,266**
Primary Dryland Forest	-	-	-	-	-	-	284,071	11,246	-	-
Secondary Dryland Forest	4,689,089	851,204	1,159,915	160,932	98,741	309,837	-	71,661	115,057	11,592
Primary Mangrove Forest	39	-	-	-	-	4,745	7,015	357	736	-
Secondary Mangrove Forest	261,406	378,024	190,143	17,394	13,235	146,370	227,532	91,083	389,110	181,462
Primary Swamp Forest	14,434,966	4,097,021	2,162,697	1,966,415	422,655	3,789,269	4,079,744	267,610	696,783	21,298
Secondary Swamp Forest	99,107,243	49,644,596	25,747,962	20,013,676	16,751,682	20,786,496	5,444,024	7,096,538	1,989,854	1,522,914
MINERAL	**302,389,438**	**89,220,674**	**80,549,813**	**70,586,846**	**27,370,045**	**36,892,202**	**60,162,499**	**41,086,099**	**20,036,682**	**16,761,957**
Primary Dryland Forest	3,735,588	3,646,567	3,382,225	3,465,079	3,997,422	1,125,595	10,298,983	6,593,370	2,986,715	3,013,871
Secondary Dryland Forest	236,384,152	57,139,657	63,619,388	59,204,427	18,165,666	26,265,891	40,517,552	28,873,039	15,255,547	10,021,214
Primary Mangrove Forest	474,688	50,142	325,256	66,047	1,841	637,500	598,946	410,252	249,026	93,249
Secondary Mangrove Forest	8,503,364	1,011,110	1,908,429	659,099	524,605	1,692,583	3,894,736	2,398,092	898,850	2,881,226
Primary Swamp Forest	1,904,686	90,033	51,183	187,292	8,709	397,743	1,517,033	59,002	28,000	853
Secondary Swamp Forest	51,386,961	27,283,165	11,263,332	7,004,902	4,671,802	6,772,889	3,335,249	2,752,345	618,545	751,544
KALIMANTAN	**336,714,580**	**150,933,959**	**99,113,242**	**163,552,163**	**52,017,855**	**110,131,295**	**139,963,547**	**108,096,256**	**44,403,184**	**24,354,821**
PEAT	**70,020,849**	**29,801,783**	**15,521,872**	**38,627,658**	**6,911,762**	**51,509,668**	**26,733,427**	**7,281,983**	**8,097,781**	**2,058,359**
Primary Dryland Forest	-	-	-	-	7,352	-	170,762	-	-	-
Secondary Dryland Forest	1,956,875	493,569	720,310	1,393,281	64,510	113,016	-	145,684	86,906	17,641
Primary Mangrove Forest	-	96,788	-	-	-	-	0	-	-	-
Secondary Mangrove Forest	118,793	6,584	22,872	55,243	6,915	36,931	6,676	73,156	8,315	2,496
Primary Swamp Forest	1,818,590	975,570	160,870	2,159,536	238,517	1,633,405	4,475	157,742	34,974	6,820
Secondary Swamp Forest	66,126,590	28,229,273	14,617,820	35,019,598	6,594,467	49,726,316	26,551,513	6,905,401	7,967,587	2,031,402
MINERAL	**266,693,731**	**121,132,175**	**83,591,369**	**124,924,505**	**45,106,093**	**58,621,626**	**113,230,120**	**100,814,272**	**36,305,403**	**22,296,462**
Primary Dryland Forest	1,379,197	168,346	3,237,846	5,152,481	914,135	868,794	2,557,852	758,506	1,205,022	849,308
Secondary Dryland Forest	204,828,256	95,829,702	68,350,879	92,177,862	37,485,591	39,693,652	84,540,815	89,966,547	23,789,272	18,843,555
Primary Mangrove Forest	224,379	60,734	74,550	269,711	4,741	52,851	205,909	111,066	79,283	96,404
Secondary Mangrove Forest	7,675,249	1,255,133	3,050,467	2,014,647	1,331,642	1,974,199	4,017,414	2,646,952	4,782,913	579,564
Primary Swamp Forest	1,534,207	3,290	284,575	57,889	13,289	244,571	273,593	80,496	31,488	-
Secondary Swamp Forest	51,052,443	23,814,970	8,593,053	25,251,915	5,356,695	15,787,558	21,634,538	7,250,706	6,417,426	1,927,631
PAPUA	**36,885,172**	**11,340,989**	**13,903,291**	**7,763,040**	**7,456,990**	**26,355,226**	**5,851,738**	**17,455,455**	**29,840,861**	**6,392,636**
PEAT	**3,442,138**	**559,776**	**390,042**	**186,171**	**467,894**	**1,264,206**	**442,373**	**739,074**	**934,747**	**177,313**
Primary Dryland Forest	19,763	94,536	243,141	-	30,771	104,686	40,496	149,924	117,799	82,647
Secondary Dryland Forest	575,023	423,014	92,586	94,537	147,045	463,563	230,388	313,153	304,898	11,567
Primary Mangrove Forest	23,506	-	16,751	10,182	-	8,241	0	18,957	23,502	-
Secondary Mangrove Forest	73,773	3,527	17,207	-	-	1	0	14,058	1,424	226
Primary Swamp Forest	1,514,477	32,378	20,357	81,452	198,043	403,850	83,632	242,983	220,812	9,548
Secondary Swamp Forest	1,235,595	6,322	-	-	92,036	283,865	87,857	-	266,312	73,325
MINERAL	**33,443,034**	**10,781,212**	**13,513,250**	**7,576,869**	**6,989,095**	**25,091,020**	**5,409,366**	**16,716,380**	**28,906,113**	**6,215,323**
Primary Dryland Forest	7,193,579	5,822,406	3,759,747	1,605,167	2,331,955	7,946,769	1,987,875	6,045,666	12,437,327	3,164,162
Secondary Dryland Forest	21,626,292	3,096,742	7,031,483	5,075,787	3,498,439	10,665,161	2,936,697	10,059,389	10,882,711	2,062,235
Primary Mangrove Forest	22,237	39,936	78,800	-	272,711	580,803	49	60,950	932,686	59,624
Secondary Mangrove Forest	129,410	118,113	82,816	36,715	10,637	57,317	0	69,838	189,195	53,829
Primary Swamp Forest	2,591,521	1,533,952	472,547	595,489	348,343	1,498,536	438,648	466,502	2,098,473	214,262
Secondary Swamp Forest	1,879,994	170,062	2,087,856	263,710	527,011	4,342,434	46,096	14,034	2,365,722	661,212
SULAWESI	**49,041,911**	**28,836,236**	**7,141,021**	**17,244,815**	**6,224,807**	**20,997,633**	**34,707,808**	**28,251,709**	**25,040,943**	**5,733,972**
MINERAL	**49,041,911**	**28,836,236**	**7,141,021**	**17,244,815**	**6,224,807**	**20,997,633**	**34,707,808**	**28,251,709**	**25,040,943**	**5,733,972**
Primary Dryland Forest	2,054,188	9,017,254	898,220	3,219,442	820,936	3,193,482	8,204,968	3,046,245	2,927,018	2,016,123
Secondary Dryland Forest	43,117,649	19,549,660	6,150,751	13,681,195	5,015,265	16,914,895	24,235,884	23,231,447	17,456,798	3,535,964
Primary Mangrove Forest	88,022	52,618	-	27,197	90,937	27,260	281,605	122,898	501,622	29,570
Secondary Mangrove Forest	1,294,770	193,432	77,749	299,243	246,171	772,849	1,785,221	1,477,498	3,660,059	132,749
Primary Swamp Forest	-	-	-	-	-	33,663	-	1,073	12,896	-
Secondary Swamp Forest	2,487,282	23,271	14,302	17,738	51,498	55,485	200,130	372,547	482,551	19,567
JAWA	**4,274,082**	**1,819,026**	**380,515**	**1,347,847**	**3,817,678**	**1,335,354**	**1,476,122**	**8,785,953**	**2,220,800**	**584,838**
MINERAL	**4,274,082**	**1,819,026**	**380,515**	**1,347,847**	**3,817,678**	**1,335,354**	**1,476,122**	**8,785,953**	**2,220,800**	**584,838**
Primary Dryland Forest	38,730	68,806	-	-	-	37,155	-	3,440	668,522	40,637
Secondary Dryland Forest	1,875,450	1,747,742	380,515	902,375	3,808,571	1,298,199	1,472,697	8,767,708	1,102,299	530,466
Primary Mangrove Forest	-	-	-	-	-	-	3,416	-	6,620	10,038
Secondary Mangrove Forest	2,359,902	2,477	-	445,472	9,106	-	9	14,805	439,383	3,697
Primary Swamp Forest	-	-	-	-	-	-	-	-	-	-
Secondary Swamp Forest	-	-	-	-	-	-	-	-	3,976	-
BALI NUSA	**1,405,503**	**1,076,959**	**16,006,617**	**257,241**	**370,065**	**5,427,462**	**9,441,214**	**2,742,924**	**10,528,680**	**3,512,995**
MINERAL	**1,405,503**	**1,076,959**	**16,006,617**	**257,241**	**370,065**	**5,427,462**	**9,441,214**	**2,742,924**	**10,528,680**	**3,512,995**
Primary Dryland Forest	90,165	68,980	666,880	-	5,528	345,190	1,626,904	294,696	5,685,610	672,394
Secondary Dryland Forest	1,315,338	896,307	14,624,485	242,544	361,353	4,914,636	6,873,880	2,431,600	2,947,125	2,773,209
Primary Mangrove Forest	-	71,681	714,117	-	-	137,269	354,402	4,641	849,219	20,551
Secondary Mangrove Forest	-	39,991	1,134	14,697	3,184	30,367	586,028	11,987	962,602	46,840
Primary Swamp Forest	-	-	-	-	-	-	-	-	-	-
Secondary Swamp Forest	-	-	-	-	-	-	-	-	84,124	-
MALUKU	**9,995,913**	**9,583,027**	**2,581,184**	**2,676,169**	**1,522,479**	**6,501,164**	**17,575,275**	**14,392,008**	**5,597,221**	**1,374,276**
MINERAL	**9,995,913**	**9,583,027**	**2,581,184**	**2,676,169**	**1,522,479**	**6,501,164**	**17,575,275**	**14,392,008**	**5,597,221**	**1,374,276**
Primary Dryland Forest	160,574	900,288	5,386	5,101	0	311,499	2,326,890	536,952	52,048	17,766
Secondary Dryland Forest	9,719,546	8,394,018	2,524,810	2,531,081	1,480,491	6,092,518	13,974,744	12,876,639	5,458,695	1,335,322
Primary Mangrove Forest	85,622	465	50,988	27,130	34,367	5,072	356,021	295,933	17,552	2,258
Secondary Mangrove Forest	16,528	7,625	-	112,858	7,622	78,379	877,365	504,171	59,594	13,120
Primary Swamp Forest	-	-	-	-	-	13,696	20,904	7,483	-	-
Secondary Swamp Forest	13,643	280,630	-	-	-	-	19,351	170,831	9,333	5,810
Grand Total	**859,199,342**	**347,781,714**	**248,936,401**	**285,586,539**	**116,066,230**	**232,677,053**	**279,220,589**	**228,348,899**	**140,859,913**	**60,452,760**
Annual Rate	**286,399,781**	**173,890,857**	**248,936,401**	**285,586,539**	**116,066,230**	**232,677,053**	**279,220,589**	**228,348,899**	**140,859,913**	**60,452,760**

