

SUMATRA MERANG PEATLAND PROJECT (SMPP)



**FOREST
CARBON**



PT. Global Alam Lestari

Document Prepared by Forest Carbon

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Project Lifetime	January 1 st , 2016 – December 31 st , 2062; 47-year lifetime
GHG Accounting Period	January 1 st , 2016 – December 31 st , 2062; 47-year lifetime
History of CCB Status	This is the CCB Project Validation
Gold Level Criteria	We aim to generate exceptional benefits related to climate and biodiversity through the SMPP, under both the Verified Carbon Standard (VCS) and Climate, Community, and Biodiversity Alliance (CCBA) standards. Climate: The SMPP will prevent the emission of an average of 1,338,569 tonnes (t) CO₂-equivalents (CO₂-e) annually through the restoration of a degraded

Expected Verification Schedule	peatland area. This will be achieved through the restoration of the project area's hydrology through the construction of dams to block canals that are currently draining the project area. Detailed information about the SMPP's climate benefits generated through project activity can be found throughout Section 3 (with project activities described in Section 2.1.11). Biodiversity: The SMPP will protect critical habitat for 10 endangered and critically endangered species, as well as 19 additional vulnerable species. The species protected within our project area include the endemic Sumatran tiger (<i>Panthera tigris</i> ssp. <i>Sumatrae</i>), the Sumatran Surili (<i>Presbytis melalophos</i>), and the Sambar deer (<i>Rusa unicolor</i>), as well as other important species such as the sun bear (<i>Helarctos malayanus</i>), the agile gibbon (<i>Hylobates agilis</i>), and the rhinoceros hornbill (<i>Buceros rhinoceros</i>). The SMPP will increase the protection of the project area, thereby protecting the endangered habitat that these species depend on. Detailed information about the SMPP's biodiversity benefits generated through project activity can be found throughout Section 5 (with project activities related to biodiversity described in Section 2.1.11.6). A summary of these biodiversity and climate benefits is available in Section 1.
	This is a joint validation/verification. The first verification for the SMPP was completed concurrently with this validation.

Table of Contents

1	Summary of Project Benefits	14
1.1	Unique Project Benefits	14
1.2	Standardized Benefit Metrics	14
2	General	19
2.1	Project Goals, Design and Long-Term Viability	19
2.2	Without-project Land-Use Scenario and Additionality	50
2.3	Stakeholder Engagement.....	51
2.4	Management Capacity	57
2.5	Legal Status and Property Rights	62
3	Climate	67
3.1	Application of Methodology	67
3.2	Quantification of GHG Emission Reductions and Removals	102
3.3	Monitoring.....	171
3.4	Optional Criterion: Climate Change Adaptation Benefits	184
4	Community.....	188
4.1	Without-Project Community Scenario	188
4.2	Net Positive Community Impacts	196
4.3	Other Stakeholder Impacts	197
4.4	Community Impact Monitoring	200
4.5	Optional Criterion: Exceptional Community Benefits	204
5	Biodiversity.....	205
5.1	Without-Project Biodiversity Scenario	205
5.2	Net Positive Biodiversity Impacts.....	219
5.3	Offsite Biodiversity Impacts.....	223
5.4	Biodiversity Impact Monitoring	224
5.5	Optional Criterion: Exceptional Biodiversity Benefits	225
6	REFERENCES.....	231
7	LIST OF ANNEXES	234

List of Figures

Figure 1. Photograph of dense forest.	31
Figure 2. Photograph and drone image of dense forest (April 25 th , 2018).	32
Figure 3. Conceptual model of the SMPP.	39
Figure 4. Results of the regression analysis to test the significance of the historic trend in the cumulative area licensed for conversion to HTI plantations between 2006 and 2015.	155
Figure 5. Data collection, QA/QC, and processing workflow. Steps in oval = conducted internally by the project staff; Steps in rectangle = conducted by either internal project staff or external project consultant.	184

List of Maps

Map 1. Location of the SMPP area in Sumatra, Indonesia.	22
Map 2. Location of the SMPP area and zone.	23
Map 3. Elevation classes in and around the SMPP.	24
Map 4. Slopes in and around the SMPP.	25
Map 5. Soil types in and around the SMPP.	26
Map 6. Hydrology of the SMPP area and Merang-Kepayang Peat Hydrological Unit (KHG).	28
Map 7. Land cover classification of the SMPP area.	29
Map 8. The SMPP project zone.	35
Map 9. Potential locations and types of canal blocks within the SMPP area.	42
Map 10. Land cover classification in the project area.	76
Map 11. Peat depth stratification (by every 50 cm) of the project area.	79
Map 12. Drainability elevation limit of the project area.	80
Map 13. Digital terrain model of the project area.	81
Map 14. Peatland area subject to microbial decomposition and burning.	82
Map 15. PDT of the project area.	83
Map 16. Stratification of peat carbon stock at the project start.	85
Map 17. Peat carbon stock in the baseline scenario at $t = 100$	86
Map 18. Peat carbon stock in the project scenario at $t = 100$	87
Map 19. Carbon stock difference between the baseline and project scenarios at $t = 100$	89
Map 20. Area eligible for crediting for WRC project activities.	90
Map 21. Eligible areas for crediting ARR project activities.	91
Map 22. Water table level monitoring and peat inventory locations.	95
Map 23. Production Forest land status map.	98
Map 24. Regional mining concessions.	101
Map 25. Location of the project area and the six reference regions selected for proxy areas.	110

Map 26. Baseline scenario map of the project area.	114
Map 27. Baseline stratification of the project area based on emission characteristics.....	116
Map 28. Fire occurrence suitability that predicted risk probability.	127
Map 29. Initial stratification based on emission characteristics for WRC.	138
Map 30. Strata changes in the project scenario.....	139
Map 31. Forest cover benchmark map	181
Map 32. HCV 5 areas throughout the SMPP.	191
Map 33. Farming areas along the southern boundary of the SMPP (HCV 5).	192
Map 34. Fishing areas along the Tembesu Daro canal (HCV 5).	193
Map 35. Fishing areas along the Kepadang river (HCV 5).	194
Map 36. Fishing areas along the Buring river (HCV 5).	195
Map 37. Approximate location for gibbon listening posts.	209
Map 38. Sites for camera-trap establishment and bird monitoring transects.	210
Map 39. Locations related to HCV 1, species diversity, in the SMPP area.	216
Map 40. Locations related to HCV 3, ecosystems and habitat, in the SMPP area.....	217
Map 41. Locations related to HCV 4, ecosystem services, in the SMPP area.	218

List of Tables

Table 1. Climate in the SMPP area. ⁹	26
Table 2. Percent (%) distribution of the SMPP land cover classification.	29
Table 3. Description of nearby settlements where other stakeholders in the SMPP area live.	37
Table 4. Key milestones in the SMPP's development and implementation.....	45
Table 5. Estimated GHG emission reduction or removals (i.e. estimated VCUs).	46
Table 6. Summary of non-permanence risk analysis for the SMPP.	48
Table 7. Summary of stakeholder consultations (one-on-one interviews, group interviews, meetings, and focus group discussions).....	53
Table 8. Key skills required to implement the project activities.	59
Table 9. List of PAN/RAP license approvals.....	65
Table 10. Summary of applicability conditions.....	67
Table 11. Summary of accuracy in an error matrix.....	74
Table 12. Requirements per VM0007 (version 1.6) Module X-STR.	77
Table 13. Peat thickness, area, and percentage.	78
Table 14. Summary of the PDT stratification of the project area.	83
Table 15. Volume of peat carbon stock in the project area at the project start.	84
Table 16. Summary of the area eligible for crediting WRC activities.....	89

Table 17. Summary of the area eligible for crediting ARR activities.....	92
Table 18. Summary of carbon pools.	92
Table 19. GHG sources included in the WRC project boundary.	93
Table 20. GHG sources included in the ARR project boundary.	94
Table 21. Description of the major alternative land-use scenarios for the project area (Outcome of Step 1a).	96
Table 22. Consistency of alternative land-use scenarios with laws and regulations (Outcome of Step 1b).	98
Table 23. Identification of barriers that would prevent the implementation of each scenario (Outcome of Step 2a).	99
Table 24. Project scale and estimated GHG emission reductions or removals (i.e. estimated VCUs). ...	102
Table 25. Reference region selection criteria.	107
Table 26. Summary of suitable reference regions	109
Table 27. Baseline stratification of peatlands and water bodies based on emission characteristics.	114
Table 28. Land use strata change in the baseline scenario for ARR	116
Table 29. Variables used for quantifying baseline GHG emissions from microbial decomposition of peat, peat burnings and dissolved organic carbon from water bodies.....	117
Table 30. A summary of the annual GHG emissions from peat microbial decomposition, uncontrolled peat burning and water bodies in the project area under the baseline scenario since the start of the project in 2016.	119
Table 31. The stratification used for the calculation of GHG emissions per stratum, the area (ha) per each stratum and the CO ₂ and CH ₄ default factors used for the specific land-use	122
Table 32. GHG emissions from microbial decomposition of peat in the baseline scenario.....	124
Table 33. Total GHG emissions from uncontrolled peat burning in the baseline scenario per stratum. ..	128
Table 34. Annual GHG emissions from uncontrolled peat burning in the baseline scenario in t CO ₂ -e yr ⁻¹	129
Table 35. GHG emissions from Dissolved Organic Carbon in water bodies in the baseline scenario.	131
Table 36. The assumed annual planting and harvesting under ARR activities within the project period.	132
Table 37. Baseline net GHG removal from ARR activities in project area within project period.	134
Table 38. Stratification of project area based on emission characteristics from peat and water bodies at project start date.	137
Table 39. Changes in strata based on emission characteristics from peat and water bodies in the project scenario.....	138
Table 40. Variables used in the schematization of quantification of GHG emissions from microbial decomposition of peat and dissolved organic carbon from water bodies in peatlands in the project scenario.	140
Table 41. A summary of the annual GHG emissions from peat and water bodies under the project scenario up to 2062.	141
Table 42. The stratification used for the calculation of GHG emissions per stratum, the area (ha) per each stratum and the CO ₂ and CH ₄ default factors used for the specific land-use.	145

Table 43. GHG emissions from microbial decomposition of peat in the project scenario.	146
Table 44. GHG emissions from Dissolved Organic Carbon in water bodies in the project scenario.....	148
Table 45. Project scenario net GHG removals by ARR activity within the project period.....	151
Table 46. Applicability of leakage modules.....	153
Table 47. Official data on historic HTI concession licenses granted. ^{55,56}	154
Table 48. Annual area of clearance by the class of agents in the absence of the project.	155
Table 49. New area of annual deforestation by the baseline class of deforestation agents at which no leakage is occurring	157
Table 50. Deforested and forested area in HTI and unlicensed HP areas right before the project start. .	160
Table 51. Summary of peat thickness and average carbon stock loss at t_{PDT} in all HTI and unlicensed HP areas in Indonesia.	161
Table 52. Projection of undrained peatland in HP areas as alternative areas for leakage to peatland....	161
Table 53. Estimated emission factors of leakage to peatland.	162
Table 54. Proportion of undrained peatland areas in the alternative area.....	162
Table 55. Total net GHG emission reductions of the WRC project activity.	165
Table 56. Total net GHG removals of the ARR project activity.....	166
Table 57. Annual non-permanence risk buffer withholding.....	168
Table 58. Calculation of estimated verified carbon units.	170
Table 59. Climate change adaptation benefits from project activities.	186
Table 60. Summary of high conservation values related to community well-being in the SMPP area....	190
Table 61. Expected impacts for specific community groups in the SMPP.....	196
Table 62. Details of the SMPP's community monitoring plan.	201
Table 63. List of fauna and flora species identified during independent rapid biodiversity assessment. .	206
Table 64. Identification of internal threats and mitigation to protect HCVs in the SMPP area.	210
Table 65. Summary of high conservation values related to biodiversity in the SMPP area.	214
Table 66. Changes to biodiversity.....	220
Table 67. Species present in the SMPP that meet IUCN Red List criteria as critically endangered, endangered, and vulnerable species.	226
Table 68. Trigger species in the SMPP.	228

List of Annexes

Annex 1 Identification of project risks	234
Annex 2 VCS AFOLU Non-Permanence risk analysis	234
Annex 3 Land Cover Classification of the project area.....	234
Annex 4 Lidar-derived Digital Terrain Model (DTM) overview	234
Annex 5 Peat inventory of the project area.....	234

Annex 6 Justification of eligibility of the ARR project area.....	234
Annex 7 Hydrological modeling for the project scenario.....	234
Annex 8 Canal blocking plan and hydrological monitoring planning standard operation procedures	234
Annex 9 Proxy analysis of reference region for conversion/deforestation rate	234
Annex 10 Strata changes in the baseline scenario.....	234
Annex 11 Default factors for quantification of GHG emissions in the baseline and project scenario.....	235
Annex 12 Regional fire probability modeling for predicting fire risk.....	235
Annex 13 Estimate of annual area burnt and simulation of 100-year fire occurrence	235
Annex 14 Uncertainty in WRC estimates	235
Annex 15 Peat characteristics and subsidence monitoring SOPs.....	235
Annex 16 HCV assessment related to biodiversity in the project zone	235

List of Acronyms

A/R	Afforestation / Reforestation
ACF	Althelia Climate Fund
AFOLU	Agriculture, Forestry, and Other Land-Use
AGB	Aboveground biomass
ANR	Assisted Natural Regeneration
APHI	<i>Asosiasi Pengusaha Hutan Indonesia</i> / Indonesian Forest Concessionaires Association
APL	<i>Area Penggunaan Lain</i> / Other Land Utilization
ARR	Afforestation, Reforestation, and Revegetation
BD	Bulk Density
BRG	<i>Badan Restorasi Gambut</i> / Peat Restoration Agency
C	Carbon
CBD	Convention on Biological Diversity
CCB(A)	Climate, Community, and Biodiversity (Alliance)
CDM	Clean Development Mechanism
CE	Total Community Engagement
CH ₄	Methane
CIFOR	Center for International Forestry Research
CIRAD	<i>Centre de cooperation Internationale en recherche agronomique pour le developpement</i> / French Agricultural Research Centre for International Development
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CO ₂	Carbon dioxide
CO ₂ -e	Carbon dioxide equivalents
CPUE	catch per unit effort
CR	Critically Endangered
CUPP	Conservation of Undrained and Partially Drained Peatland
DBH	Diameter at Breast Height
DEL	Drainability Elevation Limit
DM	Dry Matter
dNDVI	Differencing NDVI
DOC	Dissolved Organic Carbon
DRM	Disaster Risk Management
DTM	Digital Terrain Model
EN	Endangered
ENSO	El Niño / Southern Oscillation
ER	Emission Reduction
ESA	European Space Agency
EVI	Enhanced Vegetation Index

EWS	Early Warning System
F	Fire
FAO	Food and Agriculture Organization of the United Nations
FCPA	US Foreign Corruption Practice Act
FGD	Focus Group Discussion
FPIC	Free, Prior, and Informed Consent
FRS	Fire Response and Suppression
FSC	Forest Stewardship Council
FV	Total Financial Viability
G	Geological Events
GFOI	Global Forest Observations Initiative
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GMO	Genetically Modified Organism
GOFC-GOLD	Global Observation for Forest Cover and Land Dynamics
HCV	High Conservation Value
HDI	Human Development Index
HP	<i>Hutan Produksi</i> / Production Forest
HPK	<i>Hutan Produksi Konversi</i> / Conversion Production Forest
HR	Human Resources
HTI	<i>Hutan Tanaman Industri</i> / Industrial Plantation Forest
IMF	International Monetary Fund
INCAS	Indonesian National Carbon Accounting System
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IUP PAN/RAP	<i>Izin Usaha Pemanfaatan Penyerapan Karbon dan/atau Penyimpanan Karbon</i> / Carbon storage and sequestration license
KHG	<i>Kesatuan Hidrologi Gambut</i> / Peat Hydrological Unit
LiDAR	Light Detection and Ranging
LT	Total Land Tenure
MNDWI	Modified Normalized Difference Water Index
MODIS	Moderate-Resolution Imaging Spectroradiometer
MoE&F	Indonesian Ministry of the Environment and Forestry
MRPP	Merang REDD Pilot Project
MRV	Monitoring, Reporting, and Verification
MSAVI	Modified Soil Adjusted Vegetation Index
N ₂ O	Nitrous oxide
NBR	Normalized Burn Ratio

NBR2	Normalized Burn Ratio 2
NDC	National Determined Contribution
NDMI	Normalized Difference Moisture Index
NDVI	Normalized Difference Vegetation Index
NDWI	Normalized Difference Water Index
NER	Net GHG Emission Reductions
NGR	Net GHG Emission Removals
NTFP	Non-Timber Forest Products
OC	Total Opportunity Cost
OLI	Landsat 8 Operational Land Imager
ON	Other Natural Risk
PC	Total Political
PCA	principal component analysis
PD	Project Description
PD	Pest and Disease Outbreak
PDT	Peat Depletion Time
PERADI	<i>Perhimpunan Advokat Indonesia</i> / Indonesian Bar Association
PKBM	<i>Pusat Kegiatan Belajar Masyarakat</i> / Learning Centers
PL	Total Project Longevity
PM	Total Project Management
<i>Polindes</i>	<i>Pondok Bersalin Desa</i> / Village Maternity Clinic
PRA	Participatory Rural Appraisal
PT GAL	PT Global Alam Lestari
PT RHM	PT Rimba Hutani Mas
PT WLMS	PT Wahana Lestari Makmur Sukses
<i>Puskesmas</i>	<i>Pusat Kesehatan Desa</i> / Village Health Centre
<i>Pustu</i>	<i>Puskesmas Pembantu</i> / Health Branch Clinic
QA/QC	Quality Assurance/Quality Control
RDP	Rewetting of Drained Peatland
REDD	Reduced Emissions from Deforestation and forest Degradation
REDD+	Reducing Emissions from Deforestation and Degradation plus carbon stock enhancement
RTE	Rare, threatened, or endangered (species or ecosystems)
SAVI	Soil Adjusted Vegetation Index
SD	<i>Sekolah Dasar</i> / Elementary School
SDG	Sustainable Development Goals of the United Nations Organization
SMA	<i>Sekolah Menengah Atas</i> / High School
SMART	Spatial Monitoring and Reporting Tool

SMP	<i>Sekolah Menengah Pertama</i> / Junior High School
SMPP	Sumatra Merang Peatland Project
SOP	Standard Operation Procedure
SRTM	Shuttle Radar Topography Mission
TIRS	Landsat 8 Thermal Infrared Sensor
tPDT	time (years) until PDT is reached, i.e. all peat soil is depleted
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
USGS	U.S. Geological Survey
VCS	Verified Carbon Standard
VCU	Verified Carbon Unit
VIIRS	Visible Infrared Imaging Radiometer Suite
VU	Vulnerable
W	Extreme Weather
WRC	Wetlands Restoration and Conservation

1 SUMMARY OF PROJECT BENEFITS

This section highlights some of this project's important benefits. Section 1.1 (Unique Project Benefits) should be considered in conjunction with project's conceptual model and is specific to this project. Section 1.2 (Standardized Benefit Metrics) provides estimates on quantifiable benefit that will be generated over the lifetime of the project.

1.1 Unique Project Benefits

The Sumatra Merang Peatland Project (SMPP) aims to generate a variety of project benefits throughout the lifetime of our project. This section outlines unique project benefits that are not captured in Section 1.2 below.

Outcome or Impact Estimated by the End of Project Lifetime	Section Reference
1) Fire prevention and fire threat reduction, achieved through: • Reduction in human activity within the SMPP area (this is the greatest risk that leads to fire) to prevent fires; • Satellite-based early warning system (EWS) to detect and mitigate fires as early as possible; • Forest patrols focused on detecting and identifying hotspots of fire threats, and continuously monitoring the fire threats in the SMPP; • Fire training for SMPP staff working inside the project area; and • Fire training for nearby concessions and SMPP stakeholders. Through our project efforts, we aim to achieve a target of zero fires within the project area and maximize fire resilience in the SMPP and surrounding landscape. These efforts which will allow natural forest ecosystems to recover, provide extended habitats that support key species, and limit the negative impacts to health and livelihoods from smoke haze and air pollution.	2.1.11

1.2 Standardized Benefit Metrics

Category	Metric	Estimated by the End of Project Lifetime	Section Reference
GHG emission reductions or removals	Net estimated emission removals in the project area, measured against the without-project scenario	5,915,842	3.2.4.3
	Net estimated emission reductions in the project area, measured against the without-project scenario	67,308,950	3.2.4.2

Category	Metric	Estimated by the End of Project Lifetime	Section Reference
Forest ¹ cover	For REDD ² projects: Estimated number of hectares of reduced forest loss in the project area measured against the without-project scenario	N/A	N/A
	For ARR ³ projects: Estimated number of hectares of forest cover increased in the project area measured against the without-project scenario	20,601.37 Hectares (Ha)	3.1.3.1.7
Improved land management	Number of hectares of existing production forest land in which IFM ⁴ practices are expected to occur as a result of project activities, measured against the without-project scenario	N/A	N/A
	Number of hectares of non-forest land in which improved land management practices are expected to occur as a result of project activities, measured against the without-project scenario	N/A	N/A
Training	Total number of community members who are expected to have improved skills and/or knowledge resulting from training provided as part of project activities	Identified project community members: 100% = 23 Other stakeholders who are residents in nearby villages and settlements: 25% = ~1,438 people	2.1.11; 4.3.1
	Number of female community members who are expected to have improved skills and/or knowledge	At least 25% of women in community families and nearby	2.1.11.5

¹ Land with woody vegetation that meets an internationally accepted definition (e.g., UNFCCC, FAO or IPCC) of what constitutes a forest, which includes threshold parameters, such as minimum forest area, tree height and level of crown cover, and may include mature, secondary, degraded and wetland forests (*VCS Program Definitions*)

² Reduced emissions from deforestation and forest degradation (REDD) - Activities that reduce GHG emissions by slowing or stopping conversion of forests to non-forest land and/or reduce the degradation of forest land where forest biomass is lost (*VCS Program Definitions*)

³ Afforestation, reforestation and revegetation (ARR) - Activities that increase carbon stocks in woody biomass (and in some cases soils) by establishing, increasing and/or restoring vegetative cover through the planting, sowing and/or human-assisted natural regeneration of woody vegetation (*VCS Program Definitions*)

⁴ Improved forest management (IFM) - Activities that change forest management practices and increase carbon stock on forest lands managed for wood products such as saw timber, pulpwood and fuelwood (*VCS Program Definitions*)

Category	Metric	Estimated by the End of Project Lifetime	Section Reference
	resulting from training as part of project activities	villages and settlements = ~704 women	
Employment	Total number of people expected to be employed in project activities, ⁵ expressed as number of full-time employees ⁶	Approximately 75 to 100 people	2.1.11.5; 4.2.1; 4.4.1
	Number of women expected to be employed as a result of project activities, expressed as number of full-time employees	At least 25% of employees = approximately 18 to 25 women	2.1.11.5; 4.2.1; 4.4.1
Livelihoods	Total number of people expected to have improved livelihoods ⁷ or income generated as a result of project activities	At least 50% of residents in nearby villages and settlements = ~2,876 people	2.1.11.5; 4.2.1; 4.3.1
	Number of women expected to have improved livelihoods or income generated as a result of project activities	At least 50% of female residents in nearby villages and settlements = ~1,408 women	2.1.11.5; 4.2.1; 4.3.1
Health	Total number of people for whom health services are expected to improve as a result of project activities, measured against the without-project scenario	All 5,752 residents of nearby villages and settlements, comprising 1,640 families	2.1.11.5; 4.3.1
	Number of women for whom health services are expected to improve as a result of project activities, measured against the without-project scenario	All 2,817 female residents of nearby villages and settlements	2.1.11.5; 4.2.1; 4.3.1

⁵ Employed in project activities means people directly working on project activities in return for compensation (financial or otherwise), including employees, contracted workers, sub-contracted workers and community members that are paid to carry out project-related work.

⁶ Full time equivalency is calculated as the total number of hours worked (by full-time, part-time, temporary and/or seasonal staff) divided by the average number of hours worked in full-time jobs within the country, region or economic territory (adapted from the UN System of National Accounts (1993) paragraphs 17.14[15.102];[17.28])

⁷ Livelihoods are the capabilities, assets (including material and social resources) and activities required for a means of living (Krantz, Lasse, 2001. *The Sustainable Livelihood Approach to Poverty Reduction*. SIDA). Livelihood benefits may include benefits reported in the Employment metrics of this table.

Category	Metric	Estimated by the End of Project Lifetime	Section Reference
Education	Total number of people for whom access to, or quality of, education is expected to improve as result of project activities, measured against the without-project scenario	At least 45% of the population of nearby villages and settlements that are ages 11-40 = ~2,500 people	2.1.11.5; 4.2.1; 4.3.1; 4.4.1
	Number of women and girls for whom access to, or quality of, education is expected to improve as result of project activities, measured against the without-project scenario	At least 45-50% of the population of nearby villages and settlements that are women or girls ages 11-40 = ~1,250 women and girls	2.1.11.5; 4.2.1; 4.3.1; 4.4.1
Water	Total number of people who are expected to experience increased water quality and/or improved access to drinking water as a result of project activities, measured against the without-project scenario	At least 20% of residents in nearby villages and settlements = ~ 1,150 people	2.1.11.5; 4.3.1
	Number of women who are expected to experience increased water quality and/or improved access to drinking water as a result of project activities, measured against the without-project scenario	At least 20% of female residents in nearby villages and settlements = ~563 women	2.1.11.5; 4.3.1
Well-being	Total number of community members whose well-being ⁸ is expected to improve as a result of project activities	At least 50% of residents in nearby villages and settlements = ~1,438 people	4.2.1; 4.3.1; 4.4.1
	Number of women whose well-being is expected to improve as a result of project activities	At least 50% of female residents in nearby villages and settlements = ~1,408 women	4.2.1; 4.3.1; 4.4.1

⁸ Well-being is people's experience of the quality of their lives. Well-being benefits may include benefits reported in other metrics of this table (e.g. Training, Employment, Livelihoods, Health, Education and Water), and may also include other benefits such as strengthened legal rights to resources, increased food security, conservation of access to areas of cultural significance, etc.

Category	Metric	Estimated by the End of Project Lifetime	Section Reference
Biodiversity conservation	Expected change in the number of hectares managed significantly better by the project for biodiversity conservation, ⁹ measured against the without-project scenario	22,922 Ha	2.1.7; 5.4.1
	Expected number of globally Critically Endangered or Endangered species ¹⁰ benefiting from reduced threats as a result of project activities, ¹¹ measured against the without-project scenario	10 Critically Endangered or Endangered species and 19 Vulnerable species occurring in the project area.	5.5.1

⁹ Managed for biodiversity conservation in this context means areas where specific management measures are being implemented as a part of project activities with an objective of enhancing biodiversity conservation, e.g. enhancing the status of endangered species

¹⁰ Per IUCN's Red List of Threatened Species

¹¹ In the absence of direct population or occupancy measures, measurement of reduced threats may be used as evidence of benefit

2 GENERAL

2.1 Project Goals, Design and Long-Term Viability

2.1.1 Summary Description of the Project (G1.2)

About 60% of tropical peatland areas are located in the Southeast Asia region, with an estimated area of 25 million hectares (Mha).¹ Southeast Asia's tropical peatlands are particularly carbon-rich, comprising 77% of the global tropical peatland carbon pool, which is an estimated 68.5 gigatonnes (Gt).² Of the 11 countries in Southeast Asia, Indonesia's 57.4 Gt carbon pool is the largest at 65%, with an area of 15 million hectares (Mha) of peatland.^{2,3} Although peatlands have the unique capacity to store carbon in massive quantities,⁴ these ecosystems are rapidly degrading due to industrial activities and land-use changes such as logging, conversion to crop and palm oil plantations, and drainage.^{3,5} These practices lead to organic matter oxidation and render peatlands a globally significant source of damaging greenhouse gas (GHG) emissions. Additionally, the impacts of climate change such as El-Niño events have affected an increase in forest fires that degrade peatland areas while simultaneously creating costs associated with health and other social impacts on communities.³ Sumatra in particular has a vast extent of peatlands that comprise 15% of the island's area.⁶ Throughout Sumatra and Kalimantan these ecosystems represent an estimated 30 Gt of carbon, across approximately 13 Mha.⁵

The Sumatra Merang Peatland Project (SMPP) aims to protect and restore 22,922 ha of a peatland ecosystem located in the Musi Banyuasin district in South Sumatra province. The SMPP sits within the Merang-Kepayang peat dome, one of the largest carbon rich peat swamp areas in Sumatra, covering more than 150,000 ha. This area and the surrounding peat zones are known for high levels of biodiversity and a multitude of critically endangered and vulnerable species including the sun bear (*Helarctos malayanus*), the Malay tapir (*Tapirus indicus*), and the Sumatran tiger (*Panthera tigris ssp. Sumatrae*).

The Merang-Kepayang peat dome was first subjected to commercial exploitation in the 1980s, primarily for the extraction of timber. The SMPP area was commercially logged throughout the 1990s and saw the beginning of the site's degradation as canals were dug and trees felled. Commercial timber operations ceased in 2000 after the site's commercial timber stocks were exhausted, however degradation of the site continued as small-scale illegal loggers continued to extract timber from the area for local sawmills through an ever-expanding network of canals. Around this time, the expansion of commercial agriculture in the areas surrounding the SMPP area began to disrupt the overall hydrology of the landscape and gradual desiccation of the peat. Fires became a more prevalent feature in the landscape. Despite these drivers of land-use change, the SMPP area remained a site of biodiversity significance, harboring numerous endangered or rare species. Large fires in 2004, 2006, and 2015 continued the deforestation trend and further threatened these habitats.

In the absence of this project, this peatland ecosystem would be at particularly high risk for conversion to industrial agriculture, namely fast-growing Acacia plantations grown for pulp and paper. This conversion would lead to lowered water table levels and hence elevated GHG emissions due to increased microbial decomposition of the peat, as well as increased fire risks. The project prevents that scenario from happening by securing an *Izin Usaha Pemanfaatan Penyerapan Karbon dan/atau Penyimpanan Karbon* (IUP PAN/RAP or PAN/RAP) carbon storage and sequestration license – the first ever such license to be issued in Indonesia – which gives the company legal tenure of the project area and is a business license for the utilization of environmental services in protected and production forest areas. In addition to preventing the project area from being converted for industrial agriculture, the project implements fire prevention, hydrological restoration, forest rehabilitation, biodiversity conservation and community development interventions.

The SMPP is implemented by PT Global Alam Lestari (PT GAL), an Indonesian company that secured the PAN/RAP license for the project site, and Forest Carbon, a Southeast Asian technical Reducing Emissions

from Deforestation and forest Degradation plus carbon stock enhancement (REDD+) consulting and project development firm.

Project Objectives

The SMPP aims to restore the ecological functions of the Merang peatland through the use of sustainable land-use models that benefit critically endangered biodiversity and provide benefits for local communities. These overarching objectives will be achieved by implementing ecosystem and habitat restoration activities while establishing sustainable avenues for economic success amongst the local communities. Specific objectives focused on climate, biodiversity, and community goals are outlined below:

Emphasizing climate action:

- Credibly avoid peatland emissions through the protection and rehabilitation of the project site.
- Restore the variety, integrity, and extent of forest types to their original pre-2007 fire state to rejuvenate the presence of valuable ecosystem services and peatland habitats.
- Restore the hydrological integrity of the peatlands.
- Prevent fires and ensure the safety of local people through forest fire training, monitoring, and prevention procedures.

Supporting communities:

- Introduce economic opportunities and sustainable livelihood opportunities, focused on community-directed investments with both immediate, short-term, and long-term strategies in the SMPP's neighboring communities.
- Build stronger communities.
- Ensure continued access and sustainable use of natural resources by communities and local stakeholders.

Protecting biodiversity:

- Increase populations of critically endangered flora and fauna by eliminating the causes of deforestation and degradation in the project site.
- Establish ecological integrity with long-term ecosystem restoration.

Annual average and total GHG emission reductions and removals from the SMPP are 1,432,105 tonnes (t) CO₂-equivalents (CO₂-e) and 125,869 t CO₂, respectively, totaling 62,912,755 t of Verified Carbon Units (VCUs).

2.1.2 Project Scale

Project Scale	
Project	
Large project	X

2.1.3 Project Proponent (G1.1)

The SMPP has two project proponents, as listed below.

Organization name	PT Global Alam Lestari
Contact person	Mr. Riza Suarga
Title	Director
Address	Komp, Mall Ska Blok E 61, Delima, Tampan, Pekanbaru, Riau, 28294
Telephone	+62 761 7891749
Email	r.suarga@globalalamlestari.com

Organization name	Forest Carbon (registered as Equator Group Pte Ltd)
Contact person	Jeffrey Chatellier
Title	Managing Director
Address	1 Raffles Place, #44-01A One Raffles Place, Singapore, 048616
Telephone	+62 21 5740817
Email	j.chatellier@forestcarbon.com

2.1.4 Other Entities Involved in the Project

Key implementing and technical partners are listed below.

Organization	Althelia Climate Fund
Contact Person	Adam Gibbon
Title	Chief Technical Officer / Investment Director
Address	Unit 2, 7 Chalcot Road, Primrose Hill, London NW1 8LH, UK
Telephone	+44 (0) 77 362 869 27
Email	adam.gibbon@althelia.com

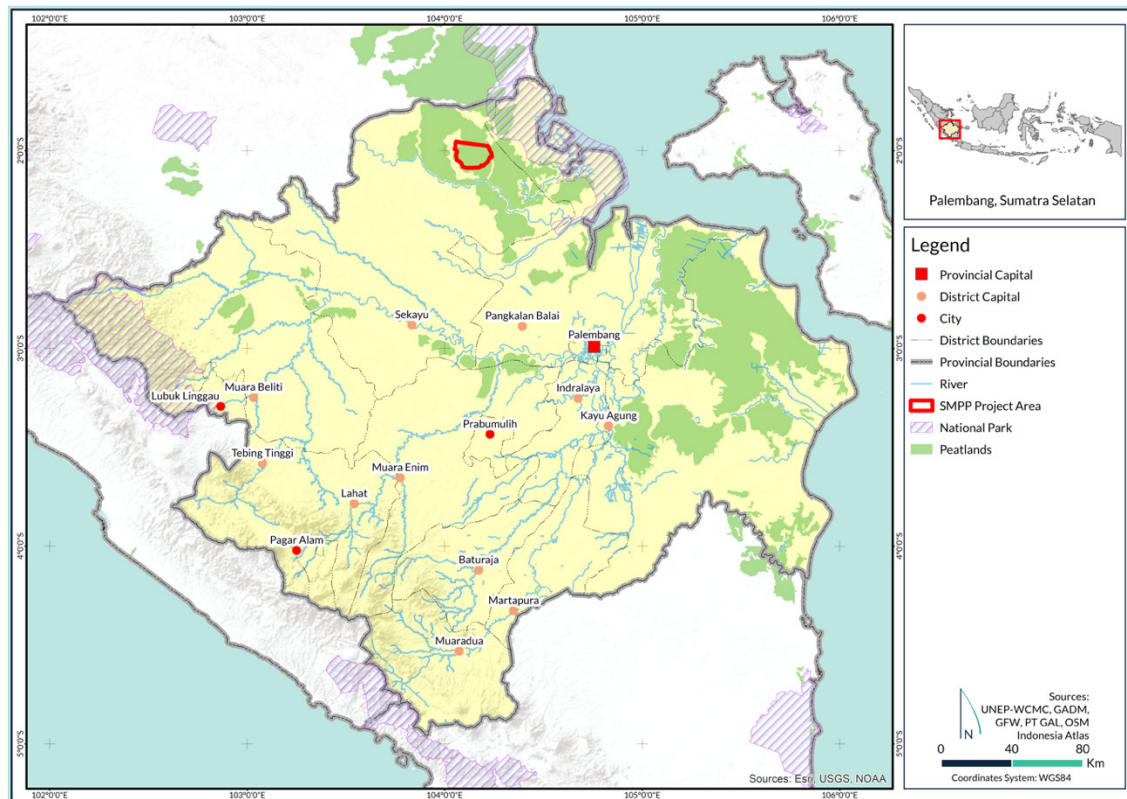
Organization	Ecosphere+
Contact Person	Lisa Walker
Title	CEO
Address	Unit 2, 7 Chalcot Road, Primrose Hill, London NW1 8LH, UK
Telephone	+44 203876 5228
Email	lisa@ecosphere.plus

2.1.5 Physical Parameters (G1.3)

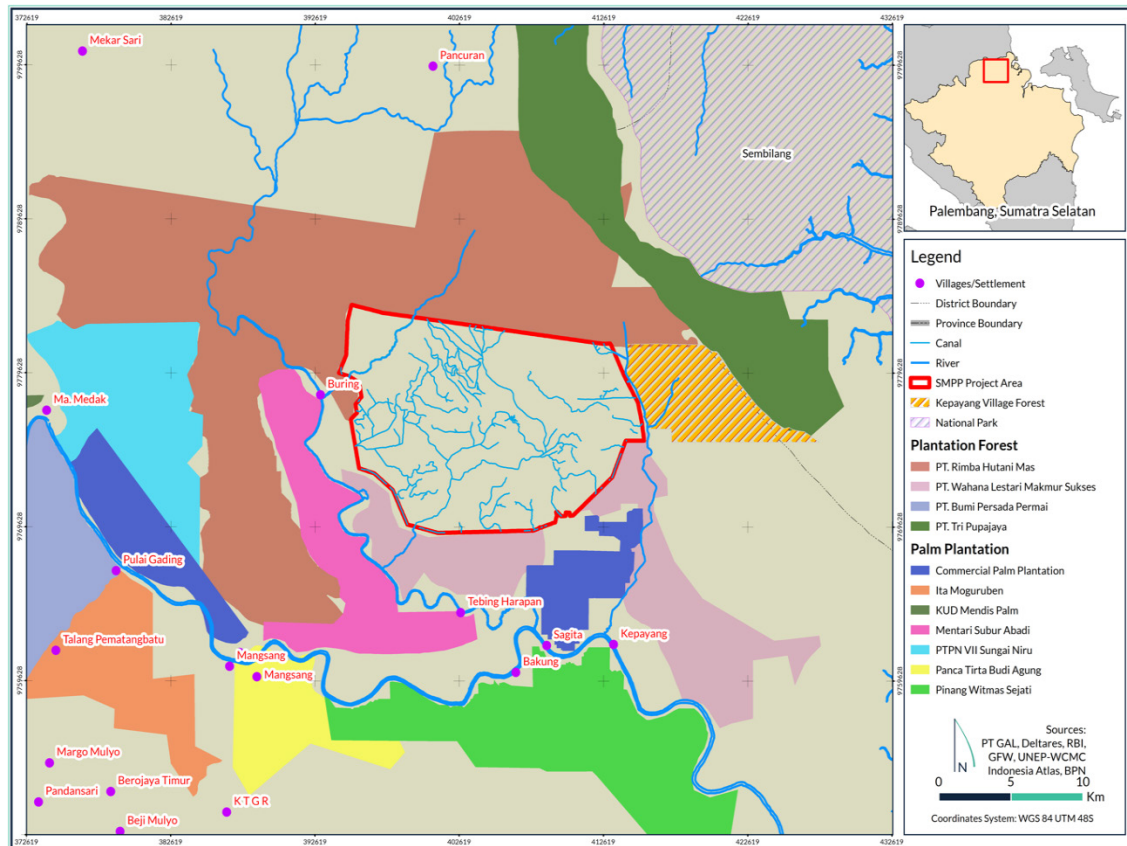
The SMPP is located within Bayung Lencir sub-district, Musi Banyuasin district, South Sumatra province, Sumatra, Republic of Indonesia (see Map 1). The Musi Banyuasin regency is located in the northern part of South Sumatra province and is between 103-104° 45' east (E) and 1.3° - 4° south (S), 14,265.96 square

kilometers (km²). The SMPP area lies between the following geographic coordinates: 2° 1' 9.01" S and 104° 8' 43.10" E (see Map 2).

Map 1. Location of the SMPP area in Sumatra, Indonesia.



Map 2. Location of the SMPP area and zone.

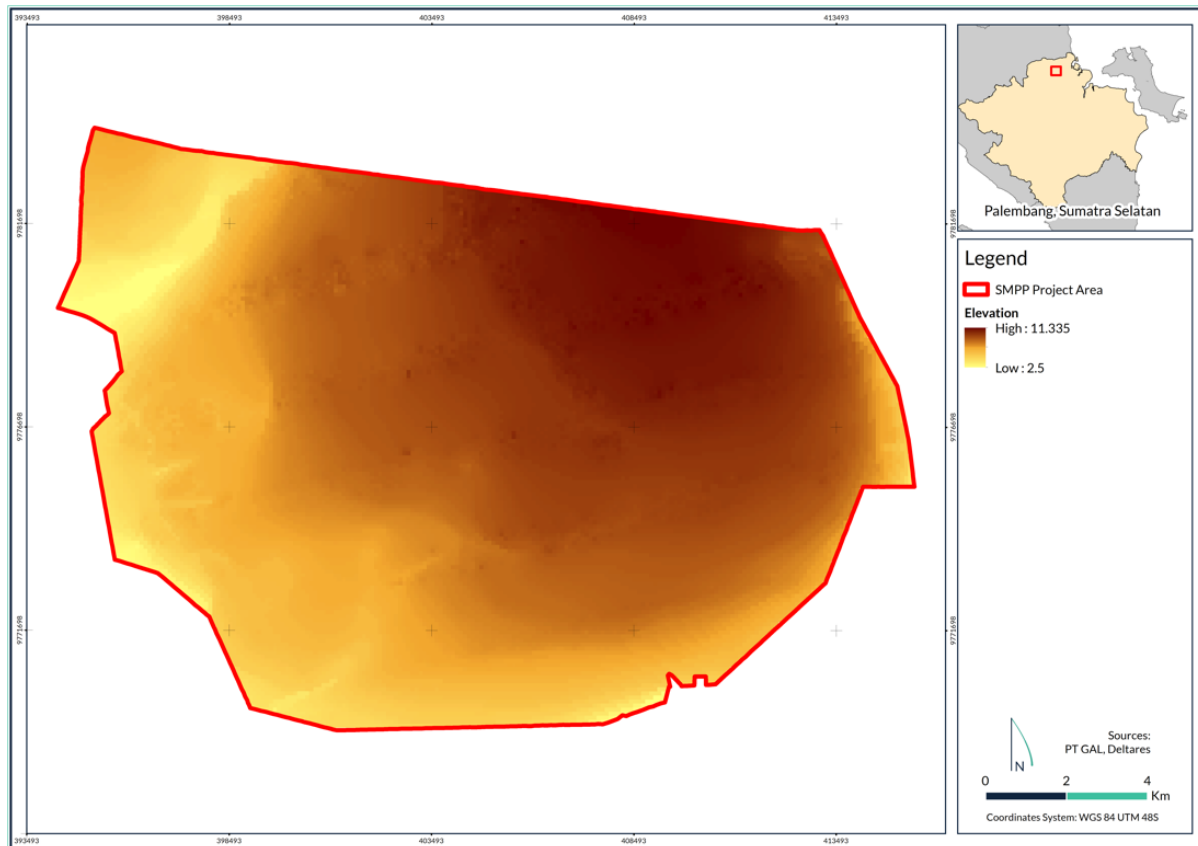


Environmental conditions of the SMPP area including topography, soil, climate, hydrology, vegetation types are described below.

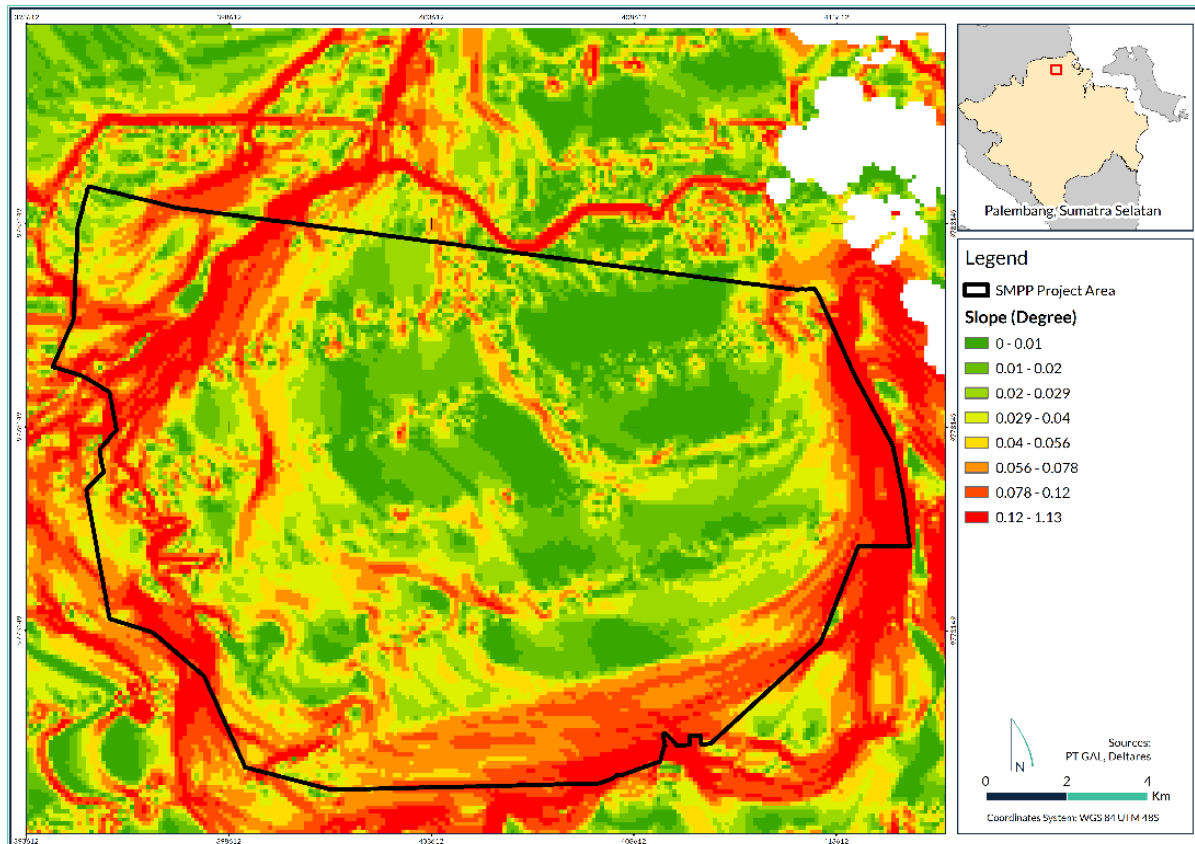
2.1.5.1 Topography

The SMPP falls within a topographically uniform and flat landscape. The majority of the project area sits within an altitude of 20-30 meters above sea level (m.a.s.l.) (see Map 3). The highest altitude is towards the center of the SMPP area (30-40 m above sea level) while the lowest areas are found in the western part of the concession near the Buring river as well as the eastern part near the Kepayang river (0-10 m.a.s.l.). All areas in the SMPP concession area have a slope class of 0-8%, which indicates flat terrain (see Map 4).