Table Annex 1.8. Activity Data for Forest Degradation

Island/Soil/ Land Cover	Forest Degradation (ha)									
	2006-2009	2009-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
SUMATERA	**70,409**	**45,449**	**2,346**	**14,795**	**1,166**	**39,162**	**227,384**	**36,232**	**12,019**	**18,775**
PEAT	**33,571**	**15,421**	**2,228**	**2,551**	**248**	**529**	**23,427**	**70**	**4,120**	**17,933**
Primary Dryland Forest										
Primary Mangrove Forest	258					381	81	7	28	
Primary Swamp Forest	33,313	15,421	2,228	2,551	248	149	23,346	63	4,092	17,933
MINERAL	**36,838**	**30,028**	**118**	**12,244**	**917**	**38,633**	**203,957**	**36,162**	**7,899**	**842**
Primary Dryland Forest	3,595	24,465	26	1,230	774	26,598	185,991	33,951	7,406	85
Primary Mangrove Forest	28,134	2,939		600		11,494	3,536	1,965	493	
Primary Swamp Forest	5,109	2,624	93	10,414	144	541	14,431	246	0	756
KALIMANTAN	**70,608**	**18,019**	**10,210**	**4,720**	**37,644**	**163,874**	**74,153**	**88,301**	**22,626**	**15,457**
PEAT	**740**	**166**	**10,210**	**434**	**1,209**	**9,064**	**1,569**	**3,223**		**233**
Primary Dryland Forest			10,210			37				
Primary Mangrove Forest					75			1,330		
Primary Swamp Forest	740	166		434	1,135	9,027	1,569	1,893		233
MINERAL	**69,868**	**17,853**		**4,285**	**36,434**	**154,810**	**72,584**	**85,078**	**22,626**	**15,224**
Primary Dryland Forest	67,975	17,713		3,126	35,782	145,534	70,604	81,100	20,297	14,358
Primary Mangrove Forest	1,887			284	442	238	1,288	3,649	2,329	619
Primary Swamp Forest	7	140		875	209	9,038	691	329		247
PAPUA	**992,217**	**62,177**	**6,165**	**168,199**	**51,369**	**263,141**	**162,406**	**74,317**	**302,397**	**13,313**
PEAT	**47,726**	**5,941**	**710**	**14,287**	**3,116**	**8,739**	**5,965**	**2,506**	**7,656**	**493**
Primary Dryland Forest	14,533	535		4,573	330	8,108	2,199	1,793	3,279	491
Primary Mangrove Forest	3,205	255		3,887	4	325	1,084	7	882	
Primary Swamp Forest	29,988	5,151	710	5,828	2,782	306	2,682	706	3,495	2
MINERAL	**944,491**	**56,236**	**5,455**	**153,912**	**48,253**	**254,402**	**156,442**	**71,810**	**294,741**	**12,821**
Primary Dryland Forest	817,699	37,989	1,009	138,898	29,573	249,465	135,226	64,686	267,806	12,668
Primary Mangrove Forest	5,547	53		2,642	2,769	568	2,354	363	18,185	7
Primary Swamp Forest	121,244	18,194	4,445	12,372	15,911	4,369	18,862	6,761	8,750	147
SULAWESI	**93,256**	**186,799**	**9,487**	**9,113**	**4,637**	**112,472**	**63,205**	**20,054**	**9,144**	**3,665**
MINERAL	**93,256**	**186,799**	**9,487**	**9,113**	**4,637**	**112,472**	**63,205**	**20,054**	**9,144**	**3,665**
Primary Dryland Forest	91,312	186,707	9,487	9,113	3,180	111,273	62,916	19,537	8,978	3,636
Primary Mangrove Forest	1,944	92			1,457	850	282	517	165	28
Primary Swamp Forest						349	7		1	
JAWA	**267,460**				**43**	**1,021**	**242**	**303**		
MINERAL	**267,460**				**43**	**1,021**	**242**	**303**		
Primary Dryland Forest	266,518				43	1,021	107	26		
Primary Mangrove Forest	942						87	277		
Primary Swamp Forest							48			
BALI NUSA	**59,491**	**2,107**	**15,010**	**255**		**71,062**	**29,379**	**37,041**	**25,715**	**7,814**
MINERAL	**59,491**	**2,107**	**15,010**	**255**		**71,062**	**29,379**	**37,041**	**25,715**	**7,814**
Primary Dryland Forest	59,457	2,107	14,387	255		69,946	28,310	35,947	24,934	7,814
Primary Mangrove Forest	33		624			1,117	1,069	1,094	781	
Primary Swamp Forest										
MALUKU	**5,266**	**7,460**		**153**	**398**	**48,005**	**39,764**	**1,434**	**149,337**	
MINERAL	**5,266**	**7,460**		**153**	**398**	**48,005**	**39,764**	**1,434**	**149,337**	
Primary Dryland Forest	56	7,375			41	45,665	38,719	531	149,336	
Primary Mangrove Forest	5,210	85		153	357	1,618	928	714	1	
Primary Swamp Forest						722	117	189		
Grand Total	**1,558,707**	**322,009**	**43,218**	**197,235**	**95,256**	**698,738**	**596,533**	**257,682**	**521,238**	**59,024**
Annual Rate	**519,569**	**161,005**	**43,218**	**197,235**	**95,256**	**698,738**	**596,533**	**257,682**	**521,238**	**59,024**

Table Annex 1.9. Emissions from Forest Degradation

Table annex 1.8. Emission from Forest Degradation

Island/Soil/ Land Cover	Emission from Forest Degradation (t CO2e)									
	2006-2009	2009-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
SUMATERA	**8,181,356**	**6,121,462**	**281,552**	**1,799,670**	**162,207**	**5,320,510**	**32,628,700**	**5,308,346**	**1,649,411**	**2,250,033**
PEAT	**4,015,542**	**1,845,991**	**266,654**	**305,319**	**29,720**	**58,615**	**2,803,393**	**8,292**	**492,815.68**	**2,146,764.98**
Primary Dryland Forest	-	-	-	-	-	-	-	-	-	-
Primary Mangrove Forest	27,720	-	-	-	-	40,834	8,684	739	3,008.68	-
Primary Swamp Forest	3,987,823	1,845,991	266,654	305,319	29,720	17,781	2,794,710	7,553	489,807.00	2,146,764.98
MINERAL	**4,165,814**	**4,275,471**	**14,898**	**1,494,350**	**132,487**	**5,261,895**	**29,825,307**	**5,300,054**	**1,156,594.94**	**103,267.63**
Primary Dryland Forest	535,760	3,646,066	3,819	183,317	115,301	3,963,940	27,718,485	5,059,807	1,103,704.04	12,713.54
Primary Mangrove Forest	3,018,437	315,321	-	64,416	-	1,233,202	379,372	210,834	52,890.56	-
Primary Swamp Forest	611,617	314,083	11,078	1,246,617	17,186	64,753	1,727,450	29,414	0.34	90,554.08
KALIMANTAN	**8,086,973**	**2,074,535**	**1,164,151**	**622,504**	**4,377,050**	**19,872,956**	**8,594,868**	**10,180,646**	**2,564,028.59**	**1,789,831.55**
PEAT	**133,138**	**29,841**	**1,164,151**	**78,140**	**212,147**	**1,628,240**	**282,251**	**483,240**	**-**	**41,870.85**
Primary Dryland Forest	-	-	1,164,151	-	-	4,262	-	-	-	-
Primary Mangrove Forest	-	-	-	-	8,038	-	-	142,699	-	-
Primary Swamp Forest	133,138	29,841	-	78,140	204,109	1,623,978	282,251	340,541	-	41,870.85
MINERAL	**7,953,835**	**2,044,694**	**-**	**544,364**	**4,164,903**	**18,244,716**	**8,312,617**	**9,697,405**	**2,564,028.59**	**1,747,960.70**
Primary Dryland Forest	7,750,208	2,019,584	-	356,367	4,079,749	16,593,227	8,050,008	9,246,687	2,314,179.14	1,637,045.21
Primary Mangrove Forest	202,400	-	-	30,506	47,475	25,576	138,214	391,466	249,849.45	66,389.11
Primary Swamp Forest	1,227	25,110	-	157,491	37,680	1,625,913	124,395	59,253	-	44,526.38
PAPUA	**93,838,355**	**5,266,503**	**396,533**	**16,266,198**	**4,392,490**	**26,442,417**	**15,513,342**	**7,197,188**	**30,192,662.57**	**1,341,489.88**
PEAT	**3,527,501**	**375,592**	**40,539**	**1,212,743**	**192,663**	**873,279**	**492,067**	**222,642**	**626,181.29**	**49,800.04**
Primary Dryland Forest	1,471,483	54,155	-	463,009	33,453	820,951	222,620	181,574	331,995.77	49,694.14
Primary Mangrove Forest	343,864	27,369	-	417,003	383	34,853	116,332	766	94,651.31	-
Primary Swamp Forest	1,712,154	294,067	40,539	332,731	158,827	17,476	153,115	40,302	199,534.21	105.90
MINERAL	**90,310,854**	**4,890,911**	**355,994**	**15,053,455**	**4,199,827**	**25,569,137**	**15,021,275**	**6,974,546**	**29,566,481.28**	**1,291,689.84**
Primary Dryland Forest	82,793,340	3,846,429	102,203	14,063,626	2,994,316	25,258,734	13,691,810	6,549,600	27,115,830.93	1,282,615.60
Primary Mangrove Forest	595,164	5,717	-	283,437	297,083	60,964	252,544	38,909	1,951,095.51	701.82
Primary Swamp Forest	6,922,350	1,038,765	253,791	706,391	908,427	249,439	1,076,921	386,037	499,554.84	8,372.42
SULAWESI	-	-	-	-	-	-	-	-	**-**	**-**
MINERAL	**11,029,105**	**22,134,778**	**1,124,242**	**1,079,892**	**533,168**	**13,328,948**	**7,486,829**	**2,370,641**	**1,081,701.78**	**433,947.32**
Primary Dryland Forest	10,820,550	22,124,946	1,124,242	1,079,892	376,876	13,185,941	7,455,557	2,315,160	1,063,904.01	430,911.07
Primary Mangrove Forest	208,555	9,832	-	-	156,292	91,171	30,255	55,481	17,720.84	3,036.25
Primary Swamp Forest	-	-	-	-	-	51,837	1,018	-	76.93	-
JAWA	-	-	-	-	-	-	-	-	**-**	**-**
MINERAL	**43,993,108**	**-**	**-**	**-**	**7,153**	**168,090**	**29,675**	**33,961**	**-**	**-**
Primary Dryland Forest	43,892,065	-	-	-	7,153	168,090	17,554	4,245	-	-
Primary Mangrove Forest	101,043	-	-	-	-	-	9,345	29,716	-	-
Primary Swamp Forest	-	-	-	-	-	-	2,777	-	-	-
BALI NUSA	-	-	-	-	-	-	-	-	**-**	**-**
MINERAL	**11,459,327**	**405,877**	**2,838,811**	**49,185**	**-**	**13,596,350**	**5,569,179**	**7,043,336**	**4,887,806.16**	**1,505,441.81**
Primary Dryland Forest	11,455,750	405,877	2,771,894	49,185	-	13,476,552	5,454,481	6,925,976	4,803,990.29	1,505,441.81
Primary Mangrove Forest	3,577	-	66,917	-	-	119,798	114,698	117,359	83,815.87	-
Primary Swamp Forest	-	-	-	-	-	-	-	-	-	-
MALUKU	-	-	-	-	-	-	-	-	**-**	**-**
MINERAL	**566,627**	**1,017,884**	**-**	**16,436**	**43,864**	**6,461,465**	**5,402,471**	**160,105**	**20,427,015.67**	**-**
Primary Dryland Forest	7,654	1,008,801	-	-	5,550	6,246,289	5,296,195	72,655	20,426,869.70	-
Primary Mangrove Forest	558,972	9,082	-	16,436	38,314	173,638	99,562	76,552	145.97	-
Primary Swamp Forest	-	-	-	-	-	41,538	6,714	10,898	-	-
Grand Total	**177,154,851**	**37,021,039**	**5,805,289**	**19,833,885**	**9,515,931**	**85,190,736**	**75,225,065**	**32,294,223**	**60,802,625**	**7,320,743**
Annual Rate	**59,051,617**	**18,510,520**	**5,805,289**	**19,833,885**	**9,515,931**	**85,190,736**	**75,225,065**	**32,294,223**	**60,802,625**	**7,320,743**

Annex 2. Calculation of Emissions from Peat Decomposition

Emissions from peat decomposition were reported in the technical annex of the Biennial Update Report (BUR) until 2020. The technical annex of the BUR also contains an explanation of the calculations involved. The following seeks to clarify the calculation process followed to obtain the achievement figures in 2018 and 2019.