Map 3. Elevation classes in and around the SMPP.



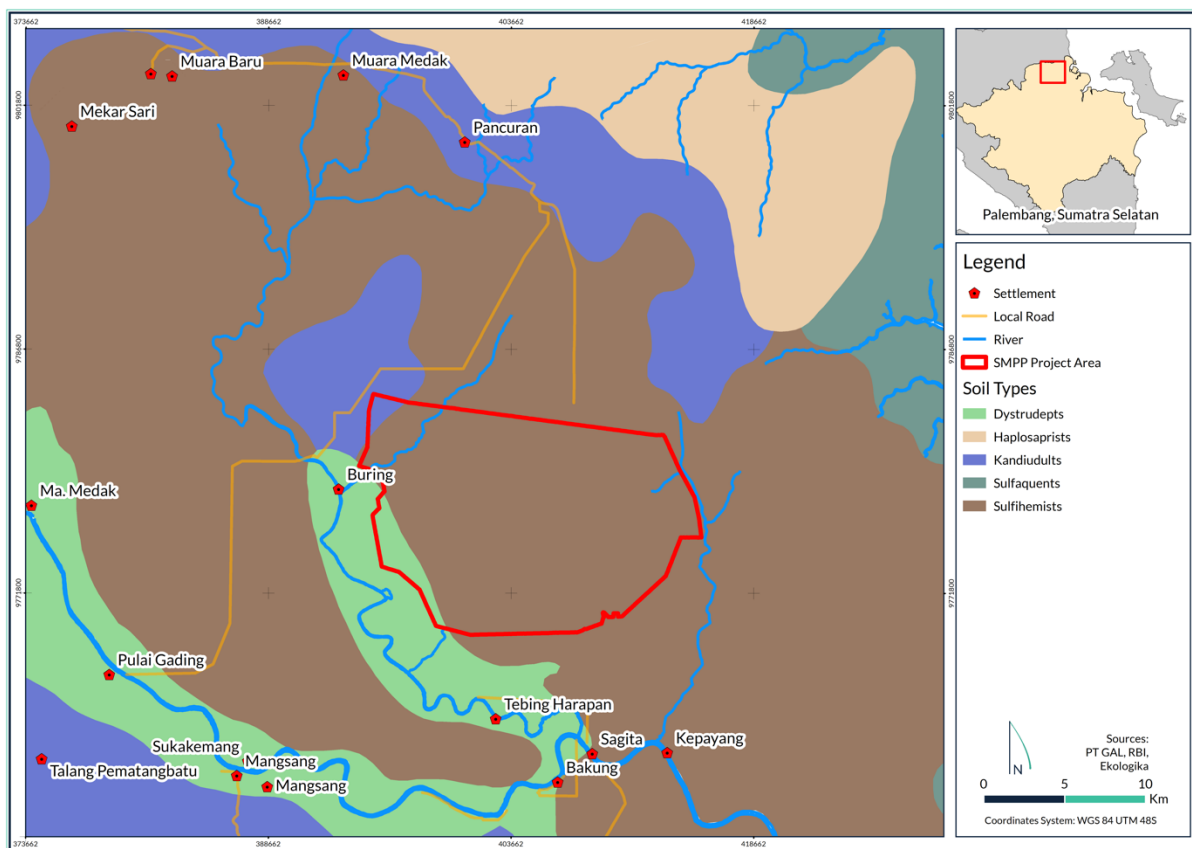
Map 4. Slopes in and around the SMPP.



2.1.5.2 Soil

Peat soils are created from the accumulation of organic materials, such as the residue of plants, that have composted at a slow rate over a long period of time.⁷ Based on the Food and Agriculture Organization of the United Nations (FAO) soil classification system, peat soils are called Histosol soils.^{7,8} There are three levels of peat maturity, fibric (immature), hemic (medium maturity), and sapric (mature) peat. Peat soils are generally inundated all year long, unless manually altered and drained due to canal construction to develop industrial forest plantations or as an irrigation system (see Map 5). Naturally, peat soils are located on the top-most layer with mineral or alluvial soils underneath.⁷ A peat dome stores water and releases it back into the watershed at a slow rate. Hence, during the dry season, a high volume of underground water is discharged at a slow rate, ensuring peat soils stay inundated until the next wet season.⁸

Map 5. Soil types in and around the SMPP.



2.1.5.3 Climate

The SMPP area experiences a tropical monsoonal climate, with two distinct rainy and dry seasons. For most of the year, there is significant rainfall in the study area (see

Table 1). There is only a short dry season starting from June, which lasts through September. Average annual rainfall is 2,179 millimeters (mm). The lowest average rainfall is in August (peak of the dry season), while the highest average precipitation falls in January (peak of the wet season). The annual temperature averages around 26.8°C. The average highest temperature is in October (27.8°C), while the lowest average temperature occurs in January (26.0°C).

Table 1. Climate in the SMPP area.⁹

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Average Temperature (°C)	26	26	26.1	27	27.1	26.9	26.3	26.9	27.5	27.8	27.5	26.5
Average Precipitation (mm)	398	296	249	188	166	81	84	50	66	132	203	266

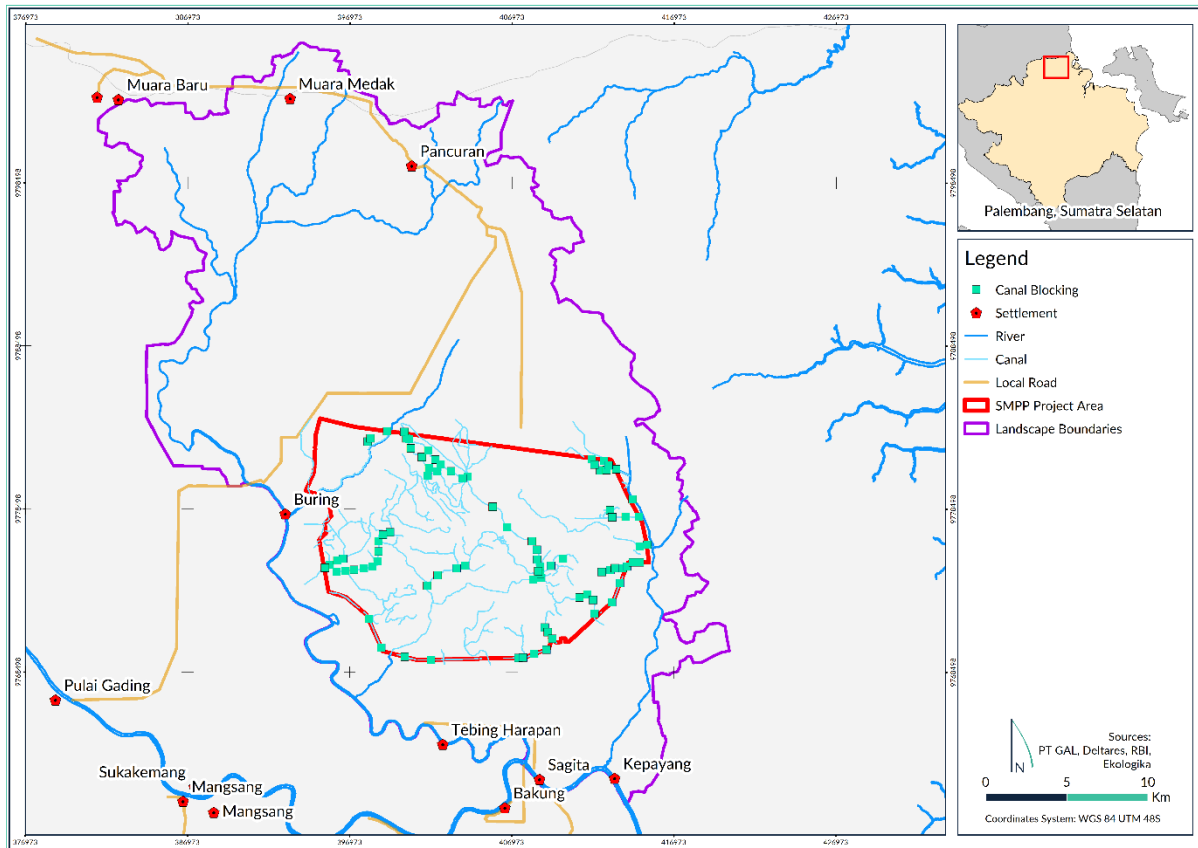
2.1.5.4 Hydrology

As mentioned in Section 2.1.1, the project area is part of the Merang-Kepayang Peat Hydrological Unit (*Kesatuan Hidrologi Gambut* or KHG). Geographically, the SMPP is situated between two main rivers, the Merang in the west and the Kepayang in the east, both of which are tributaries of the more prominent Lalan river. Other tributaries and canals are present, as well as the Tembesu Daro canal and the Buring river that cuts across the northwestern part of the project boundary. This area experiences a tropical monsoonal climate with wet and dry seasons. The hydrology profile of the Merang peat dome makes this area particularly vulnerable to desiccation from canal construction, especially during the dry season, where lower water levels are exacerbated. The average height difference from the top of the peat dome is more than 5 meters above most rivers. During the rainy season, the majority of the project area experiences a period of inundation, followed by drainage and drying out. Based on field visits, it is clear that drainage is the main cause of peat drying in the concession.

In the Merang-Kepayang Hydrological Unit, canals are manmade and were created for transporting harvested timber out of the Merang-Kepayang forest area. In early 1990, the Tembesu Daro river was only 600 m long but illegal loggers extended the scale of this small river.⁸ By 2009, the river was already more than 14 kilometers (km) cutting through the deep peat dome of the SMPP area.⁸

The SMPP site experienced a series of major fire events in 2015 when a significant portion of the site was burned, causing notable uneven patterns in the vegetation moisture content and plant-water stress level. After three years of post-fire recovery, this degraded landscape is still facing challenges to foster vegetation regrowth, considering previous peatland drainage from the canal network.

Map 6. Hydrology of the SMPP area and Merang-Kepayang Peat Hydrological Unit (KHG).



2.1.5.5 Vegetation Types

Through an extensive analysis, our land cover classification map shows that 95.4%, 1.9%, 1.3% and 1.4% of the SMPP site are 1) Open canopy tree/shrub/herbaceous mix, 2) Close canopy tree/shrub/herbaceous mix, 3) Dense forest, and 4) Water/swamp mix. The land cover classification for the SMPP project area is available in Map 7.

Map 7. Land cover classification of the SMPP area.

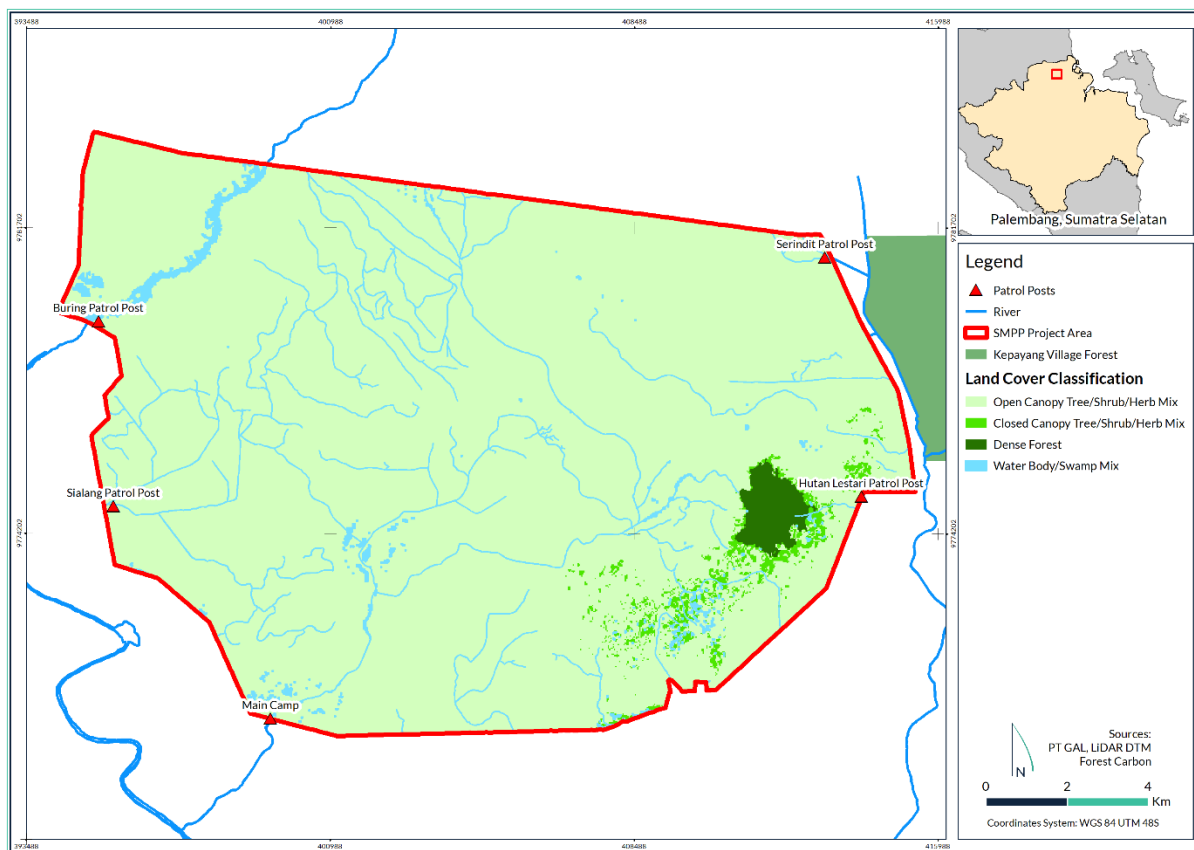


Table 2. Percent (%) distribution of the SMPP land cover classification.

Land cover type	Area percentage in SMPP (%)
Open canopy tree/shrub/herbaceous mix	95.4
Closed canopy tree/shrub/herbaceous mix	1.9
Dense forest	1.3
Water/swamp mix	1.4
Total	100 (of 22,922 ha)

The final classification for forest/non-forest classes showed that 1.3% and 98.7% of the SMPP site contained forest and non-forest areas respectively. This merged classification achieved 99.1% of overall accuracy.

Each of the four land cover classes are described in detail below:

2.1.5.5.1 Open canopy tree/shrub/herb mix

The open canopy tree/shrub/herb mix is dominated by understory dense ferns and short shrubs. While *Melaleuca cajuputi* (gelam) occurs scattered in low densities throughout the SMPP area and only dominates the vegetation in the central area along the Tembesu Daro canal, that has burnt at least four times since 2000, covers approximately 1,200 ha. In this area, *Melaleuca cajuputi* trees 4-5 m tall (dbh is 4-5

centimeters (cm)) form a relatively dense cover (up to 50-70% locally) and totally dominate the tree stratum, although other species (notably *Cratoxylum arborescens*/geronggang, *Melicope lunu-ankenda*/sepongol and *Alstonia pneumatophora*/pulai) also occur. Compared to other secondary peat swamp vegetation at the site, it is the least diverse (see Figure 2). Sedges (*Scleria sumatrana*) and ferns (*Blechnum indicum* and *Stenochlaena palustris*) form a dense ground cover, interspersed with an occasional climber (*Artabotrys suaveolens*, *Uncaria lanosa*) or small shrub (*Melastoma malabathricum*).

2.1.5.5.2 Closed canopy tree/shrub/herb mix

An average of 13 plant species were found at each location during a field survey (April 24th-26th, 2018), ranging from only 8 species at the *Melaleuca cajuputi* (gelam) dominated vegetation (site 4; see D below) to 27 species along the Buring river in the far northwest of the location. A total of 42 plant species were recorded on site, including at least three exotics (*Acacia crassicaarpa*, *Ludwigia hyssopifolia*, & *Mikania cordata*). Trees are found at all locations and secondary vegetation with ferns/sedges only was not encountered (see Figure 2). Most trees found are pioneer species (*Alstonia pneumatophora* (pulai), *Archidendron clypearia*, *Cratoxylum arborescens* (geronggang), *Elaeocarpus petiolatus*, *Fagraea fragrans* (tembesu), *Leea indica* (mamali), *Macaranga pruinosa* (mahang), *Melaleuca cajuputi* (gelam), *Melicope glabra* (bangun-bangun), *Melicope lunu-ankenda* (sepongol) and *Trema orientalis*) although some are also characteristic of mixed, primary peat swamp forest trees (e.g. *Alstonia pneumatophora* (pulai))). Along the Buring river (Figure 2) the number of trees remaining from prior to the 2015 fires is much higher than other areas, except in a zone around the 'hutan sisa' in the southeastern part of the SMPP area. From the ground, tree species that could be seen within several hundred meters include *Alstonia pneumatophora* (pulai), *Camposperma coriaceum* (terentang), *Dialium platysepalum* (keranji), *Diospyros* sp. (arang-arang), *Dyera polyphylla* (jelutung), *Koompassia malaccensis* (menggeris), *Quassia borneensis* (pahit-pahit), *Parastemon urophyllus* (mariawan) and *Shorea uliginosa* (meranti kelungkang).

2.1.5.5.3 Dense forest

Dense forest at the SMPP (of which a 232 ha remnant remains: the 'hutan sisa') is characterized by the presence of a wide range of tree species (>200), a closed canopy (with a height of ±20-25 m) and emergent species that tower above the closed canopy to heights of 35-45m (Figure 2). Closed canopy tree species include *Camposperma coriaceum* (terentang), *Carallia brachiata* (semeragi), *Dacryodes costata* (siuai), *Durio carinatus* (durian burung), *Ganua motleyana* (ketiau/nyatoh), *Horsfieldia glabra* (darah kero), *Mezzetium parviflora* (makai hitam), *Myrtistica iners* (biawak), *Palaquium burckii* (balam), *Polyalthia sumatrana* (makai putih), *Sindora bruggemanii* (kayu kapas), *Syzygium acuminatissimum* (balam cabe), *Syzygium clavimirtus* (balam sisil), *Xylopi altissima* (jangkang) and *Vatica ressak* (rasak). Emergent tree species include *Alstonia pneumatophora* (pulai), *Dyera polyphylla* (jelutung rawa), *Koompassia malaccensis* (kempas), *Shorea teysmanniana* (meranti merawan), *Shorea uliginosa* (meranti kelungkan) and *Tetramerista glabra* (punak). The understory includes various palms such as *Cyrtostachys renda* (sealing wax palm), *Eleiodoxa conferta* (asam payau), *Licuala paludosa* (fan palm or palas) and various rattan species (e.g. *Korthalsia* sp., the fish-tail rattan) and the tall pandan *Pandanus atrocarpus*, several aroids including *Aglaeonema nitidum* and *Alocasia longiloba*, a sparse scattering of ferns and several scattered sedges (including *Mapania bancanum*). The 'hutan sisa' at SMPP has been selectively logged at the edges, but to a large extent it is both floristically and structurally indistinguishable from primary mixed peat swamp forest.



Figure 1. Photograph of dense forest.



Figure 2. Photograph and drone image of dense forest (April 25th, 2018).

2.1.5.5.4 Water/swamp mix

Apart from a few small peat swamp forest streams, open water formerly did not occur in the SMPP area, so this habitat is largely new, which is also reflected by the paucity of aquatic species in the open waters. One would normally expect blackwater streams in open areas (i.e. without dense tree cover) to be lined with *Pandanus helicopus* (rasau) and *Hanguana malayana* (bakung), which is the case along rivers in the vicinity, such as along the Sungai Merang. However, *Hanguana malayana* seems absent in much of the SMPP area (except a small amount along the Buring river), and although present, *Pandanus helicopus* is scarce but can be expected to expand along many of the streams in the coming years. Bladderwort *Utricularia aurea* is the only species characteristic of open blackwater that is fairly common throughout the area (Figure 2).

2.1.6 Social Parameters (G1.3)

2.1.6.1 Communities and other stakeholders

The SMPP is in an isolated area with comparatively little interaction with local people. However, there are still some important groups related to the project location and activities, and these groups have been defined in this section. In the Climate, Community & Biodiversity Standards, Third Edition, a “community” refers to any group of people that derive any income, livelihood, cultural values, or other contributions to well-being from within the project area. Using this definition from the CCB standards, there are a total of 21 traditional fishermen and two small-scale palm oil farmers that rely on the SMPP site in some way, thus resulting in a fishing community and a farming community.

Fishing activities are spread across three main areas, including those used by four fishermen along the Kepayang river, four fishermen along the Buring river, and the remaining along the Tembesu Daru canal. Proximity of large industrial activities among other factors, has resulted in the Lalan river becoming too polluted to fish safely. Fishing communities therefore rely on the cleaner waters in and around the SMPP for safe and productive fishing efforts, despite the considerable distance away from their homes.

“Other stakeholders” are any groups other than communities that have the potential to be affected by project activities, whether or not they live in or outside of the project area. For the SMPP we define the residents of nearby settlements and villages, including those primarily from the formally recognized Muara Muang and Kepayang villages, as well as other unofficial settlements along the rivers, as other stakeholders (see Table 3 in Section 2.1.9 for further description).