Peat decomposition: Process whereby peat changes form due to declining water levels resulting from deforestation, degradation activities, and land utilization on peatlands.

Inherited emissions: Continuous release of greenhouse gases resulting from peat decomposition after peatlands are drained due to the conversion and/or utilization of peat forests for other land uses. These emissions persist until either the peatland is entirely decomposed or fully rewetted. As a consequence, emissions are passed on from one disturbance to another (inherited). The total emissions from peat decomposition consist of the accumulated emissions from 1990 onwards.

Emission factors for the calculation of emissions due to peat decomposition: The emission factors utilized for calculating peat decomposition emissions are based on the information provided in the document titled "2013 Supplement to the IPCC 2006 Guidelines for National GHG Inventory: Wetlands (2014)."

The emission factors are applied with the assumption that all utilized areas are drained. For example, in a scenario where there is a transition from primary swamp forest to secondary swamp forest, the mean emission factor of the two land cover types is used, calculated as (0 + 19) / 2 = 9.5 t CO2 ha-1yr-1. This approach assumes that the transition occurs gradually over the transition period, rather than abruptly in the first or last year of the period.

Efforts to reduce emissions from peat decomposition require consistent and serious mitigation activities. These activities include peatland rewetting, establishment of water management systems for peatlands, efforts to reduce deforestation and forest degradation, and measures to prevent fires on peatlands.

The calculation of emissions from peat decomposition in a specific year, while deforestation and forest degradation are underway, adheres to the same basis used for calculating emissions from deforestation and forest degradation. However, it includes the consideration of inherited emissions. This is because when deforestation and forest degradation take place on peat forests, emissions result from the loss of above-ground biomass (AGB) at the time of conversion, as described earlier.

Additionally, there are subsequent emissions from peat decomposition at the time of deforestation and forest degradation. Furthermore, the deforested and degraded peat forests will continue to release CO_2 emissions in the following years, known as inherited emissions from peat decomposition. The emissions from peat decomposition are calculated using the following Equation:

$$PDE_{ijt} = A_{ijt}\ x\ EF_j$$

Where: PDE_{ijt} is Peat Decomposition Emission (PDE), i.e. CO_2 emissions ($tCO_2e\ yr^{-1}$) from peat decomposition occurring in peat forest area-*i* that changed into land-cover type-*j* within the time period-*t*; A_{ijt} is the area-*i* of peat forest that changed into land-cover type-*j* within the time period-*t*; EF_j is the emission factor from the decomposition of peat forest that changed into land-cover class-*j* ($tCO_2e\ ha^{-1}\ yr^{-1}$).

Since 1990, emissions from peat decomposition have been consistently calculated in line with deforestation and forest degradation activities. The base calculation for peatland emissions considers the area that was forested peatland in 1990. The emission baseline for peat decomposition in the Forest Reference Emission Level (FREL) was estimated using a linear equation approach. Over time, this estimate will be refined and improved through a stepwise process, aiming to achieve a more precise and accurate estimate for future implementation.

The decomposition process in organic soil produces significant carbon emissions, particularly when the organic soils are drained. Exposure to aerobic conditions causes oxidation, resulting in the emission of CO_2. When forested peatland is converted to other land uses, the organic soils continue to decompose over several years. These emissions persist and are inherited for years after the initial disturbance. Consequently, emissions from peat decomposition will continuously increase as more peatland gets deforested. To ensure consistency, the data, methodologies, and procedures utilized for calculating the results presented in this report align with those used when establishing the FREL.

For example, in the land cover transition matrix of peatlands in the 2012-2013 period, the change from primary swamp forest (PSF) to swamp shrubs (SSr) was 3,379 hectares (see Table Annex 2.1, column 5, line 10). This serves as the activity data for analysis and calculation purposes. The emission factor used for this land cover transition (Table Annex 2.2, column 5, line 10), was the mean of the emission factors of the two land cover types, in this case (0+19)/2 or equal to 9.5 tonnes of CO_2e yr^{-1}. Based on the given activity data of 3,379 hectares and the emission factor of 9.5 tonnes of CO_2e per ha, the emissions from peat decomposition resulting from this deforestation event amounted to 32,102 tonnes of CO_2 (see Table Annex 2.3. column 5, line 10). In subsequent years, the emissions from peat decomposition originating from the swamp shrubs continue as inherited emissions at a constant rate of 19 tonnes of CO_2e yr^{-1}. However, it's important to note that if the swamp shrubs are further converted to a different land use type with a distinct emission factor, the emission rate will change accordingly.

Table Annex 2.1. Land Cover Transition Matrix of Peatlands in 2012-2013 (hectares)

LC		2012																							Grand Total
		PF	SF	PMF	SMF	PSF	SSF	TP	Sr	EP	SSr	AUA	MxUA	Rc	Sv	Po	Sw	Se	Ai	Tr	Br	Mn	WB	Ot	
2013	PF	372,446			1		16																		372,463
	SF	4,573	292,000				19																		296,592
	PMF			232,928																					232,928
	SMF			3,887	89,838																				93,724
	PSF		2			2,124,918																			2,124,920
	SSF		1,145		37	10,206	3,368,605	755	329	115	10,881		224									429			3,392,726
	TP		31		50	585	27,950	517,985	4,548	1,420	19,059	115	518									46,389			618,650
	Sr		1,121				1,068		106,438				13												108,641
	EP		105		10	15	19,188	2,226	2,092	992,893	42,555	89	35	6,467								26,090			1,091,765
	SSr		342	22	137	3,379	57,595	276	206	515	1,791,213						5,131					97			1,858,913
	AUA		8,890				1,186			598	1,884	87,988										238			100,784
	MxUA		2,103				490		55,956		4,378	2,787	120,391												186,105
	Rc										33			51,552											51,585
	Sv														31,703										31,703
	Po															1,555									1,555
	Sw																95,234								95,234
	Se																	5,014							5,014
	Ai																		72						72
	Tr																			669					669
	Br		959		33	6,104	93,206	28,124	1,077	4,153	11,531	5	86	109								320,660			466,046
	Mn		28				554				3										1,823				2,408
	WB																						824		824
	Ot																								-
Grand Total		377,019	306,726	236,837	90,106	2,145,207	3,569,878	549,366	170,647	999,694	1,881,538	90,983	121,267	58,128	31,703	1,555	100,365	5,014	72	669	1,823	393,902	824	-	11,133,321

Table Annex 2.2. Matrix of CO_2 Emission Factors for Peat Decomposition ($tCO_2e\ ha^{-1}$)