There are no individuals living within the SMPP area. These other stakeholders are somewhat removed from the project site, at a significant distance from the SMPP by boat, car, or motorbike (Map 8). For example, Kepayang village is located about 15 km from the SMPP’s main camp, which is about a 45-minute to 1.5-hour motorbike or car ride. On a small motorized canoe (often used by local fishermen), it can take roughly two hours. However due to their relative proximity, they are potential beneficiaries of project community development activities (see Section 4.4.1 for further details of our involvement with these stakeholders). Table 3 provides a detailed description of these areas.

2.1.6.2 Local ethnicities

All of the people living in this region, the fishermen and farmer communities, as well as the other stakeholders, have diverse ethnic backgrounds. There are currently no longer any self-described indigenous people living in the area. The current inhabitants of this region have mostly migrated from other parts of Indonesia and have lived in this region for a long time, dating back to the founding of these settlements and villages. Many people have come from other areas in Sumatra, primarily from further north of the SMPP area, including from Jambi province and further away from Medan in North Sumatra, as well as ethnic groups of Javanese and Melayu origin. Additionally, in Kepayang village there are some residents originally from Bugis and Kalimantan.

2.1.6.3 Land-uses and economic well-being

Community fishermen groups interacting with the SMPP are comprised primarily of retired older men, many of whom may not be able to complete other jobs or do not have other stable income sources. Of these fishermen, nine individuals rely solely on this fishing activity as their livelihood and harvest fish full time. The other twelve individuals conduct their fishing activities on a seasonal basis and rely on other jobs, using fishing to supplement their income and diversify their food sources. Both categories of fishermen consider these fishing activities within the SMPP and neighboring areas a crucial aspect of their livelihoods to support their families. The farmers that cultivate land along the southeastern border of the SMPP are usually of a lower economic bracket compared to others within the nearby villages, and as there are many opportunities for other more formal jobs in the wider area, farming is much less common. Specifically, these farming activities focus primarily on small scale rubber and palm oil production. Further details of the fishermen and farmer communities are described in more detail in Section 2.1.9.

Through discussion with local fishermen, we have estimated the economic value of fishing livelihoods in the SMPP to range from 47 USD profit per month per adult up to 175 USD. We have also learned that more elderly fisher groups catch less than their younger counterparts.

None of the identified community members permanently reside within the SMPP, but instead live among the other stakeholders in the closest villages and settlements (however it is important to note, as described in Table 3 in Section 2.1.9, that these villages and settlements are still a significant distance away from the SMPP).

Other stakeholders find livelihoods through more formal employment in areas throughout the Musi Banyuasin regency, and very few were identified as deriving livelihoods from within the project area. There are a variety of economic opportunities available in areas outside of the SMPP, which include opportunities

with nearby companies in the mining, oil and gas, industrial agriculture, paper pulp, and palm oil production sectors, and to a lesser degree, farming including cultivation of rubber, cassava, and pineapple crops.

The relatively stable and varied access to livelihood opportunities results in communities that have access to resources, a steadily declining poverty line and strong community infrastructure. Most people live in well-built sturdy homes with sanitation facilities, and many drive cars and other transportation vehicles. In 2018, 9.8% of the population of Indonesia lived below the national poverty line.¹⁰ In Musi Banyuasin regency, the percentage of the population that is impoverished has been declining over the years with a drop from 18.99% in 2011 to 16.75% in 2017.¹¹ In the province of South Sumatra, the poverty level is defined from a monthly household expenditures metric that is set at less than or equal to IDR 400,000. Additionally, in 2017 the Human Development Index (HDI) of the Musi Banyuasin regency was 66.96. Based on a social appraisal of the nearby villages, the average monthly income per household in the Muara Merang and Kepayang villages is 2-3 million IDR, or 24-36 million IDR per year (estimated through discussions in these villages). This value equates to around \$4.61- \$6.91 USD per day, which is also well above the international poverty line of \$1.90 USD per day according to the World Bank.

2.1.6.4 Public health

The areas near the SMPP where identified community members and other stakeholders live have existing public health infrastructure which meets limited basic health needs and support to pregnant mothers. The Muara Merang and Kepayang villages have a variety of healthcare facilities available, consisting of a health branch clinic (*Puskesmas Pembantu* or *Pustu*), a village health center (*Pusat Kesehatan Desa* or *Puskesmasdes*), and a village maternity clinic (*Pondok Bersalin Desa* or *Polindes*). There are health officers in these areas but no full-time doctors. There are also health workers from the neighboring companies that regularly visit the villages and settlements. In Muara Merang and Kepayang there is access to both professional and traditional midwives that support the women living in these areas. Residents of Tebing Harapan, a hamlet of Kepayang, also have access to health facilities that are owned and operated by a neighboring palm oil plantation. There is also access to medicines and vaccines facilitated in part by Indonesia's national healthcare system. While there are no large hospitals in proximity, this existing network of basic healthcare options supports the families living in these areas, and if more serious treatment is required, individuals can travel to the larger hospitals in Palembang and Bayung Lencir.

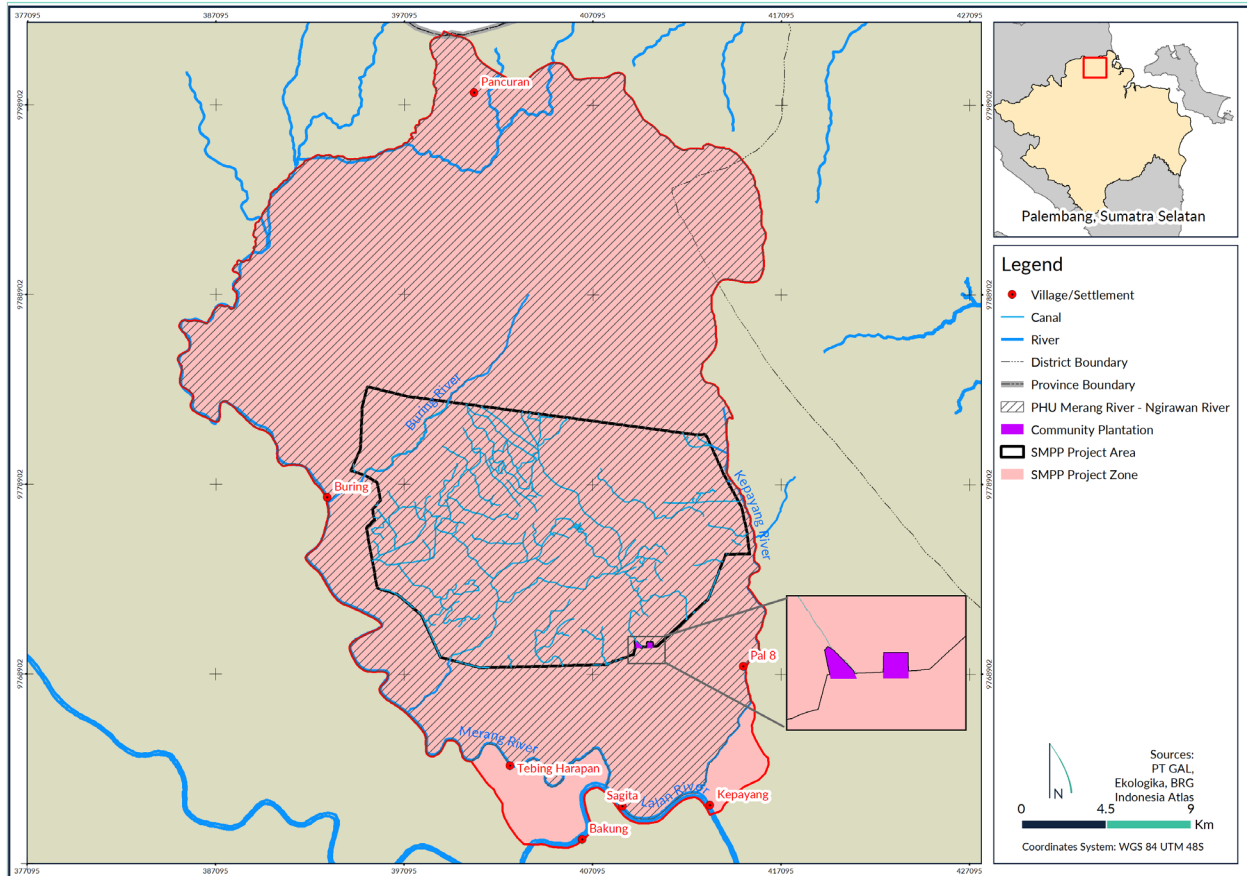
The quality of river water is poor and often unsafe for use in these settled areas. However, most families have proper toilet facilities. Wells or the rivers are used for washing, bathing, and toilet use if proper toilets are not available. For drinking and cooking, residents use collected rainwater, but also buy wholesale bottled water, sourced from treated rainwater or containers brought from Palembang.

2.1.6.5 Education

The areas near the SMPP have a variety of opportunities for formal education. This widespread infrastructure includes four elementary schools (*Sekolah Dasar* or SD) in Muara Merang and Kepayang, a junior high school (*Sekolah Menengah Pertama* or SMP) in Muara Merang, a learning park in Kepayang, and two additional learning centers (*Pusat Kegiatan Belajar Masyarakat* or PKBM). As many teachers come from within Muara Merang, teacher attendance is adequate. More than 50% of children who finish SD typically continue their education with SMP. The closest high schools (*Sekolah Menengah Atas* or SMA) are in Bayung Lencir. Some residents also go on to attend universities, often in Palembang or Jogjakarta. In addition, residents of Tebing Harapan are provided elementary school facilities by the adjacent palm oil plantation company. There are also after school programs that keep children in a learning environment for extended hours and provide time for parents to continue working to further their income from livelihood activities. As part of SMPP community development, we will work with SMPP stakeholders to further improve learning opportunities.

2.1.7 Project Zone Map (G1.4-7, G1.13, CM1.2, B1.2)

Map 8. The SMPP project zone.



The SMPP project zone consists of the formal project area, the government delineated peatland hydrology unit (PHU), and the village areas where community development plans are taking place. The project zone includes active fishing grounds inside and near the boundaries of the SMPP and the two small farms located on the southeast border of the SMPP. The project zone will cover all settlement areas associated with the villages of Kepayang and Muara Merang as these villages will be beneficiaries of community development activities. From an ecological perspective, the PHU represents peatland areas that will benefit from improved functionality of the PHU. Within the PHU, there are commercial forest plantations, palm oil, plantations, and to a limited degree small holder farms. The project zone is a total of 85,182 hectares.

The SMPP project area is defined by the PAN/RAP license and covers a total area of 22,934 ha minus 12 ha of land that have been excised which cover the farms of the two families that continue to conduct small-scale palm oil production.

The SMPP sits within the Merang-Kepayang peat dome, the largest peat swamp dome in South Sumatra, which covers more than 150,000 ha. A number of critical climate and biodiversity assets are linked to the wider peat swamp forest zone that surrounds the SMPP: the Sembilang-Berbak National Park to the northeast and the Muaro Jambi peat swamp to the north.

2.1.8 Stakeholder Identification (G1.5)

Stakeholder identification for the SMPP applies to our project's communities and other stakeholders. As indicated in Section 2.1.6 and further elaborated in Section 2.1.9 below, our communities are defined as the fishermen and farmer groups that derive their livelihoods within the SMPP area, and the other stakeholders are the people that inhabit settlements that are located outside of the SMPP area at fairly considerable distance.

To identify and define the community members and other stakeholders within the SMPP, we employed a range of methods and strategies. First, we began identifying the groups relevant to the SMPP through an assessment of previous socio-economic assessments of the project region, combined with knowledge provided by our local partners, and through an extensive literature review of previous studies in the SMPP area. Our approach then transitioned into direct engagement in the field, to communicate directly with a wide variety of the people in the area we had identified. We have conducted this direct engagement since the project start date in January 2016 (see Section 2.1.14).

For this field-based effort, we are implementing Participatory Rural Appraisal (PRA) methods to conduct social surveys in rural settings in an efficient and participatory manner over time. This is an extensive ongoing effort, that was started in January 2016, and is ongoing. This PRA consists of key individual interviews in a one-on-one setting, group interviews, formal meetings, participatory mapping, observations throughout the site over time, and focus group discussions (FGDs). To ensure participation with our community members and other stakeholders, we have established long-term positive relationships with these local groups, to maintain direct lines of communication between stakeholders and the project.

We have documented at least 22 engagements with community fishermen, one engagement with a community farmer, 50 engagements with school groups or other education facilitators, 11 engagements with village officials, 9 engagements with managers from nearby concessions, 3 engagements with local women's' groups, and 45 engagements with village residents in the Muara Merang and Kepayang villages and other nearby settlements. Further details of these stakeholder consultations are available in Section 2.3.7 below.

This extended PRA process, combined with our consistent and direct communication with local people, has ensured that we have a strong understanding of the relationship that people in the project zone have with the SMPP area or are impacted by the project.

2.1.9 Stakeholder Descriptions (G1.6, G1.13)

As per the CCB standards, our communities are defined as the groups of fishermen and farmers working in the SMPP area, a total of 21 traditional fishermen and a group of two small-scale palm oil and rubber farmers. There are no residents within the SMPP area, and therefore our other stakeholders are the largest group of involved local people as they live closer to our site than anyone else, even though they do not derive their livelihoods from within the SMPP.

As described above in Section 2.1.6, the project defines other stakeholders as the approximately 6,000 residents of nearby settlements as they have the most identified and addressable needs as beneficiaries of project community development work. These other stakeholders are primarily from the formally recognized Muara Muang and Kepayang villages, as well as other unofficial settlements along the Lalan and Kepayang rivers. In these areas there is low population density with most people inhabiting the Muara Muang and Kepayang villages, as well as several sub-villages (hamlets) and many informal settlements throughout the region. Approximately 3,316 people comprising 851 households reside in Muara Muang, and 2,436 people in 789 households reside in Kepayang as of a 2017 site visit (information was provided to our team by local village officials in the field visits).¹² It is important to emphasize that these stakeholders are still fairly removed from the project site, at a significant distance from the SMPP, as described in Section 2.1.6.

Table 3 provides a detailed description of these areas.

Table 3. Description of nearby settlements where other stakeholders in the SMPP area live.

Village	Sub-villages/Hamlets	Proximity to SMPP
Muara Merang (Population: 3,316- as of 2017) ¹²	Bakung	On the edge of the Lalan river, ± 9.2 km from project area
	Bina Desa	On the edge of the Merang river, ± 8.4 km from project area
	Pancuran	Located in the north of PT Rimba Hutani Mas (PT RHM) and SMPP, ± 16.5 km from project area
Kepayang (Population: 2,436- as of 2017) ¹²	Dusun 1	On the edge of the Lalan river, ± 8.8 km from project area
	Dusun 2	On the edge of the Lalan river, ± 8.8 km from project area
	Dusun 3 (Aspa)	On the edge of the Lalan river ± 8.8 km from project area

	Settlement Name	Proximity to SMPP
Administratively unofficial unit	Tebing Harapan (Estimated Population: 40 households- as of 2018)	Edge of the estuary of the Merang river, ± 5.2 km from project area
	Buring (Estimated Population: 15-20 households- as of 2018)	Downstream region of the Buring river, ± 1.9 km from project area
	Sagita (Estimated Population: 10-15 households- as of 2018)	On the edge of the Lalan river, ± 7.5 km from project area

Community fishermen groups that operate within the SMPP are comprised primarily of retired older men, many of whom may not be able to complete other jobs or do not have any other stable income. They do not reside within the SMPP but live in neighboring settlements and enter and exit the SMPP concession to conduct their fishing activities. Of these fishermen, nine individuals rely solely on fishing for their livelihood, and harvest fish full time. The other twelve individuals conduct their fishing activities on a seasonal basis, also relying on other jobs but use fishing to supplement their income and diversify their food sources. Both categories of fishermen consider these fishing activities within the SMPP a crucial aspect of their livelihoods to support their families. The total of 21 community fishermen range in age from 39 to 69, and live in Kepayang, Tebing Harapan, Buring, Bakung, and Pal 8. We have demographic information about each of the community fishermen and the two farmers, and this confidential information can be supplied to the auditor upon request.

The farmers that grow crops along the SMPP border are of a lower economic bracket compared to others within the nearby villages, and as there are stronger employment in the wider area where farming is much less common. Specifically, these farming activities are focused on small farms of rubber and palm oil. In the SMPP, two farmers occupy 8 and 7 ha of farmland, respectively, with 5.9 ha and 5.6 ha located within the SMPP license area. These two farms in the SMPP are identified in Section 4.1.3 in Map 33. These fishermen primarily use tradition fishing methods that use wire or wood and bamboo traps, as well as fishing

poles and lines (*tajur*). Fish are either consumed for subsistence living needs or sold as fresh catch or as dried and salted. The fishermen usually sell their catches in the weekly markets of the nearby settlements and villages. Fishing activities in the SMPP already rely on a diverse variety of species, and it is likely as the project develops, a higher abundance and diversity of fish species will be present in the project area. The other stakeholders in nearby settlements find livelihoods primarily through formal jobs working for nearby companies with mining, oil and gas, industrial agriculture, paper pulp, and palm oil production activities, and to a lesser degree, farming including cultivation of rubber, cassava, and pineapple crops.

2.1.10 Sectoral Scope and Project Type

The SMPP is an Agriculture, Forestry, and Other Land-Use (AFOLU) project. More specifically, the project activities are categorized as a combination of Afforestation, Reforestation, and Revegetation (ARR) and Wetlands Restoration and Conservation (WRC). Under the WRC component, the project activities relate to Restoring Wetland Ecosystems (RWE). The SMPP is not a grouped project.

2.1.11 Project Activities and Theory of Change (G1.8)

The SMPP aims to restore a large peatland ecosystem that is currently in a predominantly degraded state due to the historical impact of logging, canal construction, and fires. The project activities have been designed to maximize the ability of the project to restore the ecological functions of the project area, and the wider peat dome in which it exists, while building strong and supportive relationships with the broad range of stakeholders within the landscape. The SMPP is structured with the conceptual model illustrated in Figure 3 describing in more detail the direct project interventions and how they help to meet our project objectives.

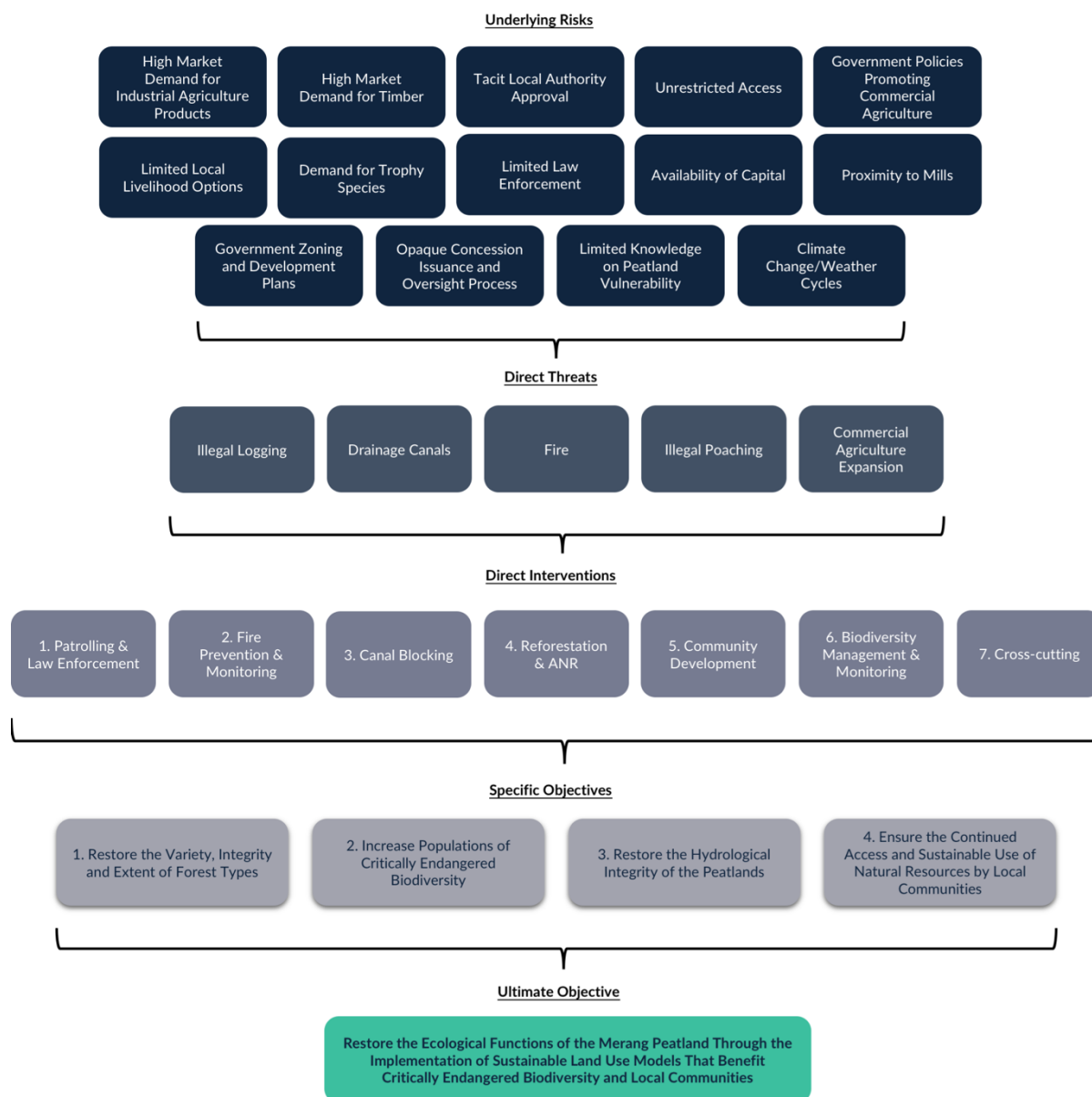


Figure 3. Conceptual model of the SMPP.

Our project activities cover seven core areas and are describe in detail below:

2.1.11.1 Forest patrolling

Patrolling activities aim to reduce or eliminate risks to the project site that cause ecosystem degradation, including illegal logging, poaching, exploitative fishing, and further conversion for small-scale agriculture. In addition to the potential removal of flora and fauna from the site, these activities create heightened fire risks and keep canals open and active.

Patrolling activities include:

- Physical demarcation of the project area;

- Stakeholder engagement to educate on the project area boundary and permissible activities within and in the near vicinity of the project area;
- Establishment of a series of guard posts around the perimeter of the project area, strategically located at known key access points (see Map 9);
- Establishment of a radio communication system for effective monitoring and reporting on potential risks (including fire – see below);
- Regular foot, bicycle, boat and vehicle patrolling along the perimeter and within the project area. Patrol teams consist primarily of community members from the two nearby villages.
- Data collection and analysis on identified threats (i.e. evidence of illegal logging, encounters with poachers or animal traps, illegal entries to fish, etc.) to prioritize patrolling activities;
- Regular drone monitoring across the project area provides additional information on potential risks in harder to access areas of the project site; and
- Engagement with forest police and local law enforcement to prevent forest crimes.