LC		T1																						
		PF	SF	PMF	SMF	PSF	SSF	TP	Sr	EP	SSr	AUA	MxUA	Rc	Sv	Po	Sw	Se	Ai	Tr	Br	Mn	WB	Ot
	PF	-	9.5	-	9.5	-	9.5	36.5	9.5	20.0	9.5	25.5	25.5	17.5	17.5	-	-	17.5	-		25.5	25.5	-	-
	SF	9.5	19.0	9.5	19.0	9.5	19.0	46.0	19.0	29.5	19.0	35.0	35.0	27.0	27.0	9.5	9.5	27.0	9.5	35.0	35.0	35.0	9.5	9.5
	PMF	-	9.5	-	9.5	-	9.5	36.5	9.5	20.0	9.5	25.5	25.5	17.5	17.5	-	-	17.5	-	25.5	25.5	25.5	-	-
	SMF	9.5	19.0	9.5	19.0	9.5	19.0	46.0	19.0	29.5	19.0	35.0	35.0	27.0	27.0	9.5	9.5	27.0	9.5	35.0	35.0	35.0	9.5	9.5
	PSF	-	9.5	-	9.5	-	9.5	36.5	9.5	20.0	9.5	25.5	25.5	17.5	17.5	-	-	17.5	-	25.5	25.5	25.5	-	-
	SSF	9.5	19.0	9.5	19.0	9.5	19.0	46.0	19.0	29.5	19.0	35.0	35.0	27.0	27.0	9.5	9.5	27.0	9.5	35.0	35.0	35.0	9.5	9.5
	TP	36.5	46.0	36.5	46.0	36.5		73.0	46.0	56.5	46.0	62.0	62.0	54.0	54.0	36.5	36.5	54.0	36.5	62.0	62.0	62.0	36.5	36.5
	Sr	9.5	19.0	9.5	19.0	9.5	19.0	46.0	19.0	29.5	19.0	35.0	35.0	27.0	27.0	9.5	9.5	27.0	9.5	35.0	35.0	35.0	9.5	9.5
	EP	20.0	29.5	20.0	29.5	20.0	29.5	56.5	29.5	40.0	29.5	45.5	45.5	37.5	37.5	20.0	20.0	37.5	20.0	45.5	45.5	45.5	20.0	20.0
	SSr	9.5	19.0	9.5	19.0	9.5	19.0	46.0	19.0	29.5	19.0	35.0	35.0	27.0	27.0	9.5	9.5	27.0	9.5	35.0	35.0	35.0	9.5	9.5
	AUA	25.5	35.0	25.5	35.0	25.5	35.0	62.0	35.0	45.5	35.0	51.0	51.0	43.0	43.0	25.5	25.5	43.0	25.5	51.0	51.0	51.0	25.5	25.5
T0	MxUA	25.5	35.0	25.5	35.0	25.5	35.0	62.0	35.0	45.5	35.0	51.0	51.0	43.0	43.0	25.5	25.5	43.0	25.5	51.0	51.0	51.0	25.5	25.5
	Rc	17.5	27.0	17.5	27.0	17.5	27.0	54.0	27.0	37.5	27.0	43.0	43.0	35.0	35.0	17.5	17.5	35.0	17.5	43.0	43.0	43.0	17.5	17.5
	Sv	17.5	27.0	17.5	27.0	17.5	27.0	54.0	27.0	37.5	27.0	43.0	43.0	35.0	35.0	17.5	17.5	35.0	17.5	43.0	43.0	43.0	17.5	17.5
	Po	-	9.5	-	9.5	-	9.5	36.5	9.5	20.0	9.5	25.5	25.5	17.5	17.5	-	-	17.5	-	25.5	25.5	25.5	-	-
	Sw	-	9.5	-	9.5	-	9.5	36.5	9.5	20.0	9.5	25.5	25.5	17.5	17.5	-	-	17.5	-	25.5	25.5	25.5	-	-
	Se	17.5	27.0	17.5	27.0	17.5	27.0	54.0	27.0	37.5	27.0	43.0	43.0	35.0	35.0	17.5	17.5	35.0	17.5	43.0	43.0	43.0	17.5	17.5
	Ai	-	9.5	-	9.5	-	9.5	36.5	9.5	20.0	9.5	25.5	25.5	17.5	17.5	-	-	17.5	-	25.5	25.5	25.5	-	-
	Tr	25.5	35.0	25.5	35.0	25.5	35.0	62.0	35.0	45.5	35.0	51.0	51.0	43.0	43.0	25.5	25.5	43.0	25.5	51.0	51.0	51.0	25.5	25.5
	Br	25.5	35.0	25.5	35.0	25.5	35.0	62.0	35.0	45.5	35.0	51.0	51.0	43.0	43.0	25.5	25.5	43.0	25.5	51.0	51.0	51.0	25.5	25.5
	Mn	25.5	35.0	25.5	35.0	25.5	35.0	62.0	35.0	45.5	35.0	51.0	51.0	43.0	43.0	25.5	25.5	43.0	25.5	51.0	51.0	51.0	25.5	25.5
	WB	-	9.5	-	9.5	-	9.5	36.5	9.5	20.0	9.5	25.5	25.5	17.5	17.5	-	-	17.5	-	25.5	25.5	25.5	-	-
	Ot	-	9.5	-	9.5	-	9.5	36.5	9.5	20.0	9.5	25.5	25.5	17.5	17.5	-	-	17.5	-	25.5	25.5	25.5	-	-

Table Annex 2.3. Matrix of CO_2 Emissions from Peat Decomposition ($tC0_2e$)

LC		2012																							Grand Total
		PF	SF	PMF	SMF	PSF	SSF	TP	Sr	EP	SSr	AUA	MxUA	Rc	Sv	Po	Sw	Se	Ai	Tr	Br	Mn	WB	Ot	
	PF	-	-	-	5	-	150	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	155
	SF	43,442	5,548,000	-	-	-	358	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5,591,800
	PMF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SMF	-	-	36,924	1,706,913	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,743,837
	PSF	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16
	SSF	-	21,750	-	703	96,952	64,003,498	34,747	6,260	3,388	206,744	-	7,832	-	-	-	-	-	-	-	-	15,001	-	-	64,396,876
	TP	-	1,434	-	2,300	21,343	-	37,812,876	209,190	80,255	876,716	7,108	32,137	-	-	-	-	-	-	-	-	2,876,095	-	-	41,919,455
	Sr	-	21,306	-	-	-	20,297	-	2,022,327	-	-	-	447	-	-	-	-	-	-	-	-	-	-	-	2,064,376
	EP	-	3,094	-	308	306	566,045	125,761	61,716	39,715,730	1,255,384	4,051	1,592	242,497	-	-	-	-	-	-	-	1,187,080	-	-	43,163,564
	SSr	-	6,506	212	2,611	32,102	1,094,303	12,692	3,920	15,182	34,033,041	-	-	-	-	-	48,743	-	-	-	-	3,387	-	-	35,252,698
	AUA	-	311,140	-	-	-	41,523	-	-	27,222	65,957	4,487,368	-	-	-	-	-	-	-	-	-	12,127	-	-	4,945,338
2013	MxUA	-	73,599	-	-	-	17,159	-	1,958,469	-	153,225	142,115	6,139,945	-	-	-	-	-	-	-	-	-	-	-	8,484,512
	Rc	-	-	-	-	-	-	-	-	-	897	-	-	1,804,327	-	-	-	-	-	-	-	-	-	-	1,805,225
	Sv	-	-	-	-	-	-	-	-	-	-	-	-	-	1,109,621	-	-	-	-	-	-	-	-	-	1,109,621
	Po	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sw	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Se	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	175,494	-	-	-	-	-	-	175,494
	Ai	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Tr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	34,130	-	-	-	-	34,130
	Br	-	33,552	-	1,147	155,650	3,262,211	1,743,714	37,684	188,941	403,577	267	4,373	4,688	-	-	-	-	-	-	-	16,353,669	-	-	22,189,474
	Mn	-	991	-	-	-	19,386	-	-	-	97	-	-	-	-	-	-	-	-	-	92,961	-	-	-	113,436
	WB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Ot	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grand Total		43,442	6,021,388	37,137	1,713,987	306,353	69,024,931	39,729,791	4,299,566	40,030,718	36,995,639	4,640,910	6,186,325	2,051,513	1,109,621	-	48,743	175,494	-	34,130	92,961	20,447,359	-	-	232,990,006

Historical emissions from peat decomposition

Emissions from peat decomposition are progressive due to the presence of inherited emissions from previously degraded peatlands. As long as these degraded peatlands remain in their current state and are not reconverted to forests, the emissions from peat decomposition will not decrease. Unfortunately, the conversion of degraded peatlands back into forests is unlikely to occur during the assessment period. In the first FREL document, linear equations were developed through regression analysis, utilizing historical data on annual peat emissions.

The estimation of emissions from peat decomposition was based on land cover maps. However, in certain years, instead of having yearly land cover maps, only multi-year land cover maps were available, such as 3-yearly (2006 – 2009), 2-yearly (2009-2011), and annually (2011-2020). To deal with this, annual emissions were generated from the average values of the mapping periods. Each year was assigned an estimated emission value, and this value was then regressed against the corresponding year to establish the linear equations.

To construct the reference emission level for the period 2017-2020, the same method as in the first FREL document was utilized. This uses linear projection with the equation y = 6,706,744.03x – 13,266,946,368.06, where 'y' represents the estimated emissions and 'x' represents the corresponding year. The coefficient of determination (R^2) for this linear projection was 0.97, indicating a strong correlation. The reference period for this analysis spanned from 2006/2007 to 2015/2016 (See Table Annex 2.4 and Figure Annex 2.1.)

Table Annex 2.4. Emission from Peat Decomposition

Year	Peat Decomposition	Actual Emission	Result
2007	200,067,598		
2008	200,067,598		
2009	200,067,598		
2010	215,742,080		
2011	215,742,080		
2012	226,109,789		
2013	234,152,020		
2014	240,799,350		
2015	248,530,578		
2016	255,413,778		
2017	260,556,280	256,741,233	3,815,047
2018	267,263,024	270,321,401	-3,058,377
2019	273,969,768	280,910,820	-6,941,052
2020	280,676,512		

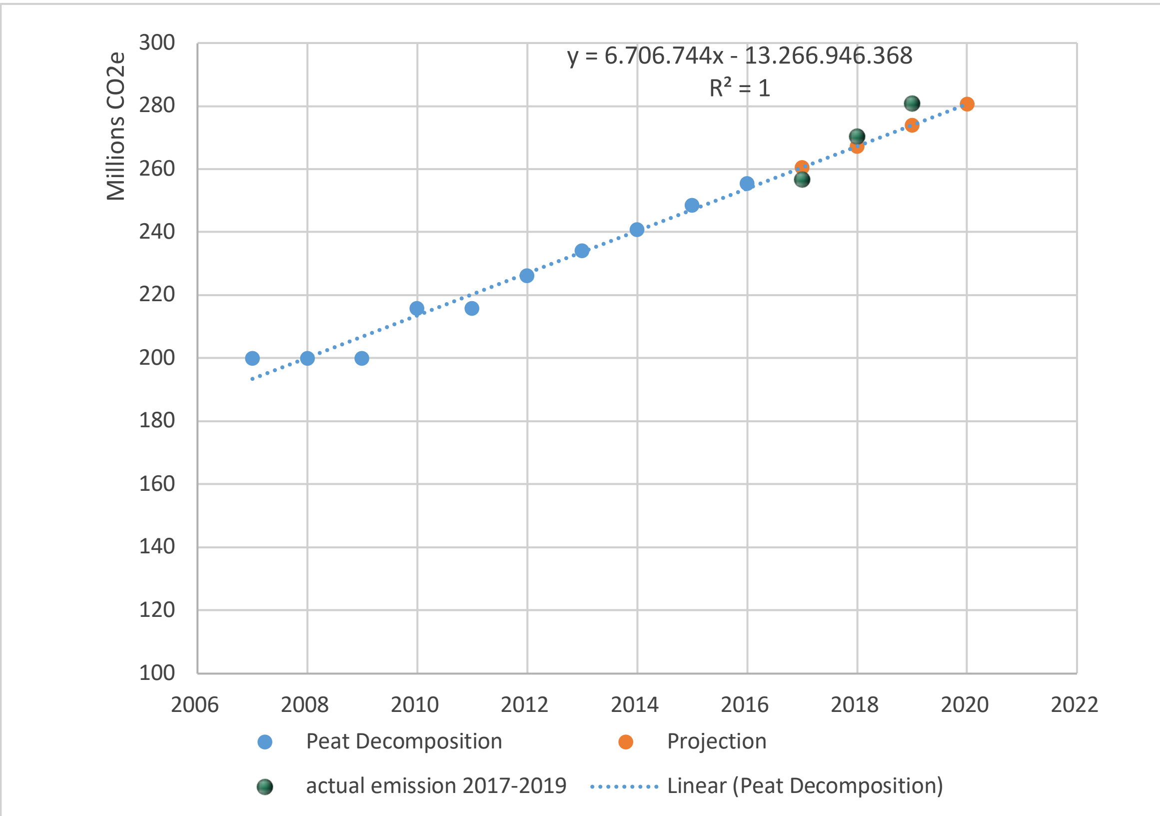

Figure Annex 2.1. Emission Level from Peat Decomposition

Emission reduction from peat decomposition in 2017/2018

In 2017/2018, actual peat decomposition emissions were measured at 270,321,401 tCO_2e. Based on historical emissions in the reference emission level for the period 2006-2016, the 2017/2018 emissions were projected to be 267,263,024 tCO_2e. As such, the **emission reduction for this period amounted to -3,058,377 tCO_2e.**

Emission reduction from peat decomposition in 2018/2019

In 2018/2019, actual peat decomposition emissions were measured at 280,910,820 tCO_2e. Based on historical emissions in the reference emission level for the period 2006-2016, the 2018/2019 emissions were projected to be 273,969,768 tCO_2e. As such, the **emission reduction for this period amounted to -6,941,052 tCO_2e.**

Annex 3. Calculation of Emissions from Peat Fires

Emissions from peat fires were not included in Indonesia's first FREL calculation, However, according to the MRV protocol, emissions from peat fires should be reported. In this report, fire data have been utilized, incorporating significant improvements through the visual delineation of burnt areas using Landsat imageries.

According to the IPCC Wetlands Supplement (IPCC, 2014), emissions from fires in organic soils are calculated using the following formula:

$$L_{fire} = A \times MB \times CF \times G_{ef}$$

where, L_{fire} is emissions from peat fires, A is burnt peat area, MB is the mass of fuel available for combustion, CF is the combustion factor (default factor = 1.0) and G_{ef} is the emission factor.

The accurate estimation of burnt areas is crucial for assessing the national greenhouse gas (GHG) emission level, as these areas represent a major source of emissions. The use of a robust and standardized method for producing annual burnt area maps is essential.

The Ministry of Environment and Forestry (MoEF) undertook mapping of burnt areas based on remote sensing data from 2000 to 2020 (MoEF, 2021). During this period, the largest extents of burnt area were recorded in 2006 and 2015, amounting to 3.9 million hectares and 2.6 million hectares respectively. The majority of fires occurred in mineral soils, **with only approximately 30% in peatlands**. However**, it is important to note that most fires occurred in non-forest land cover types, while forest cover types accounted for only between 2% to 13% of the fire occurrences** (Figure Annex 3.1).