Limiting illegal incursions not only prevents the extraction of valuable flora and fauna, but also greatly reduces the risk of potential fire vectors that are known to have major negative impacts on peatland ecosystem restoration from entering the project area.

2.1.11.2 Fire prevention and monitoring

Historically, fire has had the largest impact on the integrity and health of the SMPP area. Fires can either initiate within the project area or spread from neighboring concessions, which occurred in 2015. Fires pose an especially dangerous risk to peatlands, typically during dry spells (i.e. in an El Niño year) and if water levels have been artificially lowered from canal construction. Peatland fires can spread quickly and burn for long periods of time underground. Therefore, maintaining fire preparedness and dispatching rapid response teams are critical means of avoiding fires and extinguishing them as quickly as possible.

Fire prevention and monitoring activities include:

- Patrol activities to prevent the access of fire vectors into the project area (see activity 1 above).
- Establishment of an early warning system (EWS) to rapidly inform the project management team of potential fires. The EWS combines satellite data alerts (Moderate-Resolution Imaging Spectroradiometer or MODIS hotspots), patrol team communications, and drone monitoring to alert senior technical project staff of potential risks. Established protocols are subsequently followed by field teams to investigate and respond as necessary.
- Establishment of Fire Response and Suppression (FRS) teams. These are the field teams based at the project site who can respond in case of a fire alert. All members of the field teams, including forest patrol team members, biodiversity staff and the project site manager, have been professionally trained in peatland firefighting by the fire brigade of the Indonesian Ministry of Forestry. The training documents a Standard Operation Procedure (SOP) for handling fire, outlining communication logistics to inform the all key stakeholders in surrounding concessions and communities. SMPP teams are also fully equipped with the necessary firefighting equipment, such as personal protective clothing, pumps, hoses, and other safety gear.
- Establishment of cooperation agreements with neighboring concessions. In most cases fires originate outside of the project area, due to the higher intensity of agricultural activities and human presence in those areas. The SMPP's EWS extends far beyond the boundaries of the project area to monitor and report fire presence in nearby concessions. Additionally, the FRS teams are available to assist nearby concessions, and have extinguished several fires successfully, in concessions that have less-developed response protocols.

- Stakeholder engagement to train local individuals in the surrounding residents on best practices for avoiding and preventing fires, and information on how to signal help when fires arise.

Fire prevention and monitoring activities contribute to the project objectives by greatly limiting GHG emissions due to peat fires, allowing natural forest ecosystems to recover and provide extended habitats for key biodiversity species, and limit the negative health and livelihood impacts of excessive haze.

2.1.11.3 Canal blocking and hydrology management

The presence of canals in the project site has significantly contributed to desiccation of the peatland. The extensive peatland drainage in surrounding areas due to logging and commodities production has further exacerbated drying throughout the landscape. Restoring the hydrological integrity of the project area is therefore of critical importance to its long-term recovery, as well as preventing ongoing GHG emissions from peat microbial decomposition and peatland fires.

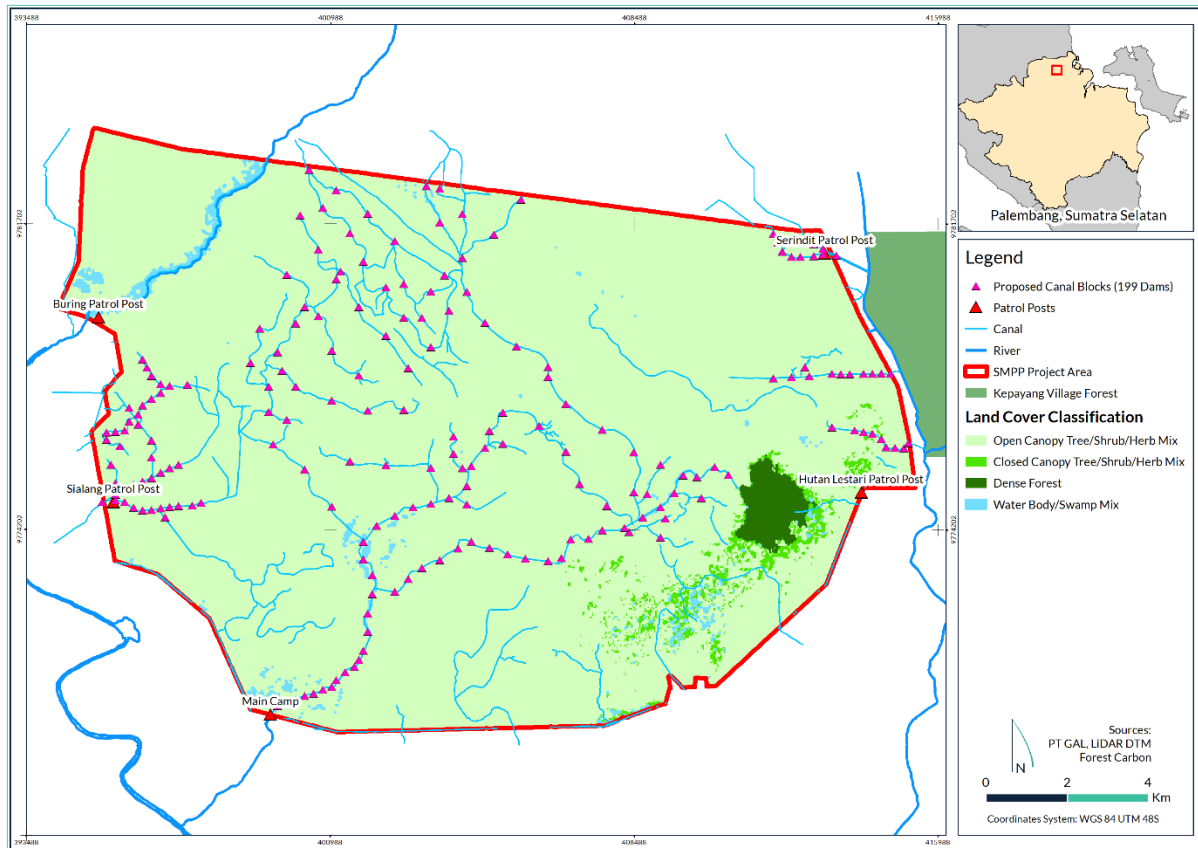
This includes the rewetting of partially drained peatlands in and around areas with existing canals, and the conservation of undrained and partially drained peatlands (CUPP) in those areas further away from the existing canal network. Existing canals are principally small logging canals (shallower than 1 meter and narrower than 2 meters), with only a few medium sized canals (wider than 2 meters) present.

Canal blocking activities include:

- Conducting a technical assessment on the most feasible canal block strategy taking into consideration access needs, hydrological flows, priority restoration areas, etc. Careful attention will be placed on the need to avoid ecological leakage.
- Development of a proposed canal block plan (see Map 9).
- Installation of different canal blocks types depending on canal size, water flows, and topographical gradients. Canal blocks will be constructed as a cascade to gradually raise water levels across drained areas and limit the pressure exerted on any one canal block from water flows. Canal blocks will be principally built using natural materials available on-site (lying deadwood and peat). Compaction dams will likely be required in areas towards the edge of the project area boundary to prevent water outflow.
- Ongoing monitoring of water table levels and canal block conditions. In combination with an iteratively refined hydrological model, ongoing monitoring data will allow for continued optimization of water table levels throughout the project area. Regular checks on canal block conditions will ensure maintenance can be administered quickly should repair be required.
- Collaboration with neighboring concessions on hydrological management. The SMPP has and continues to actively engage with neighboring concessions to promote improved hydrological management, both for the SMPP area and the neighboring concessions. The SMPP has already successfully lobbied the nearby PT WHLM concession to install compaction canal blocks in the large canal that forms the southern boundary of the SMPP area.

The canal blocking activities are essential in supporting the SMPP area to return to its natural ecological condition. Raised water table levels reduce the risk of fire, prevent microbial decomposition and peat subsidence, and provide the necessary hydrological conditions to allow for the successive regeneration of forests.

Map 9. Potential locations and types of canal blocks within the SMPP area.



2.1.11.4 Reforestation and assisted natural regeneration (ANR)

After the 2015 fire, the majority of the project area is now covered in young regenerating fallows and shrubs, with a small remaining forest block on the eastern side of the project area (see Section 2.1.7 for a full land cover listing). Over the lifetime of the project, the intent is to support the recovery of the project area back to a fully forested state. This will be achieved primarily through natural regeneration due to the absence of fire disturbance and restoration of the project area's natural hydrological functions. Further forest regeneration activities will be conducted through a combination of active planting and ANR activities to both support natural regeneration and canal blocking. The three key areas for reforestation and ANR activities are currently considered:

- The area to the north of the largest remaining forest block in the eastern part of the project area to act as a natural link to the Berbak-Sembilang national park, which is to the east of the project area;
- The areas in and around the existing gelam tree vegetation to promote biodiversity values and reduce the risk of fire, and;
- The areas bordering conservation forest areas of nearby concessions.

Key reforestation and ANR activities include:

- Establishment of tree nurseries at guard posts and within neighboring areas (see below on tree nurseries as a community development activity) by collecting seeds and seedlings from the remaining forest block in the eastern part of the SMPP area. Only native species shall be used for any planting activities.

- Trialing of ANR and reforestation approaches to inform the development of a final reforestation and ANR strategy.
- Annual ANR and planting activities in the project area.
- Potential technical support to reforestation activities in the nearby Kepayang village forest.

The reforestation and ANR activities will lead to reduced fire risk, the restoration of natural habitats, carbon storage, and generation of local incomes through the involvement of communities.

2.1.11.5 Community development

Almost none of the members of the communities in the broader project zone derive direct livelihood benefits from the project area. Nevertheless, SMPP is committed to supporting community development activities in the villages closest to the project, to demonstrate how large land-use projects can act as positive agents of change in the broader landscape in which they operate. Furthermore, building strong and supportive relationships with local communities prevents risks associated with future encroachment in the case where the project's restored ecological functions become attractive for illegal activities such as logging or poaching.

Key community development activities include:

- Education support through continued education opportunities for local teachers through Open University (*Universitas Terbuka*), after school programs for elementary school children, adult education for employees who do not hold a high school diploma, improvement of elementary and middle school sanitation facilities, and enrichment and maintenance of school libraries.
- Improved livelihoods and quality of life through local food sourcing for project employees, training for the craftsmen/women and support to community health programs.
- Investments in women's groups in both Muara Merang and Kepayang villages.
- Youth and local employment to increase the number of SMPP field staff recruited locally and the creation of educational development and capacity building opportunities for employees.
- Community garbage and plastic waste cleanup initiatives including plastic recycling and trash collection, which creates value from plastic waste, supported by community clean up events on a monthly basis.
- Co-financing for the construction of household rainwater catchment systems to address the need of clean and pollution-free water

Community investments are designed to be an integral part of SMPP's operating expenses. The project aims to deliver tangible benefits to surrounding communities by through community-based business development programs and education initiatives. The project will continue to allocate a significant portion of its operating budget for community development throughout its long-term operations.

2.1.11.6 Biodiversity management and monitoring

The project expects that through the implementation of the above listed patrolling, fire suppression, canal blocking, and regeneration activities, biodiversity quantities and variety will increase. This will be due to both the reduction in threats and restoration of natural habitats. As such, biodiversity specific activities are limited to monitoring programs at this stage. The monitoring program will track potential fluctuations across specific species and inform management activities across the SMPP area.

The project intends to devote significant resources to detecting, identifying and understanding the characteristics, distribution, sensitivity and vulnerability of HCVs. The intensity of SMPP activities are considered low because all or most of the natural ecosystems in the project area are designated as conservation areas and activities include restoring degraded natural ecosystems. Furthermore, there is no

activity that relates to converting forest to monoculture plantation, grazing or browsing by domestic animals, or substantial abstraction of water.

2.1.11.7 Cross-cutting

This final group of direct interventions does not directly address specific threats. However, this cross-cutting allows for the overall enabling conditions that support the effectiveness and sustainability of the other direct project interventions.

Key cross-cutting interventions include:

- Implementation of adaptive management: The effectiveness of project interventions will be periodically reviewed to determine if changes are necessary in the location, intensity, approach, capacity needs, and resourcing of activities. Evaluations will be primarily conducted by the Project Management Board and key technical staff.
- Implementation of effective administration and human resources protocols: The backbone of any organization or project is an effective administrative system and qualified, well-trained staff to implement project activities. These systems and protocols will be continuously reviewed and revised to ensure effective project management and logistical planning.
- Robust financial management: This includes the implementation of accounting systems, development of clear financial management SOPs and elaboration of annual budgets. Additionally, it requires the marketing and sale of VCU to ensure the ongoing financial flows required to sustain the long-term sustainability of the project.
- Ensuring legal compliance: To retain the legal rights associated with the PAN/RAP license, the project will need to abide by a number of reporting requirements at various levels of government, conduct various forest carbon management activities including monitoring, evaluating, and reporting, pay taxes, prepare work plans and performance reports for the Ministry of Forestry, and ensure ongoing compliance with all other requirements to maintain its active license status.

2.1.12 Sustainable Development

The SMPP is aligned with a number of sustainable development and environmental protection targets designated by the Indonesian government. The following key policy components align directly with our project objectives, including emphasizing climate action, supporting communities, and protecting biodiversity.

Indonesia's Medium-Term Development Plan covers nine priorities, called *Nawacita*, which include references to sustainable development in the forestry sector. Specifically, the Environment and Forestry Development Strategic Priorities Plan for the period between 2015-2019¹³ aims to protect the quality of the environment to maintain ecosystem services function and to improve water security and community health; utilize forest and environmental resources in sustainable manner to improve the economy and prosperity of local people; and preserve the balance of ecosystems and biodiversity as a way to support sustainable development.

These targets for reporting and monitoring are listed below.

2.1.12.1 Economic growth and development

The government seeks to improve the economic development of Indonesia with a target to increase the per capita income from USD 3,918 in 2015 to USD 6,0181 by the end of 2019.¹⁴

The SMPP contributes to economic growth by providing project stakeholders with employment opportunities and a variety of livelihood enhancement activities. The project will employ local stakeholders including work involving forest protection and facility management, and provide access to education, as well as livelihood enhancements from investments into income generating activities.

2.1.12.2 Poverty and equity

Based on Indonesia's National Medium-Term Development Plan for 2015-2019 it is expected that the poverty rate can decrease to 7.0-8.0% by the end of 2019 and the unemployment rate can become 4.0-5.0% by the end of 2019. In order to achieve these goals, the Indonesian government plans to improve access to job opportunities by increasing the productivity of industries that can create jobs and increasing workers' living standards and changing low-skilled industries to skills-based industries. The government is highly focused on lowering poverty levels in rural areas, to develop Indonesia from the periphery by strengthening regions and villages.¹⁴

The SMPP will support rural poverty reduction by generating employment for groups with low education levels and support an increase in household incomes. The SMPP has a target to hire 80% of its field staff from communities in proximity to the project area. In addition, the SMPP is working to ensure gender balance and aims to employ 25% women as project staff, along with a community development component targeting a number of women's groups in nearby villages and settlements.

2.1.12.3 Education

The Ministry of Education and Culture has a target to increase the capacity and quality of 14,000 educators throughout the country. The government also aims to improve infrastructure for education by building 210 new schools and 2,500 classroom; rehabilitating 41,000 classrooms and renovating 294 schools as well as building 2,140 laboratories and 1,332 libraries.¹⁵ The SMPP's educational program is clearly in line with these development targets as it seeks to support school infrastructure initiatives and increase the capacity of local teachers in the area.

2.1.12.4 Sustainable forest and land-use

The Indonesian Peat Restoration Agency (*Badan Restorasi Gambut* or BRG) has a target to restore two million ha of peatlands in the country. The project area is located in one of the agency's priority area.¹⁶

2.1.12.5 Climate change

Indonesia ratified the Paris Agreement as part of its commitment to address climate change and submitted its National Determined Contribution (NDC) which is also in line with *Nawacita* priorities that are integrated across the Medium-Term Development Plan. The SMPP aims to contribute to Indonesia's overall CO₂ emission reduction target by 2020 in conjunction with the appropriate monitoring and reporting.

2.1.13 Implementation Schedule (G1.9)

Provided below are the expected key milestones in the implementation of the SMPP (Table 4).

Table 4. Key milestones in the SMPP's development and implementation.

Date	Milestone(s) in the project's development and implementation
2016	Project Start with establishment of permanent field camp in the project area.
2016	Initiation of patrolling of the project area with project staff.
2016	Initiation of community engagement.
2016	Phase I of canal block construction.
2018 - 2019	Data collection and development of VCS/CCBA project document.
2017	Phase II of canal block construction.
2018	Formal boundary demarcation and approval from government.
2018	Project tree nursery establishment.

Date	Milestone(s) in the project's development and implementation
2019	Verified Carbon Standard (VCS)/ Climate, Community, and Biodiversity (CCB) validation.
2019	Upscaling of community development interventions.
2019 - 2020	Phase III canal block construction.
2019	Trialing of reforestation and ANR activities.
2020 – 2025	Upscaling of ANR activities.
2019 – 2062	Ongoing implementation of field activities.
2019 – 2062	VCS/CCB monitoring events and reports generated (annually).
2019 – 2062	VCS/CCB verification (annually).

2.1.14 Project Start Date

The project start date is January 1st, 2016, as according to the VCS definition, this was the date activities on the ground were begun to contribute toward GHG emission reductions and removals. In January of 2016, the project started to establish a permanent presence within the project area through the construction of the project's main camp and by starting to conduct formal patrol activities leading to effective prevention of fire and forest degradation.

2.1.15 Benefits Assessment and Crediting Period (G1.9)

The duration of the VCS project crediting period is 47 years, with the project beginning on January 1st, 2016 and ending on December 31st, 2062. The PAN/RAP carbon storage and sequestration license held by local partner PT GAL is extendable up to 50 years.

Per the VCS guidelines, a mandatory baseline re-evaluation is to be executed at a minimum of every 10 years after the project start. Therefore, there will be a mandatory baseline re-evaluation on or before January 1st, 2026 and every ten years afterwards.

2.1.16 Differences in Assessment/Project Crediting Periods (G1.9)

There are no differences between the duration assessment periods of GHG emissions accounting, climate adaptive capacity and resilience, community, and biodiversity.

2.1.17 Estimated GHG Emission Reductions or Removals

Table 5. Estimated GHG emission reduction or removals (i.e. estimated VCUs).

Year	Estimated GHG emission reductions or removals (t CO ₂ -e) (estimated VCUs)
2016	336,581
2017	439,999
2018	492,325
2019	487,966

Year	Estimated GHG emission reductions or removals (t CO ₂ -e) (estimated VCUs)
2020	1,081,349
2021	1,107,735
2022	1,210,235
2023	1,276,896
2024	1,362,486
2025	1,378,830
2026	1,485,689
2027	1,512,235
2028	1,643,700
2029	1,613,677
2030	1,622,027
2031	1,585,265
2032	1,687,316
2033	1,549,637
2034	1,585,128
2035	1,545,999
2036	1,658,436
2037	1,553,427
2038	1,525,843
2039	1,548,639
2040	1,598,080
2041	1,525,229
2042	1,484,457
2043	1,449,954
2044	1,529,117
2045	1,440,378
2046	1,449,510
2047	1,391,788
2048	1,510,217
2049	1,381,253

Year	Estimated GHG emission reductions or removals (t CO ₂ -e) (estimated VCUs)
2050	1,374,405
2051	1,332,050
2052	1,429,344
2053	1,350,037
2054	1,333,945
2055	1,281,424
2056	1,359,406
2057	1,253,072
2058	1,267,736
2059	1,250,312
2060	1,270,852
2061	1,192,850
2062	1,165,919
Total estimated ERs	62,912,755
Total number of crediting years	47 years
Average annual ERs	1,338,569.26

2.1.18 Risks to the Project (G1.10)

The possible natural and human-induced risks that may impact the SMPP's climate, community, and biodiversity benefits are outlined in great detail in Annex 1. Additional mitigation strategies will be developed if new risks emerge during project implementation. These risks should be considered in conjunction with the non-permanence risk assessment carried out in accordance with the most recent AFOLU Non-Permanence Risk Tool v3.3 (October 19th, 2016 version). A summary of this risk analysis is outlined in Table 6 below, indicating that in the SMPP the Internal Risks have the highest score, followed by the Natural Risks, and our External Risks have a score of zero. This analysis is elucidated further in Annex 2. Additional information regarding risks particularly associated with communities in our project are discussed in sections 2.3.4, 4.2.1, and 4.5.

Table 6. Summary of non-permanence risk analysis for the SMPP.

VCS AFOLU non-permanence risk category	Score
a) Internal Risk	
Total Project Management (PM) Risk Value	-4.0

VCS AFOLU non-permanence risk category	Score
Total Financial Viability (FV) Risk Value	0.0
Total Opportunity Cost (OC) Risk Value	0.0
Total Project Longevity (PL) Risk Value	15
Total Internal Risk (PM + FV + OC + PL)	11
b) External Risk	
Total Land Tenure (LT) Risk Value	2.0
Total Community Engagement (CE) Risk Value	-5.0
Total Political (PC) Risk Value	0.0
Total External Risk (LT + CE + PC)	0.0
c) Natural Risk	
Fire (F) Risk Value	1.0
Pest and Disease Outbreak (PD) Risk Value	0.0
Extreme Weather (W) Risk Value	0.0
Geological Events (G) Risk Value	2.0
Other Natural Risk (ON) Value	0.0
Total Natural Risk (F + PD + W + G + ON)	3.0
Total Overall Risk Rating (a + b + c)	14

2.1.19 Benefit Permanence (G1.11)

While the SMPP has a 25-year IUP PAN/RAP carbon storage and sequestration license that is extendable up to 50 years, the project's activities are designed to enhance the CCB benefits beyond the project's lifetime. Community development activities are designed to increase family incomes by creating local employment opportunities. The project will make investments into small businesses and provide support to increase the quality of education to increase the education levels among nearby community members. By investing in the human capital of the region SMPP support can create more possibilities for formal employment with more reliable and higher wages. The project will also promote the importance of conservation and hydrology management to nearby villages as a way build local stewardship for the landscape. Youth will be targeted to promote a shift away from exploitative land-use practices to activities in the formal economy. These community development activities are outlined in more detail in Section 2.1.11.

From a biodiversity permanence perspective, the SMPP will rewet the peatlands through the construction of permanent canal blocks which is a recognized approach to restore the hydrology of this degraded area, which will reduce the risk of fire in the landscape allowing the natural vegetation to be restored over the life of the project. This activity is explained in more detail in Section 2.1.11.