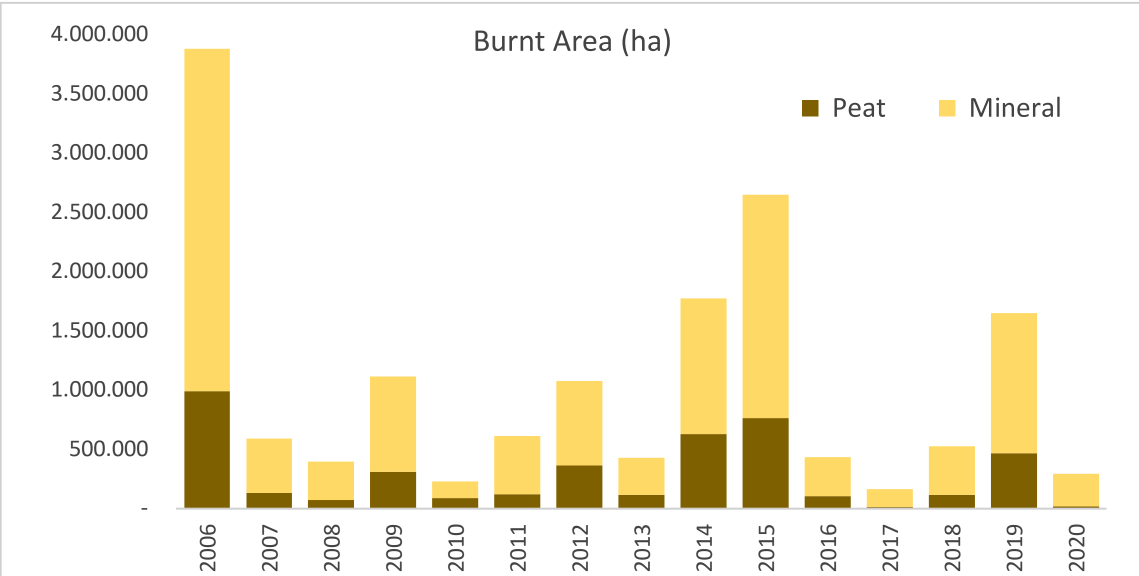

Figure Annex 3.1. Estimates of burnt area 2006-2020 (MoEF, 2021)

The classification method for identifying burnt areas was enhanced by incorporating visual interpretation of medium-resolution imageries, such as Landsat 5/7/8 with 30m resolution, and Sentinel 2A and 2B with 20m resolution. To support and validate the identification of burn scars, several additional datasets were utilized. These included MODIS and NOAA hotspot data, ground thruth data, and a burnt area model based on the Normalized Burn Ratio (NBR). The combination of these datasets improves the accuracy and reliability of identifying burnt areas and their extent

Visual interpretation of the satelite imageries was conducted at a map scale of 1:25,000 – 1:50,000 to achieve good resolution for published maps at scale 1:50,000 to 1:250,000. The minimum burnt area polygon identified was 0.5 cm x 0.25 cm at a map scale of 1:50,000, equivalent to a minimum area of 6.25 hectares. The classification of each burnt area included the delineation of the polygon with 3 levels of accuracy, i.e. high, medium and low.

High level accuracy was determined when satellite imageries, hotspot data and ground thruth data confirmed the occurrence of fire within the polygon. Medium-level accuracy was assigned when only hotspots and burn scars were detected in the satellite imageries. On the other hand, if fire was observed solely in satellite imageries, the polygon was categorized as having low-level accuracy regarding fires. The procedure for determining burnt peat areas is depicted below (Figure Annex 3.2).

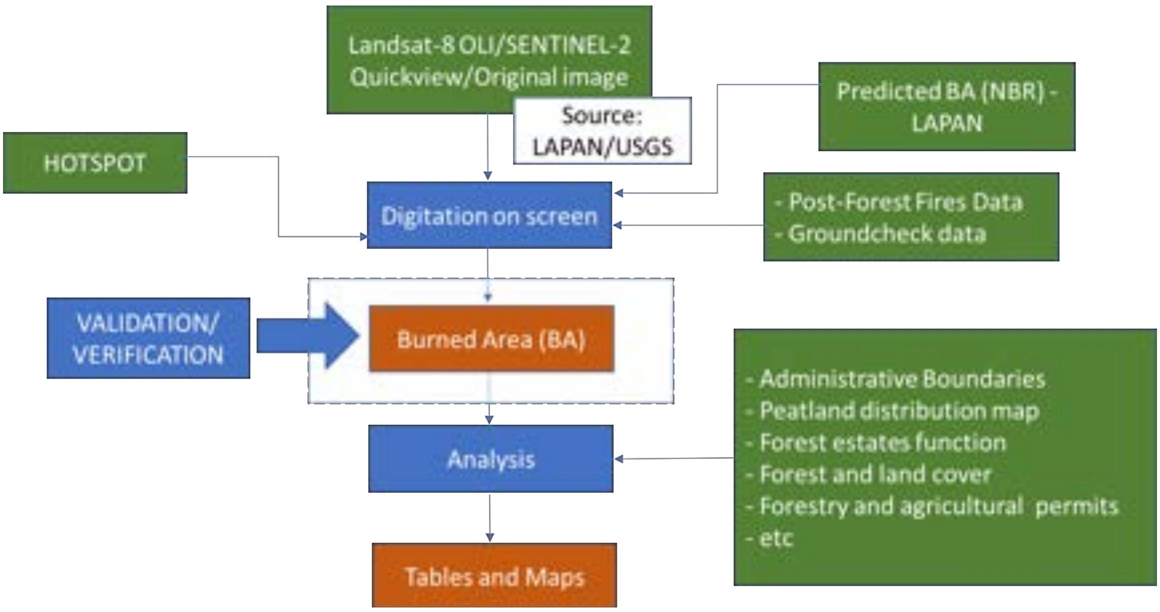

Figure Annex 3.2. Procedure for estimating burnt peat area (MoEF, 2021)

Mass of fuel available for combustion

The mass of fuel available for combustion (MB) is calculated by multiplying the mean depth of burnt peat (D) by the bulk density (BD). Assuming that the average depth of peat burnt by fire is 0.33 meters and the bulk density is 0.153 ton/m3, the resulting mass available for combustion is thus 0.05049 ton/m2 or 504.9 ton/ha.

Emission factor

The CO_2 emission factor (G_{ef}) can be indirectly estimated from the organic carbon content (C_{org}) as a percentage of weight. The relationship between the CO_2 emission factor and the organic carbon content is expressed by the following equation:

$$G_{ef} = C_{org} \times 3.67$$

The organic carbon content (C_{org}) can be estimated using the following equation:

$$C_{org} = \frac{(1 - {M_{ash}}/{M_s})}{1.724} \times 3.67$$

Where the mass of soil solids (Ms) is equal to the accumulated mass of ash (Mash) and mass of organic matter. The ratio of Mash to Ms is 14.04%, which represents the mean ash content of three peat types: Sapric (4.98%), Hemic (21.28%), and Fibric (15.85%).

To convert the organic matter estimate to organic carbon content, an adjustment factor of 1/1.724 is used. Based on this factor, the estimated organic carbon content, or C_{org}, is 49.86% (kg/kg), which is equivalent to 498.6 grams of carbon per kg of dry matter burnt.

If the value of organic carbon content is converted to CO_2e, it would be multiplied by the conversion factor of 3.67, thus C_{org} x 3.67 = 1,828.2 CO_2 g/kg of dry matter burnt or 1,828.2 CO_2 kg/ton of dry matter burnt. Assuming that 1 hectare of peat is burnt, the resultant CO_2 emissions released to the atmosphere are calculated as follows:

$$L_{fire} = A \times MB \times CF \times G_{ef}$$

= 1 ha × 504.9 t/ha × 1,828.2 kg/t

= 923,058.18 kg/ha

= 923.1 tCO_2e/ha

This result is used as the emission factor of burnt peat.

Historical emissions from peat fires

For this report, historical emissions from peat fires were calculated for the period 2006-2016. Significant variation was found in the annual estimated burnt peat areas from 2006 to 2016 (Figure Annex 3.3). The highest rate of burnt peatland occurred in 2006, amounting to 1,140,438 hectares, while the lowest rate was in 2008, with only 71,321 hectares of burnt peat areas. Using this historical data set, the average value of burnt peat areas used as activity data was determined to be 374,948 hectares.