2.1.20 Financial Sustainability (G1.12)

The SMPP and its project proponents have received an investment from Althelia Climate Fund (ACF) and the Belantara Foundation totaling 5.6 million Euros which is sufficient to cover all project costs until it has secured the needed revenues to develop a sustainable revenue source. ACF has a proven track record in investing in conservation projects globally and supporting them to achieve VCS/CCBA certification. In collaboration with its partner organization, Ecosphere+, ACF is experienced in marketing and sales of VCS credits on the global market and has already attracted potential buyers for the SMPP credits. Forest Carbon, one of the project proponents, has a track record supporting projects as they develop and obtain VCS/CCBA certification. Along with PT Global Alam Lestari, both project proponents have been in operation for a number of years and are established companies with stable cash flows. Documents supporting these investments and outlining the project's financial feasibility and breakeven and can be produced for the project auditor for inspection.

2.1.21 Grouped Projects

This is not a grouped project.

2.2 Without-project Land-Use Scenario and Additionality

2.2.1 Land-Use Scenarios without the Project (G2.1)

The conditions of the project area prior to the start of the project can be described as a highly degraded peatland area, resulting from consistent and severe fire incidents and illegal logging activities spanning the last 20 years. The condition of the project site was not a result of actions by the project or related parties to purposely create GHG emission potential for subsequent reduction.

We demonstrate that the project has not been implemented to generate GHG emissions for the purpose of their subsequent reduction, removal or destruction in Section 3.1.4 and the project's baseline scenario and additionality is justified by using the Clean Development Mechanism (CDM) Afforestation/Reforestation (A/R) Methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities".

As described in Section 3.1.4 the most likely land-use in the absence of the project is the establishment of an industrial Acacia plantation. The 2015 fires would likely have been beneficial for an Acacia plantation company as the fires would have cleared away significant aboveground biomass that the plantation company otherwise would have had to clear mechanically. As such, the SMPP area, in its post-2015 condition, would have been considered as an attractive area for an Acacia plantation company as it would have been able to establish its operations more extensively from bordering concessions and at lower cost than in the pre-2015 condition.

2.2.2 Most-Likely Scenario Justification (G2.1)

Justification of the most likely land-use scenario in the baseline is provided in Section 3.1.4.

2.2.3 Climate, Community and Biodiversity Additionality (G2.2)

Benefits to the climate, communities and biodiversity would be negatively impacted in the absence of the project. The most credible baseline for the project is the development of an industrial paper pulp plantation as there are no financial, technological, institutional, or capacity barriers.

In terms of biodiversity, an industrial plantation would clear most of the concession area and only keep a small portion of the area, usually 10%, as a conservation area. While an Acacia plantation can have certain biodiversity benefits such as connectivity and habitat for certain niche species, it does not create anywhere near the benefits of a natural forest area due to on-going commercial activities.

Industrial plantation companies often have Corporate Social Responsibility programs and make donations to nearby communities. However, the communities that generate their livelihoods from the project area such as fishermen and small-scale farmers would lose access to these livelihood resources if a plantation was developed. Further, the SMPP will have a more comprehensive community development plan and will be investing in communities at a higher level than that of a business as usual Acacia plantation company.

In terms of climate, the baseline scenario would emit millions of tons of CO₂ further causing climate change. As a result of the project activities such as canal blocking, the SMPP will prevent CO₂ emissions from occurring as compared to the baseline scenario as outlined in section 2.1.17.

The identified without project scenario for both communities and biodiversity is described in more detail in Section 4.1.4 and 5.1.3 respectively.

2.2.4 Benefits to be used as Offsets (G2.2)

The project does not intend to generate any community or biodiversity benefits to be used as offsets.

2.3 Stakeholder Engagement

2.3.1 Stakeholder Access to Project Documents (G3.1)

To provide stakeholders with access to project documents, the SMPP Field Office will maintain a full, printed version of the project description (PD) document in English for public viewing. The executive summary will be translated into Bahasa Indonesia and will be given to community leaders to make available in public places in the surrounding villages, and the full PD with its executive summary will be posted in English and in Bahasa Indonesia on relevant SMPP social media or website accounts.

2.3.2 Dissemination of Summary Project Documents (G3.1)

To disseminate project documents to communities, other stakeholders, and the public, the SMPP Field Office will maintain a full, printed version of the PD in English for public viewing. The executive summary will be translated into Bahasa Indonesia and will be given to community leaders to make available in public places in the surrounding villages, and the full PD with its executive summary will be posted in English and in Bahasa Indonesia on relevant SMPP social media or website accounts. In addition to the executive summary, we will provide a brochure in Bahasa Indonesia advertising the project, and an email address will be posted in local villages and given to SMPP communities and other stakeholders as a point of contact. Finally, notices in Bahasa Indonesia advertising the public comment period and field validation will be posted in communities throughout the project area. It will include details on how to make a comment on the CCB version.

2.3.3 Informational Meetings with Stakeholders (G3.1)

The project began conducting informational meetings in 2016 and continued to conduct more informal follow-up meetings through 2019. The purpose of these meetings was to continue to build trust and forge relationships with project stakeholders and engage in further efforts to understand the local history, livelihoods and potential community concerns. Identification of other social, religious, and economic factors that could potentially influence how the community respond to the project were also considered to ensure

a more seamless transition for surrounding communities and other stakeholders as implementation begins to scale-up.

2.3.4 Community Costs, Risks, and Benefits (G3.2)

The project has implemented a variety of social consultations, described further in Section 2.3.7, where information was provided on the potential costs, risks and benefits to the identified communities. The SMPP aims to work collaboratively with the identified communities of fishermen and farmers to ensure their engagement throughout the duration of the project (see sections 2.1.6 and 2.1.9 for more details on community and stakeholder groups). These identified project communities are familiar with the project and its intentions as a result of consultative meetings. The primary communication method with the communities is through direct meetings as many do not have mobile phones and are often located at their remote fishing areas or farms.

Other stakeholders, who are residents of Muara Merang, Kepayang, and other nearby settlements were also engaged as part of the consultative process. The project organized formal group meetings that were announced through letters to village officials. These consultation meetings with other stakeholders took place during May and July 2018 in Muara Merang and Kepayang. Follow up meetings have taken place with other stakeholders in these villages through one-on-one discussions, small group meetings, and through participation in formal village meetings where village officials invited project representatives. These meetings with other stakeholders discussed project costs, risks and benefits to the relevant stakeholders.

Further, an SMPP field office was established in early 2016 and now serves as an information hub that is open to community members and other stakeholders who wish to gain information about the project and/or submit comments or grievances.

The communication with the fishermen and farmers can be improved through more consistent meetings. The project will therefore conduct quarterly meetings with the fishermen and farmers and discuss project activities and potential impacts on them. The project will also conduct quarterly meetings with stakeholders in Merang and Kepayang to provide updates on the implementation of the community development program. If any concerns are highlighted by the communities and stakeholders, these will be addressed with follow up meetings and plans to mitigate any negative impact.

The consultative process consisted of multiple one-on-one meetings with community members, and larger formal group meetings with other stakeholders from the villages of Muara Merang and Kepayang. Details of the consultations including the dates, locations and number of attendants, are provided in Section 2.3.7.

2.3.5 Information to Stakeholders on Validation and Verification Process (G3.3)

To provide information to communities and other stakeholders on the validation and verification process, the SMPP Field Office will maintain a full, printed version of the PD in English for public viewing. The executive summary will be translated into Bahasa Indonesia and will be given to community leaders to make available in public places in surrounding villages, and the full PD and its executive summary will be posted in English and Bahasa Indonesia on relevant SMPP social media or website accounts. In addition to the executive summary, we will provide a brochure in Bahasa Indonesia advertising the project, and an email address will be posted in local villages and given to SMPP communities and other stakeholders as a point of contact. Finally, notices in Bahasa Indonesia advertising the public comment period and field validation will be posted in communities throughout the project area. It will include details on how to make a comment on the CCB version.

2.3.6 Site Visit Information and Opportunities to Communicate with Auditor (G3.3)

The SMPP staff meet with the identified project communities and residents of nearby villages and settlements on a frequent basis. In order to prepare for the audit, project staff will inform relevant

stakeholders in advance about the details of the audit process and prepare local groups with ample time for the auditor's site visit so that there is ample time to communicate with the auditor. The project will arrange for meetings with all relevant stakeholders during the validation and verification site visit where the auditor will be able to ask questions of all stakeholders regarding Free, Prior, and Informed Consent (FPIC) consultations engagement with the project.

2.3.7 Stakeholder Consultations (G3.4)

The project has conducted a combination of formal stakeholder consultations and informational meetings with the communities dating back to 2016 (see Section 2.3.3). We will continue to facilitate these meetings throughout the duration of the project. We recognize the feedback and advice provided by these parties is critical to the long-term success of this project, and therefore consider all information gathered in these meetings. Additionally, this feedback is a valuable opportunity for us to enhance and adapt all aspects of project design and implementation according to guidance from relevant identified stakeholders.

Participatory Rural Appraisal (PRA), a method used to conduct social surveys in rural settings in a quick and efficient manner, is described above in Section 2.1.8. Our community development team have carried out extensive direct engagement with the communities and other stakeholders in the SMPP and surrounding villages and settlements. Overall, since our project start date in 2016, this effort has consisted of a variety of meetings and discussions. This engagement has been broad and in addition to formalized discussions, many meetings were informal conversations without specific written agendas. However, we have documented at least 22 engagements with community fishermen, one engagement with a community farmer, 50 engagements with school groups or other education facilitators, 11 engagements with village officials, 9 engagements with managers from nearby concessions, 3 engagements with local women's groups, and 45 engagements with village residents in the Muara Merang and Kepayang villages and other nearby settlements. A summary of these meetings is outlined in Table 7 below. These stakeholder consultations and engagements consisted of one-on-one interviews, group interviews, formal meetings, and focus group discussions (FGDs). Throughout the duration of the project, until most recently in April 2019, we have consulted with the local communities and stakeholders to ensure mutual understanding regarding all project activities and potential impacts.

Stakeholders were consulted on the development of the community development program. During a series of meetings, communities requested support on improving the education of the nearby villages, supporting the health facilities that exist, and supporting them on improved livelihoods. As a result, these programs have been included in the design of the program.

Table 7. Summary of stakeholder consultations (one-on-one interviews, group interviews, meetings, and focus group discussions).

SMPP group	Stakeholder Groups	Number of times engaged
Community	Fishermen	22
	Farmers	1
	Total formal community consultations:	23
Other stakeholders	School groups and education facilitators	50
	Officials from nearby villages	11
	Managers from nearby concessions	9
	Residents from nearby villages and settlements	45
	Women's groups from nearby villages and settlements	3
	Total formal other stakeholder consultations:	118

SMPP group	Stakeholder Groups	Number of times engaged
Type of engagement	One-on-one interview	71
	Group interview	15
	Meeting	53
	Focus Group Discussion (FGD)	2
	Total number of consultations:	141

We have specifically implemented increased engagement with consistent notetaking with direct observation and monitoring of the people deriving their livelihoods from within the SMPP area: the fishermen and farmer communities. Our team has met with fishermen groups and other stakeholders from nearby villages and settlements as part of our effort to disseminate project information to educate the people in our communities and the surrounding area. Engagement meetings focused on project activities including peat ecosystem preservation, canal blocking, and fishing. We carried out these stakeholder consultations with community fishermen from Kepayang, Tebing Harapan, Buring, Pal 8, and Bakung.

FGDs have been employed to communicate with a range of SMPP stakeholders and community members, with representatives invited from a variety of groups to learn about village history, land ownership history, livelihoods, local socio-cultural systems, natural resource utilization, locations of natural resources, and land-uses in the area. Both of these events were conducted by SMPP staff on June 2nd, 2018. At both events, the SMPP team communicated directly with the participants about the aims of the project and the SMPP's intentions in the area.

- The first FGD was conducted in Muara Merang village at the house of the Bakung sub-village Head to discuss meeting the needs of the Muara Merang villagers. This event was attended by 17 individuals, including three fishermen, one local public figure, one charcoal maker, and the head of Dusun 1. Within this group there were six women and eleven men in attendance.
- The second FGD was conducted in Kepayang village at the Kepayang Elementary School to discuss village spatial boundaries, the distances that members of the village typically traveled, and the basic needs of the people in the village. This event was attended by 13 individuals, including three elementary school teachers, one school principle, three public figures, one craftsman, and the leaders of Dusun 1, Dusun 2, RT 04, Financial Affairs (Kaur Keuangan) and (Kaur Pemerintahan). Within this group there were four women and nine men in attendance.

Throughout May, June, and July of 2018, we conducted 27 of the one-on-one interviews mentioned in Table 7 within our communities, including with one farmer from Karang Agung, three fishermen from Kepayang, and one fisherman from Bakung, a sub-village of Muara Merang. In addition, other stakeholders from the Muara Merang area including Bakung and Bina Desa, from the Kepayang area, and from unofficial settlements including Tebing Harapan, Buring, and Sagita were interviewed in this setting. There were 7 females and 20 males that participated in the interviews. We also conducted meetings directly with local women's groups in Muara Merang and Kepayang villages. These interviews have provided invaluable information about the activities of communities and other stakeholders in relation to the SMPP. As we continue to engage with these groups throughout the duration of the project, we will pay attention to the attitudes of individuals and listen to the feedback provided, so that we can employ adaptive management to guarantee positive impacts to all entities. Our PRA approach to community engagement and stakeholder consultations ensures that we maintain long-term positive relationships with these local groups, to maintain direct lines of communication between stakeholders and the project proponent.

2.3.8 Continued Consultation and Adaptive Management (G3.4)

Throughout the lifetime of the project, we will maintain a direct line of communication with community members, and relevant stakeholders. This will establish a commitment to communication and consultation to keep stakeholders informed of project activities including restoration, maintenance, monitoring and the CCB validation and verification process. SMPP staff in the field will maintain communications with the fishermen and farming community groups and other stakeholders through in-person meetings. We will actively listen to recommendations made by any identified community members, or other stakeholder groups, and adapt and improve our methods as necessary.

The project will host a meeting and site visit with impacted fishermen to assess the impact of the dams on their ability to continue subsistence fishing and receive input on how to improve conditions for them. The project will look for solutions that meet the farmer's needs and work to implement them. The results of these impact mitigation activities will be reviewed in the quarterly meetings.

Our project has an adaptive management plan to effectively grow as our project progresses, and systematically develop existing practices through project monitoring and evaluation. We will periodically review our plans, methods, goals and objectives, to incorporate new lessons learned, available technology, and scientific knowledge. These strategies will be in accordance with our project's Standard Operating Procedures (SOPs) and our monitoring plans (see sections 0, 4.4.1, 5.4.1).

2.3.9 Stakeholder Consultation Channels (G3.5)

We have conducted a number of stakeholder engagement and consultation meetings with identified project communities and other stakeholders from the nearby villages and settlements. Our project staff have conducted participatory surveys with the Participatory Rural Appraisal (PRA) method as part of the consultative process. This included focus group discussions (FGDs), interviews with men and women living in nearby settlements and villages, and observation and ground checks with local residents including participatory visits to a variety of important areas and community epicenters. See Section 2.3.3 to learn more about informational meetings with stakeholders and Section 2.3.2 for more information on project information dissemination.

2.3.10 Stakeholder Participation in Decision-Making and Implementation (G3.6)

The SMPP engages in consistent consultations with project communities and other stakeholders on project implementation and design as a way to incorporate local knowledge into the project. Consultations ensure to engage with both men and women, and more marginal stakeholder groups in culturally appropriate ways to ensure that the project can hear a wide range of perspectives. Our project consultations and methods are described in more detail in Section 2.3.7.

2.3.11 Anti-Discrimination Assurance (G3.7)

Our project team holds every individual involved in project design and implementation to a high standard of integrity, to ensure no one is involved in, or complicit in, any form of discrimination or sexual harassment with respect to the project. This includes discrimination based on gender, race, religion, ethnicity, social class, or other aspects of human individuality. Throughout the project duration, the SMPP will abide by all relevant Indonesian labor laws and regulations. Further, the project has an equal opportunity policy that ensures that the project will not engage in or be complicit in any form of discrimination or sexual harassment. To ensure compliance, the project has a grievance system in place that will provide all project employees, identified community members, and other stakeholders with a formal system in the event that any discriminatory actions or sexual harassment does occur, to ensure grievances can be addressed quickly and appropriately.

2.3.12 Feedback and Grievance Redress Procedure (G3.8)

We recognize the importance of a feedback grievance redress mechanism within the SMPP to keep the project running smoothly and free of conflict. If conflicts or grievances arise, the project relies on the feedback and grievance redress policy. This process is designed to be an efficient, fair and accessible mechanism for resolving complaints and conflicts in a transparent and comprehensive manner. The mechanism can also address issues or conflict between the community and the project, or issues use related to employee rights, work practices, and employee safety raised by project staff or contractors.

If any grievances occur and are reported from surrounding communities or other relevant stakeholders, we will quickly respond to them by following the formal mechanism process. Grievances will be assessed to identify and verify the cause, actors and scale of grievances, and our project team will recommend resolution options based on feedback from the stakeholders. If a grievance is not amicably resolved after this process, it will be submitted to an unbiased third party for a formal mediation and arbitration process, and subject to a hearing at which both disputing parties can testify. All cases will be referred and examined to the extent allowed by Indonesian laws and regulations of the relevant jurisdiction before decisions are made.

This grievance policy is outlined in the document “SMPP Grievance Redress Mechanism” and will be described in general at community meetings, and the document will be provided to key locations in the project area. Further, the grievance policy was translated into Bahasa Indonesia and will be kept at the SMPP field office and given to project community members other stakeholders. To ensure transparency, the project will maintain a record book with all received and resolved grievances, which can be viewed upon request by project stakeholders or auditors.

2.3.13 Accessibility of the Feedback and Grievance Redress Procedure (G3.8)

Our project encourages identified community members, stakeholders, and employees to visit the project office and forest patrol posts which are located around the perimeter of the project area to discuss any issues or feedback directly with project staff. Verbally reported grievances will be documented by project staff and submitted into the formal system for resolution. At these project locations, grievance submission forms will be available and can be submitted directly to project staff. In nearby settlements, the project's community liaison officer's phone number and email will be distributed to village leaders and will be available to meet with stakeholders to receive reported grievances. To ensure transparency, the project will maintain a record book with all received and resolved grievances, which can be viewed upon request by project stakeholders or auditors.

2.3.14 Worker Training (G3.9)

The SMPP has a target to employ 80% of its field staff with residents of nearby villages and settlements. As part of the on-boarding process, the project provides all staff with an orientation program where it provides overviews of the project's Standard Operating Procedures (SOPs) and policies with specific attention to health and safety policies. The employees also receive training in the use of technology such as GPS units, computers, solar energy, and firefighting equipment which will expand employee knowledge increasing their prospects of future employment. Local capacity is constantly being supported through training programs and recruitment drives for full-time and part time employment opportunities to ensure strong local capacity despite staff turnover.

2.3.15 Community Employment Opportunities (G3.10)

The SMPP is an equal opportunity employer and is committed to engage with the identified community groups and local stakeholders on employment opportunities. To achieve this, the project has a policy to

hire 80% of its staff from local areas as a way to increase community and stakeholder benefits. Further, the project has a target to have 25% of its work force be women to ensure greater gender balance in fields traditionally dominated by men. To create opportunities for marginal groups, the project also has positions available for staff who have not obtained high school diplomas to ensure these vulnerable groups have access to meaningful employment opportunities. The project also works with staff to increase their education levels through continuing adult education programs.

Job opportunities are publicly advertised in similar channels where other project news is publicized, such as community sign boards and announcements via community leaders. Meetings are convened within project stakeholder villages and settlements as part of the recruitment process in order to spread the word and attract candidates. The project has also communicated that it is always actively recruiting for forest patrol officers and that interested parties can apply directly at the project office.

Job applicants are selected for interviews based on their skills and experience required for the advertised positions. Successful candidates are then selected in accordance with the project's equal opportunity policy. Applicants who live in the local villages and settlements are given preference in the case where two applicants show the same capacity for a given position whereas one is from the local area and the other is not.

2.3.16 Relevant Laws and Regulations Related to Worker's Rights (G3.11)

The SMPP complies with all national and provincial laws related to worker's rights, including: Law No. 13/2003 regarding Manpower. This is an umbrella law on labor relationship in Indonesia, which stipulates the working conditions and rights and obligations of the employees and the Company. The SMPP operations fully attend to the rights of workers and seek to ensure that the rights of all employees are upheld in a manner where all individuals are aware of their rights. The project has its own human resource policies containing the details of employment practices that we follow. These policies are explained to all staff during their orientation program and are available for review in the project's field office and posted at all forest patrol offices. SMPP has principles to treat all persons in the project with dignity and respect.

2.3.17 Occupational Safety Assessment (G3.12)

The project is committed to ensuring occupational safety for all project staff and follows all relevant Indonesian worker's rights laws and regulations, particularly those pertaining to health and safety. The project has created a comprehensive Health and Safety Plan and informs all staff on the workplace risks and safe practices to mitigate those risks during the employee orientation. A hard copy of the relevant project regulations will be kept at the project office for reference by project staff. Project staff are exposed to a number of risks that include strenuous activity in wet, humid, and hot conditions, forest fires, transportation accidents, interactions with illegal loggers, encounters with dangerous wildlife, and exposure to mosquito borne sicknesses. The health and safety training for the project addresses these risks and also trains staff on the proper handling of equipment and other materials. In addition, project proponents maintain a public liability insurance of 9,000,000 EUR in case major accidents do occur.

2.4 Management Capacity

2.4.1 Project Governance Structures (G4.1)

The SMPP is implemented by two project proponents: PT GAL and Forest Carbon. The joint development of the project is managed via a project management board that is composed of representatives of PT GAL and Forest Carbon with an observer from the investment partner, Althelia Climate Fund. This body is responsible for:

- Developing and approving strategic plans;

- Approving annual budget and large expenditures;
- Reviewing key personnel performance;
- Evaluating project performance;
- Determining project finance needs; and
- Providing oversight to subcontractors and consultants.

At the implementation level, each proponent focuses on different areas of implementation. PT Global Alam Lestari, a subsidiary of an established Indonesian forestry company, specializes on the ground operations for forest restoration in the project area. Its staff have significant experience in overseeing the implementation of large-scale land management projects in Indonesia. As the holder of the PAN/RAP license, its role in the project is to implement all field activities in line with the project design, manage and oversee community and stakeholder relations, and ensure compliance with all government regulations.

Forest Carbon is a leading forest conservation and restoration company that has been working in Indonesia since 2007. Forest Carbon has staff experienced in project management, VCS/CCBA project design, Geographic Information Systems (GIS) and remote sensing, forest and biomass inventories, biodiversity mapping and monitoring, and community engagement. Forest Carbon's also leads project management, project design, field data collection and analysis, VCS/CCBA certification monitoring and compliance, and technical advisory services.