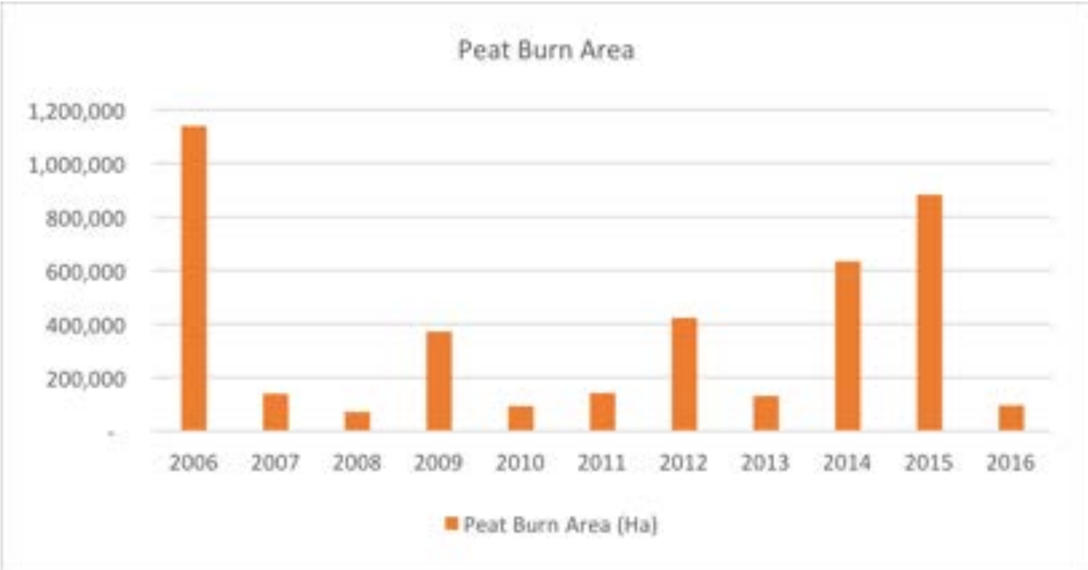

Figure Annex 3.3. Estimated burnt peat areas

The results of the calculation of emissions from burnt peat areas are presented in Figure Annex 3.4. The average emissions from extreme years peat fire from 2006 to 2016 were 711,277,540 $tCO_2e\ yr^{-1}$, whereas for normal years they were 137,424,802 $tCO_2e\ yr^{-1}$.

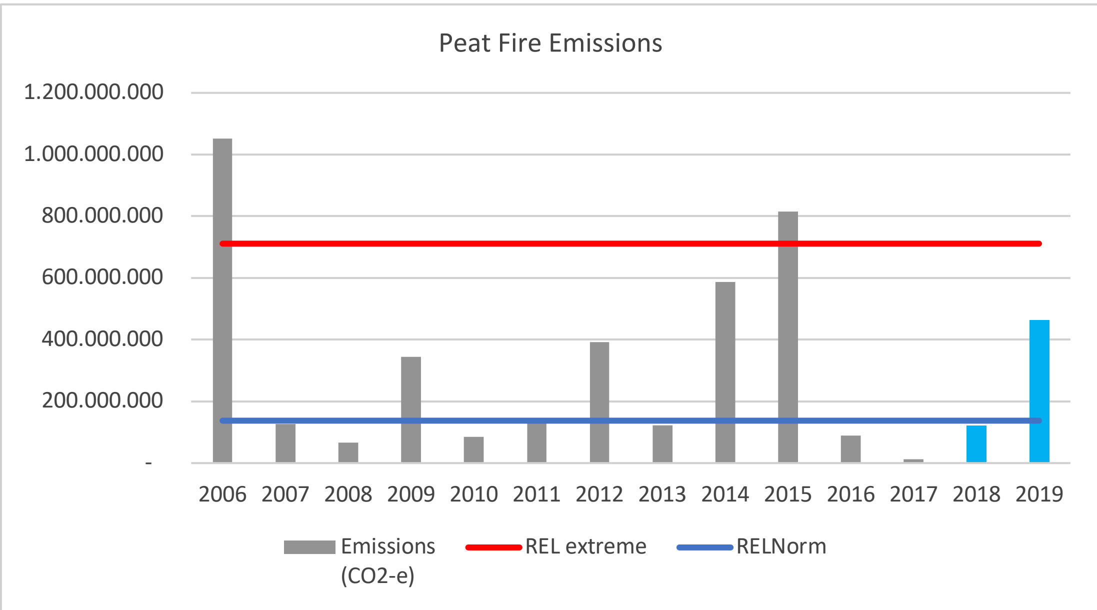

Figure Annex 3.4. Estimated historical emissions from burnt peat areas

Emission reductions from peat fires in 2018 and 2019

In 2018, emissions from peat fires decreased significantly, primarily due to stringent and extensive law enforcement measures and the continued moratorium (termination) on granting new licenses on primary forest and peatland. Fire incidents in peat areas that year impacted an area of 132,051 hectares. In 2019, the number of fire incidents increased substantially, driven by factors including the El Niño extreme weather phenomenon, impacting an area of 501,499 hectares.

When converted to emissions, this amounts to 121,890,305 tCO_2e for the former normal year and 462,912,976 tCO_2e for the latter extreme year. To calculate emission reductions from peat fires in 2018, the Reference Emission Level (REL) used for comparison was 137,424,802 tCO_2e yr-1 (normal year REL), whereas for 2019 the REL used for comparison was 711,277,540 tCO_2e yr-1 (extreme year REL). **As such, the emission reductions from peat fires in 2018 and 2019 amounted to 15,534,497 tCO_2e and 248,364,564 tCO_2e respectively.**

Annex 4. Estimates of AGB Stocks and Their Uncertainties in Each Forest Class in Indonesia

Forest Class	Main Island	Mean AGB (Mg ha^{-1})	95% Confidence Interval (Mg ha^{-1})		N of plot measurement	SE(%)
Primary Dryland Forest	Bali-Nusa Tenggara	274.4	247.4	301.3	52	10%
	Jawa					
	Kalimantan	269.4	258.2	280.6	333	4%
	Maluku	301.4	220.3	382.5	14	27%
	Papua	239.1	227.5	250.6	162	5%
	Sulawesi	275.2	262.4	288.1	221	5%
	Sumatera	268.6	247.1	290.1	92	8%
	Indonesia (Average)	**266.0**	**259.5**	**272.5**	**874.0**	**5%**
Secondary Dryland Forest	Bal- Nusa Tenggara	162.7	140.6	184.9	69	14%
	Jawa	170.5			1	
	Kalimantan	203.3	196.3	210.3	608	3%
	Maluku	222.1	204.5	239.8	99	8%
	Papua	180.4	158.5	202.4	60	12%
	Sulawesi	206.5	194.3	218.7	197	6%
	Sumatera	182.2	172.1	192.4	265	6%
	Indonesia (Average)	**197.7**	**192.9**	**202.5**	**1299**	**4%**
Primary Swamp Forest	Bali-Nusa Tenggara					
	Jawa					
	Kalimantan	275.5	269.2	281.9	3	2%
	Maluku					
	Papua	178.8	160	197.5	67	10%
	Sulawesi	214.4	-256.4	685.2	3	
	Sumatera	220.8	174.7	266.9	22	21%
	Indonesia (Average)	**192.7**	**174.6**	**210.8**	**95**	**8%**
Secondary Swamp Forest	Bali-Nusa Tenggara					
	Jawa					
	Kalimantan	170.5	158.6	182.5	166	7%
	Maluku					
	Papua	145.7	106.7	184.7	16	27%
	Sulawesi	128.3	74.5	182.1	12	42%
	Sumatera	151.4	140.2	162.6	160	7%
	Indonesia (Average)	**159.3**	**151.4**	**167.3**	**354**	**13%**
Primary Mangrove Forest	Kalimantan	263.9	209.0	318.8	8	21%
	Indonesia (Average)	**263.9**	**209.0**	**318.8**	**8**	**21%**
Secondary Mangrove Forest	Kalimantan,Sulawesi	201.7	134.5	244.0	12	21%
	Indonesia (Average)	**201.7**	**134.5**	**244.0**	**12**	**21%**