2.4.1.1 Project Proponent (G1.1)

Organization name	PT Global Alam Lestari
Contact person	Mr. Riza Suarga
Title	President Director
Address	Komp, Mall Ska Blok E 61, Delima, Tampan, Pekanbaru, Riau, 28294
Telephone	+62 761 7891749
Email	r.suarga@globalalamlestari.com

Organization name	Forest Carbon (Equator Group PTE LTD)
Contact person	Jeffrey Chatellier
Title	Managing Director
Address	1 Raffles Place, #44-01A One Raffles Place, Singapore, 048616
Telephone	+62 21 5740817
Email	j.chatellier@forestcarbon.com

2.4.1.2 Project Partners

Organization	Althelia Climate Fund
Contact Person	Adam Gibbon
Title	Chief Technical Officer / Investment Director

Address	Unit 2, 7 Chalcot Road, Primrose Hill, London NW1 8LH, UK
Telephone	+44 (0) 77 362 869 27
Email	adam.gibbon@althelia.com

Organization	Ecosphere+
Contact Person	Lisa Walker
Title	CEO
Address	Unit 2, 7 Chalcot Road, Primrose Hill, London NW1 8LH, UK
Telephone	+44 203876 5228
Email	lisa@ecosphere.plus

2.4.2 Required Technical Skills (G4.2)

The project requires a range of technical and managerial skills in order to implement the project activities listed in Section 2.1.11. Table 8 outlines the skills required per project activity.

Table 8. Key skills required to implement the project activities.

Project Activity	Sub-project Activity	Key Skills Required
Carbon stock measurements	Aboveground and belowground biomass measurement	Peatland science, forestry, GIS/ remote sensing, forest and peatland inventories, statistics, and carbon monitoring, reporting, and verification (MRV).
FPIC and community engagement and development	Stakeholder consultation, livelihood development, and education program.	Community organizing, conflict resolution, business management, adult education, and livelihoods.
Biodiversity assessment and monitoring	Habitat conservation and management and biodiversity monitoring.	HCV mapping, forest conservation, conservation biology, and biodiversity monitoring
Monitoring skills	Land cover mapping, water level monitoring, subsidence monitoring, climate monitoring, biodiversity monitoring, community monitoring, and fire monitoring.	GIS/remote sensing, hydrology, peatland science, conservation biology and monitoring, social science surveys, and peatland forest fire management
Forest protection and enforcement	Enforcement and patrolling and forest fire prevention and control.	Forestry, peatland forest fire management, and community engagement.
Forest and peatland conservation and restoration	Hydrological management, reforestation, enrichment planting, and habitat conservation.	Hydrology, peatland science, silviculture, forestry, and biodiversity conservation, engineering.
Project management and administration	Logistics, finance and accounting, human resources (HR),	Finance and accounting, HR, business management, legal compliance, and administration.

	administration, and government reporting.	
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2.4.3 Management Team Experience (G4.2)

Provided below is a description of the experience and qualifications of the key members of the management team.

2.4.3.1 Project Management Leads

Dr. Riza Suarga – President Director – Global Alam Lestari – SMPP Project Lead

Dr. Suarga is PT GAL's President Director and is a seasoned corporate executive with over 30 years of experience running large-scale businesses in Indonesia's forestry sector. His academic credentials are extensive, with a BA from Ohio University in engineering, a master's in human resource management from Triskakti University, and a Ph.D. in natural resource management from the University of Indonesia. His experience and wide-ranging academic background make him well-suited to manage teams within the sustainable forestry and conservation sectors. As a member of the Indonesian Chamber of commerce for over eight years, he is currently the chamber's liaison at the Ministry of Environment and Forestry since 2014 where he serves as the chairman of the Ecolabel desk focusing on certification standards for products from the forestry sector. He has also been a member of the Indonesian Forest Concessionaires Association (*Asosiasi Pengusaha Hutan Indonesia* or APHI) since 1998 and served as Vice Chairman of its Carbon Team as well as the Chairman of its Law & Regulations Board. He has written numerous academic articles covering topics such as sustainable forest management and ways to combat illegal logging in Indonesia. He is fluent in English, Bahasa Indonesia, and conversant in Japanese.

Mr. Jeffrey Chatellier – Managing Director - Forest Carbon – SMPP Project Lead

Mr. Chatellier is Forest Carbon's Managing Director. He is an environmental scientist who has worked on environmental conservation, forestry, and sustainability for the past 10 years. With a combined background in economics and environmental science, Mr. Chatellier has advised major corporations and international environmental organizations on forest conservation, environmental risk mitigation, and sustainability. He has worked closely on the development of multiple REDD+ projects in Southeast Asia, which has given him in depth knowledge of various carbon standards and the technical and political challenges to conservation projects in the developing world, including. He has reviewed existing scientific carbon accounting methodologies and worked with companies on developing the necessary project documents to obtain carbon credits, Rimba Raya peatland project in Central Kalimantan, Indonesia, and the REDD+ project in Keo Seima Wildlife Sanctuary, Cambodia.

In addition to these two managers, the team of project team is highly skilled in forest management, peatland science, Indonesian and legal and policy compliance, GIS and remote sensing, community engagement, that will support project management and implementation.

2.4.3.2 Project Design, Monitoring, Implementation

Dr. Ophelia Wang – Technical Director - Forest Carbon – SMPP MRV:

Dr. Wang is Forest Carbon's Technical Lead. A specialist in conservation entrepreneurship, Dr. Wang brings more than 17 years of experience in technical forestry and program management, backed by Ph.D. and M.Sc. studies in tropical conservation spatial planning in regions as diverse as Latin America and Southeast Asia. Dr. Wang brings deep technical expertise in program management system design and strategic planning for conservation projects, in addition to multiple years of experience in Latin America, U.S. and Southeast Asia using GIS and remote sensing techniques to improve landscape-scale spatial planning, information system management, and conservation implementation. Dr. Wang's strengths lie in

data analysis, specifically in integrating habitat and species data with peatland hydrology and fire risk analysis to provide comprehensive ecosystem service models.

Sebastian Persch - Forest and Peatland Scientist – Forest Carbon – SMPP MRV

Mr. Persch is a tropical peat hydrology expert who has worked on various topics related to forestry, conservation, and climate change since 2011. He specializes in tropical peat ecology, including advanced data analysis and statistical programming using open source software and has conducted research on peatlands in Sumatra on carbon stock and carbon dynamics estimation. Sebastian holds B.Sc. and M.Sc. in Tropical Forestry Ecology, all from the Georg-August Universität Göttingen in Germany and is currently pursuing a PhD. He conducted post-doctoral research at the Center for International Forestry Research (CIFOR), and his dissertation focused on root dynamics within land-use change from forest to oil palm plantation in the tropical peat swamps of Berbak National Park and the *Taman Hutan Raya* in Jambi, Indonesia. He has held previous positions and consultancies with the Centre de cooperation *Internationale en recherche agronomique pour le développement* (CIRAD), the James Hutton Institute, and the University of Göttingen. With Forest Carbon he has completed assignments modeling baseline and expected emissions from peat drainage in Berbak National Park and in the degraded peat lands of the Ex-Mega Rice project area in Central Kalimantan. For those assignments Sebastian modeled emissions from drainage, established proxies with calibrated GHG emission profiles in Strata I and identified possible canal blocking locations in conjunction with Forest Carbon GIS and Remote Sensing teams.

Abdul Haris Marzuki – Field Site Manager – Global Alam Lestari – SMPP Head of Field Operations

Mr. Marzuki oversees all field operations in the SMPP project area. He has 25 years' experience working in the forestry sector in Indonesia and has experience overseeing field staff and ensuring a safe and healthy work environment.

Mr. Ahmad Susilo– Community Engagement Manager – Global Alam Lestari – SCR Community Engagement lead

Mr. Susilo has extensive experience in engaging with local communities and government officials. He will be supporting all community engagement activities and implementation of the community development program for the SMPP.

Mary Osmond – Legal Advisor – Forest Carbon – Legal Compliance for SMPP

Ms. Osmond is a trained lawyer with a background in business and environmental law in Indonesia. She holds a law degree from Atmajaya University and an LLM from the University of Groningen in the Netherlands and is also member of the Indonesian Bar Association (*Perhimpunan Advokat Indonesia* or PERADI). She has significant experience on government regulation and policy and previously acted as the Indonesian government UKP4/REDD+ Agency representative in Jambi where she worked with local government, civil society, and private sector to implement a transparent licensing system for the mining and plantation sectors. She is supporting the SMP on legal compliance and policy monitoring.

Prasetya Mahardhitama – Remote Sensing Manager – Forest Carbon – MRV

Mr. Mahardhitama is an expert in GIS and remote sensing. His background in information technology systems enables him to build custom applications that leverage GIS & Remote Sensing data, including high-resolution satellite imagery from Light Detection and Ranging (LiDAR), Satellite and Unmanned Aerial Systems. He has developed custom web and mobile GIS applications for conservation projects and has supported forest landscape analysis and mapping across Southeast Asia and is also a certified drone pilot.

2.4.4 Project Management Partnerships/Team Development (G4.2)

All relevant project management experience is present in the current SMPP partners.

2.4.5 Financial Health of Implementing Organization(s) (G4.3)

Both project proponents, PT GAL and Forest Carbon, are financially stable companies, capable of implementing and maintaining a project of the scale of the SMPP. Additionally, the initial project activities are fully supported by the Althelia Climate Fund. See Section 2.1.20 for information on the financial sustainability of the project's funding. Project validators may request to see more specific financial statements and to verify the financial health.

2.4.6 Avoidance of Corruption and Other Unethical Behavior (G4.3)

As a collaborative effort, the SMPP team is committed to upholding a high level of integrity and professionalism throughout all aspects of project design and implementation. We have a zero-tolerance attitude towards corruption and unethical behavior, and are not involved in, or complicit in, any form of corruption such as bribery, embezzlement, fraud, extortion, and collusion. The project is also compliant with the US Foreign Corruption Practice Act (FCPA).

2.4.7 Commercially Sensitive Information (Rules 3.5.13 – 3.5.14)

Our project's commercially sensitive information that is not publicly available includes:

- Project implementation plans, financial plans, budgets, and projections – Including detailed organizational project implementation and work plans as well as initial and long-term project budgets for the duration of the project (30-year projections).
- Original data, electronic shape files, computer model code, and classified satellite imagery – Including GIS project boundary, land-use, and remote sensing data, biomass inventories, models assessing hydrology and carbon calculations, and social assessments in the SMPP area.
- Agreements and contracts between project proponents, other project entities, and stakeholder groups – regarding implementation of project activities.

Specific information is available privately to project validators upon request.

2.5 Legal Status and Property Rights

2.5.1 Statutory and Customary Property Rights (G5.1)

In the project area there are no outside statutory claims as the project has officially received all statutory rights to manage the area under its PAN/RAP license as described in Section 2.5.7. However as described in the Section 2.1.6 on identified project communities, a number of fishermen from nearby villages and settlements access the areas inside or bordering the project area. Two small farms border the concession area and have a total overlap of approximate 11.62 hectares. Both groups have customary usage rights in the project area but not statutory rights. Details of the areas of their customary usage are described in Section 4.1.3 and shown in Map 32 and Map 33.

2.5.2 Recognition of Property Rights (G5.1)

Our project is committed to recognizing, respecting, and supporting all property rights of communities and other stakeholders. An assessment of the project area showed that there are no groups living in the project area full time and that there were two small farms that overlap with the project license area and a small number of fishermen that fish inside and near the project area. However, the project was specifically designed, following the identification of these customary rights holders, to ensure that no impingement upon these rights holders or their livelihoods will occur.

2.5.3 Free, Prior and Informed Consent (G5.2)

As outlined previously, the project does not impinge on any rights holder's access or use of the project area. As per CCB requirements, FPIC is required only when these rights are negatively impacted. If it is ever determined that the project impacts these rights holders, either inadvertently or through the implementation of project activities, then an FPIC process will be initiated. Nevertheless, the project continues to adopt a highly consultative engagement process which ensures that all stakeholders and communities are consulted in an informative and meaningful way.

2.5.4 Property Rights Protection (G5.3)

Our project activities do not lead to involuntary removal or relocation of property rights holders from their lands or territories and does not force rights holders to relocate activities important to their culture or livelihood. If in the future any relocation of activities needs to be undertaken, it will take place with a written agreement that demonstrates that the agreement was made with the free, prior, and informed consent of those concerned and includes provisions for just and fair compensation.

2.5.5 Illegal Activity Identification (G5.4)

Small-scale illegal activities, such as illegal logging or hunting, were historically practiced in parts of the project area and could negatively impact the rehabilitation of the forest and reduce the returning levels of biodiversity. The project has constructed and staffed several forest patrol posts along the boundary of the project area to ensure an equal distribution of forest patrol coverage to all parts of the project area. The SMPP is also reducing the risk of these illegal activities and negative impacts with the implementation of its forest protection plan and a community development plan that provides sustainable livelihoods options. With stronger economic alternatives, the project expects that the need to participate in illegal activities will be further reduced. These project activities will reduce the risk that benefits from the project are derived from illegal activities.

2.5.6 Ongoing Disputes (G5.5)

There are no ongoing disputes or any previously unresolved conflicts inside the project area.

2.5.7 National and Local Laws (G5.6)

The SMPP is designed to be in full compliance with national, regional, and local laws of the Republic of Indonesia, especially laws regulating forest conservation projects. Relevant laws and regulations include:

Fire Prevention:

- Law No. 32/ 2009 regarding Environmental Protection and Management.
- Government Regulation No. 45/2004 regarding Forest Protection.
- Government Regulation No. 71/2014 regarding Protection and Management of Peatland Ecosystem.
- Government Regulation No. 57/2016 regarding the Change of the Government Regulation No. 71/2014 regarding Protection and Management of Peatland Ecosystem.
- Ministry of Environment and Forestry (MoE&F) Regulation No. 32/2016 regarding Controlling the Forest and Land Fire.

- South Sumatra Provincial Regulation No.1/2018 regarding the Peatland Ecosystem Protection and Management (“Peraturan Daerah No.1/2018”). This regulation stipulates the peatland management and protection including the obligations to prevent fire and avoid the damages of peatland.

Canal Blocking:

- Ministry of Environment and Forestry Regulation Np. P.14 / MENLHK / SETJEN / KUM.1 / 2/2017 regarding the Procedures for Inventory and Determination of the Function of Peat Ecosystems;
- Ministry of Environment and Forestry Regulation No. P.15/MENLHK/SETJEN/KUM.1/2/2017 regarding the Procedures of Water Table Measurement in the Peat Ecosystem’s Monitoring Point.
- Ministry of Environment and Forestry Regulation No.P.16/MENLHK/SETJEN/KUM.1/2/2017 regarding the Technical Guidelines for Restoring the Function of Peat Ecosystems.
- Ministry of Environment and Forestry Regulation No. P10/MENLHK/SEKJEN/KUM.1/3/2019 regarding the Enactment and Management of Peat Dome Based on the Peatland Hydrology Unit.

Community Development: GAL conducts the community development around its concession areas, which is line with the following regulations:

- Law No. 40 of 2007 regarding the Limited Liability Company (“Company Law”).
- Government Regulation No. 47 of 2012 on the Social and Environmental Responsibilities of the Limited Liability Company.
- The Ministry of Environment and Forestry No.P.39/MENHUT-II/2013 on the Local Community Development through Forestry Partnership. This regulation is required the forestry license holders to conduct community development activities.

Forest Conservation Activities

Business License: GAL holds a PAN/RAP license that allows to conduct the carbon sequestration and stock activities. The relevant regulations on licensing process are the following:

- Ministry of Environment and Forestry Regulation No. P.36/Menhut-II/2009 regarding Procedures for Licensing of Commercial Utilization of Carbon Sequestration and/or Storage in Production and Protected Forests. This regulation establishes the PAN/RAP License type and sets out the allowable activities of this license type.
- The Ministry of Environment and Forestry Regulation No. 11 of 2013 regarding the Amendment of MoE&F Regulation 36/09 on the Procedure of License of Utilization of Carbon Sequestration and/or Stock in the Production Forest and the Protected Forest.
- Ministry of Environment and Forestry Regulation No. 7/2015 regarding Technical Guidelines Rendering License and Non-License in Environment and Forestry Sector in Implementation of One Stop Service.
- Ministry of Environment and Forestry Regulation No. P.22/MENLHK/SETJEN/KUM.1/2018 regarding Norms, Standards, Procedures and Criteria of One Stop Integrated Services through Electronically in Environment and Forestry Sector.

PAN/RAP Management Activities:

- Government Regulation No. 6/2007 regarding Forest Governance and Preparation of Forest Management Plan that was amended by Government Regulation No. 3/2008.
- Ministry of Environment and Forestry Regulation 43/2013 regarding Boundary Arrangement.
- Ministry of Environment and Forestry Regulation No.P.73/MENHUT-II/2014 regarding the Work Plan of PAN/RAP in Production Forest.

- Ministry of Environment and Forestry No.P.74/Menhut-II/2014 regarding the Implementation of Silviculture Technics in Utilization of Carbon Sequestration and/or Carbon Stock Business in Production Forest.
- Ministry of Environment and Forestry Regulation No.P.71/MENLHK/SETJEN/KUM.1/12 2017 regarding the Climate Change National Registration System. This regulation creates the National Registration System which all project related to reduce carbon emission shall be registered in this system in order to avoid double counting of carbon.

Trading & Taxation:

- The Government Regulation No. 46 of 2017 regarding the Green Environmental Instrument. This regulation specifically relates to for environmental services trading.
- Ministry of Environment and Forestry No.P.12/Menhut-II/2014 regarding Types and Tariffs of Non-Tax State Revenue Applicable to the Ministry of Forestry. This specifically relates to taxes on carbon credit transactions.
- The Ministry of Environment and Forestry No. 50 of 2014 regarding the Sale of Indonesia Certified Emission Reduction. This regulation sets out the guidelines and rules for the license and management rights holders, including PAN/RAP license holder to both sell and trade ICER/SPEKHI unit.

Labor:

- Law No. 13/2003 regarding Manpower.
- The Manpower and Transmigration Regulation No.233/2003 regarding the Type of Works can be conducted in continuously. This regulation stipulates the exemption of work hours for certain sector, including conservation.
- The Manpower and Transmigration Decree No. Kep.100/MEN/VI/2004 regarding the Implementation of Definite-Term Employment Agreement.

2.5.8 Approvals (G5.7)

The project has all of the necessary approvals from the government at the district, provincial, and national levels as outline in Table 9 below.

Table 9. List of PAN/RAP license approvals.

Decree / Approval No.	Description	Approval from	Date of Issuance
<i>Surat Bupati Musi Banyuasin Nomor: 522/2591/Dishut/2011. Rekomendasi Pertimbangan Teknis Izin Usaha Pemanfaatan Penyerapan Karbon dan/atau Penyimpanan Karbon (UP RAP-KARBON/UP PAN-KARBON) An. PT Global Alam Lestari.</i>	Technical recommendation for PT GAL Concession under carbon storage and sequestration license.	Head of Musi Banyuasin district (<i>Bupati</i>)	November 7 th , 2011
<i>Surat Gubernur Sumatera Selatan Nomor: 522/0293/I/2012. Rekomendasi Izin Usaha Pemanfaatan Penyerapan dan Penyimpanan Karbon (UP RAP-KARBON/UP PAN-KARBON) An. PT</i>	Business license recommendation for PT GAL Concession under carbon storage	Governor of South Sumatra	February 1 st , 2012

<i>Global Alam Lestari di Kabupaten Musi Banyuasin.</i>	and sequestration license.		
<i>Keputusan Menteri Kehutanan Republik Indonesia Nomor: SK. 494/Menhut-II/2013.</i>	Carbon storage and sequestration license approval.	Ministry of Forestry, Republic of Indonesia	July 12 th , 2013
<i>Tata Batas</i>	Permanent Concession Boundary Marking	Ministry of Forestry, Republic of Indonesia	2018

2.5.9 Project Ownership (G5.8)

PT Global Alam Lestari, an SMPP project proponent, holds the land tenure rights for the SMPP, with the entire project area officially recognized and nationally zoned as a Production Forest area (*Hutan Produksi* or HP). In 2012, PT GAL submitted a request for an IUP PAN/RAP license for the utilization of carbon sequestration and carbon sinks. This license was granted by the government on July 12th, 2013 by the Department of Forestry (Decree of the Minister of Forestry No. SK. 494 Menhut-II/2013). This license falls under regulation P.36/Menhut-II/2009 on the utilization license of carbon sequestration and/or sink in production forest and explicitly allows the project to conduct restoration and conservation activities and sell carbon credits on the international voluntary markets. See Section 2.5.2 for further details.

2.5.10 Management of Double Counting Risk (G5.9)

The SMPP has not received any form of environmental or social credit, including any tradable climate, community or biodiversity units. The SMPP does not participate under any other program to create environmental or social credits.

2.5.11 Emissions Trading Programs and Other Binding Limits

The SMPP's activities and GHG emission reductions do not fall under any other emissions trading program or other binding limit in relation to GHG emissions.

2.5.12 Other Forms of Environmental Credit

The SMPP only seeks to generate VCUs and has never received another form of GHG-related environmental credit.

2.5.13 Participation under Other GHG Programs

The SMPP does not participate under any other GHG program.

2.5.14 Projects Rejected by Other GHG Programs

The SMPP has not applied for or been rejected by any other GHG program.

2.5.15 Double Counting (G5.9)

The SMPP does not generate credits in a country participating in a compliance mechanism, as such double counting risks do not need to be considered.

3 CLIMATE

3.1 Application of Methodology

3.1.1 Title and Reference of Methodology

The Project applies the latest version of VCS Methodology VM0007 (version 1.5). Applicable modules are available in Table 10 in Section 3.1.2.

3.1.2 Applicability of Methodology

Table 10 indicates how the project meets all applicability conditions of VM0007 and its associated modules.

Table 10. Summary of applicability conditions.

No	Module	Applicability Condition	Comment
1	REDD-MF, 4.3 ARR	The project area is non-forest land or land with degraded forest.	Condition met. See Section 2.1.5.
2	REDD-MF, 4.3 ARR	The project scenario does not involve the harvesting of trees. Therefore, procedures for the estimation of long-term average carbon stocks are not provided.	Condition met. See Section 2.1.11.
3	REDD-MF, 4.3 ARR	ARR activities are not eligible if the project scenario does not involve the application of nitrogen fertilizers.	Condition met. The project does not involve the application of any fertilizers. See Section 2.1.11.
4	REDD-MF, 4.3 ARR	Where project activities on wetlands are excluded by the applicability conditions of applied modules or tools, these can be disregarded for the purpose of their use within this methodology, as quantification procedures for the peat soil are provided in modules BL-PEAT and M-PEAT.	Condition met. The project applies modules BL-PEAT and M-PEAT alongside all modules related to ARR.
5	REDD-MF, 4.4 WRC	This methodology is applicable to rewetting drained peatland (RDP) and conservation of undrained and partially drained peatland (CUPP) activities on project areas that meet the VCS definition for peatland. The scope of this methodology is limited to domed peatlands in the tropical climate zone.	Condition met. The project area contains peatland (see Section 2.1.5) which would be drained in the baseline and which will be conserved and restored in the project scenario. The project therefore falls in the category of RDP and CUPP. The project meets the definition of domed peatlands (see Section 2.1.5) and is located in the tropical climate zone (see Section 2.1.5 (see Section 2.1.5).
6	REDD-MF, 4.4 WRC	Fire reduction projects on peatland that exclude rewetting as part of the project activity are not eligible.	Condition met. The project includes extensive rewetting across the entire project area (see Section

No	Module	Applicability Condition	Comment
			2.1.11) in conjunction with WRC and ARR activities.
7	REDD-MF, 4.4 WRC	Rewetting of drained peatland and conservation of undrained or partially drained peatland may be implemented in combination with REDD project activities. REDD project activities on peatland must not increase drainage.	N/A. The project does not include any REDD components.
8	REDD-MF, 4.4 WRC	Rewetting of drained peatland may be implemented as a separate activity or in combination with ARR project activities. ARR activities must not enhance peat oxidation and therefore this activity requires at least some degree of rewetting.	Condition met. The project includes extensive rewetting across the entire project area (see Section 2.1.11) in conjunction with WRC and ARR activities.
9	X-STR	In case of REDD, aboveground biomass stratification is only used for pre-deforestation forest classes, and strata are the same in the baseline and the project scenario. Post-deforestation land-uses are not stratified. Instead, average post-deforestation stock values (e.g., simple or historical area-weighted approaches are used, as per Module BL-UP).	N/A. The project does not include any REDD components.
10	X-STR	For peatland rewetting and conservation project activities this module must be used to delineate non-peat versus peat and to stratify the peat according to peat depth and soil emission characteristics, unless it can be demonstrated that the expected emissions from the soil organic carbon pool or change in the soil organic carbon pool in the project scenario is de minimis.	Condition met. See application of X-STR in Section 3.1.3.
11	X-STR	In the case of peatland rewetting and conservation project activities, the project boundary must be designed such that the negative effect of drainage activities that occur outside the project area on the project GHG benefits are minimized.	Condition met. The project is taking significant steps to maintain the intactness of hydrology in the project area and to restore hydrology in areas which have been disturbed by existing drainage. The project is monitoring areas outside the project area which could be under threat of disturbance in order to minimize potential impacts in terms of drainage. See Section 3.2.3.
12	BL-ARR	The applicability conditions set out in AR-ACM0003 Afforestation and reforestation of lands except wetlands must be met.	See #25 & 17 below.
13	BL-ARR	Applicability conditions included in AR-ACM0003 Afforestation and reforestation of lands except wetlands and corresponding tools that exclude	Condition met. See #2 above.

No	Module	Applicability Condition	Comment
		project activities on wetlands can be disregarded for the purpose of their use in this module, as accounting procedures for the peat soil are provided in module BL-PEAT.	
14	BL-ARR	Where the ARR project activity is implemented on peatland, the peatland must be degraded in the baseline scenario as identified by the presence of drainage infrastructure (ditches, canals) and associated lowered water tables below the surface. In the case of forested peatland, degradation may be identified by the removal or degradation of the tree cover before the project start date.	Condition met. ARR project activities are only implemented on already degraded land which would be further degraded in the baseline as demonstrated in Sections 3.1.3 and 3.2.1.
15	BL-ARR	The project scenario does not involve the harvesting of trees. Therefore, procedures for the estimation of long-term average carbon stocks are not provided.	Condition met. See #2 above.
16	ACM0003	This methodology is applicable under the following conditions: (a) The land subject to the project activity does not fall in wetland category; (b) Soil disturbance attributable to the project activity does not cover more than 10 per cent of area in each of the following types of land, when these lands are included within the project boundary: (i) Land containing organic soils; (ii) Land which, in the baseline, is subjected to land-use and management practices and receives inputs listed in appendices 1 and 2 to this methodology.	Per #13 above, condition (a) can be neglected, as the project applies relevant wetland procedures. Condition (b) is not relevant, as the project does not cause soil disturbance.
17	ACM0003	A project activity applying this methodology shall also comply with the applicability conditions of the tools contained within the methodology and applied by the project activity.	Condition met. This table lists all relevant applicability conditions and describes how they are fulfilled.
18	BL-PEAT	This module is applicable to RDP and CUPP activities on project areas that meet the VCS definition for peatland. The scope of this module is limited to domed peatlands in the tropical climate zone	Condition met. See #5 above.
19	BL-PEAT	It must be demonstrated by using the latest version of the CDM A/R methodological tool: "Tool for testing significance of GHG emissions in A/R CDM project activities" (T- SIG) that N ₂ O emissions in the project scenario are not significant, or it must be demonstrated that N ₂ O emissions will not increase in the project scenario compared to the baseline scenario, and therefore N ₂ O emissions need not be accounted for	Condition met. The project does not cause an increase in N ₂ O emissions.

No	Module	Applicability Condition	Comment
20	BL-PEAT	In the baseline scenario the peatland must be (partially) drained. At project start the peatland may still be undrained.	Condition met. Peatland will be drained in the baseline (see Section 3.2.1).
21	BL-PL	The module is applicable for estimating the baseline emissions on forest lands (usually privately or government owned) that are legally authorized and documented to be converted to non-forest land.	N/A. The project does not include any REDD components.
22	BL-PL	Where, pre-project, unsustainable fuelwood collection is occurring within the project boundaries modules BL-DFW and LK-DFW shall be used to determine potential leakage	N/A. Unsustainable fuelwood collection not occurring within the project boundaries.
23	LK-ECO	This module is applicable under the following condition: • Leakage caused by hydrological connectivity is avoided by project design and site selection, as outlined in Chapter 5 (Procedures).	Condition met. Project does not cause ecological leakage. See application of LK-ECO in Section 3.2.3.
24	T-ADD	The tool is applicable under the following conditions: • Forestation of the land within the proposed project boundary performed with or without being registered as the A/R CDM project activity shall not lead to violation of any applicable law even if the law is not enforced. • This tool is not applicable to small - scale afforestation and reforestation project activities.	Condition met. Reforestation activities do not violate any applicable laws indeed they are required under the project scenario. The reforestation activities are not classified as small scale.
25	T-SIG	The tool shall be used in the application of an A/R CDM approved methodology to an A/R CDM project activity: a) To determine which decreases in carbon pool and increases in emissions of the greenhouse gases measured in CO ₂ equivalents that results from the implementation of the A/R project activity, are insignificant and can be neglected b) To ensure that it is valid to neglect decreases in carbon pools and increases GHG emission by source stated as being insignificant in the applicability conditions of an A/R CDM methodology	Condition met. T-SIG was used, however no significance calculations needed to be performed as carbon pools and sources of GHG emissions were only neglected where it was demonstrably conservative.
26	E-BPB	This module is applicable to avoiding unplanned deforestation or degradation (AUDD), avoiding planned deforestation (APD) and avoiding degradation project activities, whether or not situated on peatland.	Condition met. Project includes WRC activities.
27	M-ARR	This module is applicable under the following conditions: • The applicability conditions provided in A/R CDM consolidated methodology AR- ACM0003 (Afforestation and reforestation of lands except	Condition met. See #13 & #14 above

No	Module	Applicability Condition	Comment
		wetlands) and associated tools. • Where exclusion of project activities on wetlands exist in the applicability conditions of methodologies and tools, these can be neglected for the purpose of their use in this module, as accounting procedures for the peat soil are provided in nodule M-PEAT.	
28	M-PEAT	This module is applicable to RDP and CUPP activities as defined in VCS AFOLU Requirements. The project area must meet the VCS definition for peatland. This module is limited to domed peatlands in the tropical climate zone.	Condition met. See #5 above.
29	M-PEAT	Furthermore, the following applicability conditions apply: It must be demonstrated using tool T-SIG that N ₂ O emissions in the project scenario are not significant, or it must be demonstrated that N ₂ O emissions will not increase in the project scenario compared to the baseline scenario, and therefore N ₂ O emissions need not be accounted for. In the baseline scenario the peatland must be drained or partially drained. At project start the peatland may still be undrained. It must be demonstrated using Module LK-ECO that ecological leakage must not occur.	Condition met. See #19 regarding N ₂ O emissions. Baseline scenario includes draining of peatland. Project is partially drained at project start. Per Section 3.2.3 ecological leakage does not occur.
30	M-MON	Strata as defined in the relevant baseline modules are fixed and may not be changed without baseline revision.	Condition met. See Section 3.1.3.
31	M-MON	The module is always mandatory. Without application of this module the methodology shall not be used	Condition met. The module is applied as per the requirement.
32	M-MON	Where selective logging is taking place in the project case: • Emissions from logging may be omitted if it can be demonstrated the emissions are de minimis using T-SIG. • If emissions from logging are not omitted as de minimis, logging may only take place within forest management areas that possess and maintain a Forest Stewardship Council (FSC) certificate for the years when the selective logging occurs. • Logging operations may only conduct selective logging that maintains a land cover that meets the definition of forest within the project boundary. • All trees cut for timber extraction during logging operations must have a DBH greater than 30 cm. • During logging operations, only the bole/log of	Condition met. Project does not include selective logging.

No	Module	Applicability Condition	Comment
		the felled tree may be removed. The top/crown of the tree must remain within the forested area. • The logging practices cannot include the piling and/or burning of logging slash • Volume of timber harvested must be measured and monitored.	
33	X-UNC	The module is mandatory when using VCS methodology VM0007. It is applicable for estimating the uncertainty of estimates of emissions and removals of CO ₂ -e generated from REDD and WRC project activities. The module focuses on the following sources of uncertainty: • Determination of rates of deforestation and degradation • Uncertainty associated with estimation of stocks in carbon pools and changes in carbon stocks • Uncertainty associated with estimation of peat emissions • Uncertainty in assessment of project emissions	Condition met. X-UNC has been used throughout to estimate uncertainties associated with this project. See Section 3.2.4.
34	X-UNC	Where an uncertainty value is not known or cannot be simply calculated, then a project must justify that it is using an indisputably conservative number and an uncertainty of 0% may be used for this component.	Condition met. The uncertainty value is known, see Section 3.2.4.

3.1.3 Project Boundary

3.1.3.1 Spatial boundary of the project area

Following the VCS Module X-STR, the project area was stratified into the following discrete, relatively homogenous units:

1. Aboveground biomass (AGB) stratification and vegetation types;
2. Differentiation of peatland from non-peatland;
3. Stratification of the peatland area based on peat thickness and peat depletion time (PDT);
4. Area of peatland eligible for crediting; and
5. Stratification according to PDT.

Sections 3.1.3.1.1 to 3.1.3.1.7 below describe the procedures followed to stratify according to the units listed above. All the analyses took place following the project area's delineation. Spatial models were performed in the resolution (i.e. raster pixel size) that suit the nature of input datasets or parameters settings, and then standardized into a minimum mapping 50-m units.

3.1.3.1.1 Aboveground biomass (AGB) stratification

We stratified the project area into land cover classes based on vegetation types that are indicative of varying aboveground carbon stocks as a result of land cover classification. This classification will be the basis to inform the 2020 field inventory design to quantify AGB and carbon (C) in each stratum. The classification

also informs the appropriate emission characterization and emission factors. Annex 3 provides details on the employed methodology to conduct the classification.

Classification data acquisition

We performed a land cover classification on medium-resolution Landsat 8 satellite imagery products (WRS path/row 125/61, acquisition date: 2016/08/22), with Landsat 8 Operational Land Imager (OLI)/Thermal Infrared Sensor (TIRS) instruments on board. The U.S. Geological Survey (USGS) offers on-demand products of Landsat 8 OLI/TIRS Surface Reflectance data.¹⁷ The Surface Reflectance products correct satellite images for atmospheric effects to create Level-2 data at a 30-m spatial resolution.

The Level-2 products used for the project area land cover classification included surface reflectance rasters of seven visible multi-spectral bands (bands 1-7), and spectral indices of Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), Soil Adjusted Vegetation Index (SAVI), Modified Soil Adjusted Vegetation Index (MSAVI), Normalized Difference Moisture Index (NDMI), Normalized Burn Ratio (NBR), and Normalized Burn Ratio 2 (NBR2). We also computed two other indices using the surface reflectance bands: Normalized Difference Water Index (NDWI) and Modified Normalized Difference Water Index (MNDWI).

In addition, we transformed the original surface reflectance bands 1-7 by conducting principal component analysis (PCA) to reduce the dataset dimensionality. With PCA, the original seven bands that were correlated were transformed into a simpler dataset of uncorrelated variables representing the most important variance from the original dataset.¹⁸ We included the first two PCA axes into the classification models, which accounted for 95.5% variance of the original bands 1-7 surface reflectance distributions.

Reference data acquisition

For satellite reference imagery, we obtained two Sentinel-2A Level 1C images (acquisition date: 2018/06/02) from the Sentinel data hub of the European Space Agency (ESA).¹⁹ The multispectral visible bands of Sentinel images contained different spatial resolutions (20 m and 10 m). We first performed a pan-sharpening technique to resample the visible bands to 10-m spatial resolution to enhance visual contrast, texture, and pattern among different vegetation types.

We obtained 2017 high-resolution Light Detection and Ranging (LiDAR) orthorectified color photographs (produced and shared by Deltares, see Annex 4 for the LiDAR data acquisition specification). A total of 244 and 48 orthophotos at 10-cm spatial resolution covered 8,622 ha of the project area. In addition, we obtained 2017 canopy height data at a spatial resolution of 25 m (produced and shared by Deltares), produced from median values of canopy profile readings in 25-m grid cells.

In 2018, we collected additional high-resolution aerial photographs using a fixed wing drone, with a 2014 Skywalker frame, a Sony QX1 camera, and a 20-mm lens. The 20 photo strips had a spatial resolution of 3.5-3.7 cm. The drone strips covered 4,714 ha of the project area, mostly in non-overlapping areas with the LiDAR orthophotos.

From August to November 2018, our peat inventory team documented vegetation type at each peat sampling location, with clear and consistent land cover class definitions given during inventory training. We completed peat inventory by mid-November, with approximately 80 of these ground plot data (see Annex 5 for the peat inventory sampling design).

Classification training sample development

We generated randomly distributed 200 x 200 m and 100 x 100 m virtual plots within the coverage of LiDAR and drone photographs across the study area, as well as field observation from approximately 80 peat inventory plots. These virtual plots were mostly at least 200 m apart to minimize spatial clustering.

We were aware that all the reference data came from 2017-2018 collections, while the classification image was dated 2016. To account for young vegetation regrowth into a later succession type, we performed

visual examination to compare color, shape, pattern and texture using the same visible band composite between the 2016 Landsat 8 and 2018 Sentinel-2A images.

The classification model required iterative refinement on training samples in order to improve classification accuracy. We conducted the classification runs with anticipation to merge a few classes in the final output.

Classification modeling

We employed Random Forest, a supervised, decision tree-based classifier. Earlier studies have used Random Forest for classification of multi-sensor remote sensing and geographic data.²⁰ Random Forest proved a robust tool for yielding accurate land cover classifications, training data reduction and noise in addition to identifying the most important variables.^{21,22}

We compared preliminary classification results to determine the best input variable combination. The best performing input variables were NDWI and PCA axes (three bands in total). Therefore, we continued and finalized the Random Forest classifier with these three variables.

Accuracy assessment

The reference data for accuracy assessment included the LiDAR and drone photos. Given the need to balance thematic accuracy with positional accuracy, we employed a clustered pixel approach, creating a cluster of pixels (i.e. virtual plots in 3 x 3 pixel size = 90 m) using a stratified random sampling design to place testing samples in each of the land cover classes.²³

To ensure that the virtual testing samples contained homogeneous information of a land cover class within each sample, we excluded classification features that were smaller than the virtual plots to avoid multiple classes seen within one reference sample. Within the remaining map, we created stratified random virtual testing samples relatively proportionate to the land cover class of each area, following best practices for random sample size.^{24,25}

In the Sampling Design Tool,²⁶ we allocated sample sizes for each class ranging from 30 to 100 virtual plots. With the criteria of minimum distance (200 m) between samples within each stratum, random samples that were spatially clustered were eliminated.

We conducted the accuracy assessment by visual interpretation to evaluate whether each virtual plot belonged to its corresponding land cover class, according to the reference data. Agreement and disagreement were summarized in an error matrix, with calculation of overall accuracy, user accuracy (complement of commission error), producer accuracy (complement of omission error) and kappa coefficient per guidance of Global Observation for Forest Cover and Land Dynamics (GOFC-GOLD)²⁷ and Global Forest Observations Initiative (GFOI).²⁸

Accuracy assessment results

The final classification of four land cover classes showed that 95.8%, 1.9%, 1.3% and 1% of the project area were 1) Open canopy tree/shrub/herbaceous mix, 2) Close canopy tree/shrub/herbaceous mix, 3) Dense forest, and 4) Water/swamp mix, respectively. This classification achieved 92.7% overall accuracy and a kappa coefficient of 0.87, indicating 87% reduction in error generated by the classification in comparison with a completely random process (Table 11). This final classification for forest/non-forest classes showed that 1.3% and 98.7% of the project area contained forest and non-forest areas, respectively. This merged classification achieved 99.1% of overall accuracy.

Table 11. Summary of accuracy in an error matrix.

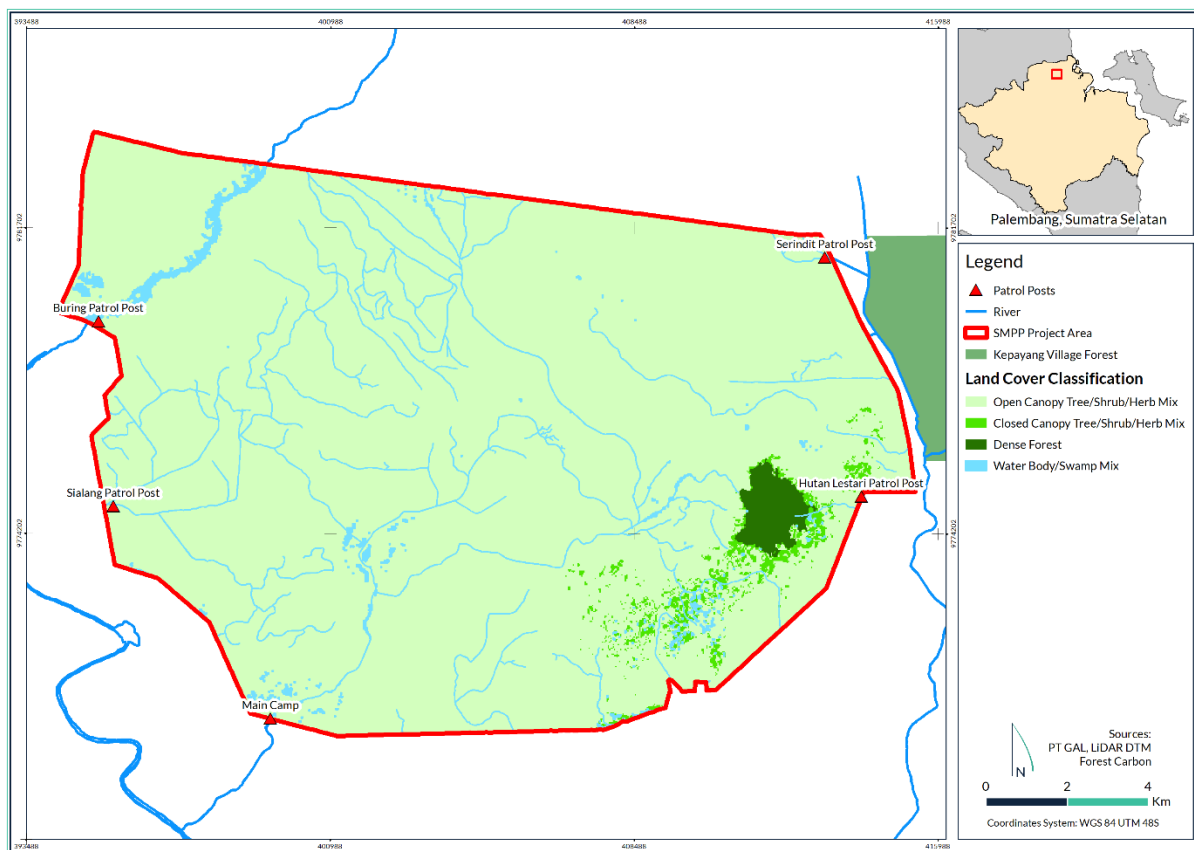
	Error of commission	User's accuracy	Error of omission	Producer's accuracy
KbBM	3.6%	96.4%	7.6%	92.4%
KtBM	32.0%	68.0%	19.0%	81.0%
SF	6.9%	93.1%	0.0%	100.0%

W/S	3.7%	96.3%	3.7%	96.3%
	Overall accuracy	92.7%		

(KbBM = Open canopy tree/shrub/herbaceous mix, KtBM = Close canopy tree/shrub/herbaceous mix, SF = Dense forest, W/S = Water/swamp mix)

The known canals and rivers, which often did not appear in the Landsat image due to the image resolution, were added to the final classification by overlaying our GIS canal/river network layer. This resulted in a final map showing that 95.4%, 1.9%, 1.3% and 1.4% of the project area were 1) Open canopy tree/shrub/herbaceous mix, 2) Close canopy tree/shrub/herbaceous mix, 3) Dense forest, and 4) Water/swamp mix, respectively (see Map 10 below).

Map 10. Land cover classification in the project area.



3.1.3.1.2 Stratification of peatland and non-peatland

Stratification of areas in peat versus non-peat areas, as well as the peat thickness was determined through a field peat inventory, and subsequent peat depth modeling (see Annex 5 for a detailed description of the peat inventory and thickness modeling). This sampling design fulfilled the requirements described in the VCS methodology VM0007 modules M-PEAT and X-STR. The result showed that 99.99% of the project area constituted peat thickness ≥ 50 cm.

3.1.3.1.3 Stratification of peatland based on peat thickness and peat depletion time (PDT)

Drained peatland is subject to microbial decomposition and uncontrolled burning. Therefore, peat at some locations in the project area may be depleted before the end of project period in the baseline scenario. We calculated the amount of time it would have taken for the peat in the project area to become depleted (peat depletion time; PDT) without the project based on the following parameters:

1. Peat thickness;
2. Drainability elevation limit;
3. Surface elevation; and
4. Subsidence related to microbial decomposition and burning.

Peat thickness

Following VCS Module X-STR requirements, our analysis indicated that the entire peatland in the project area must be stratified, although stratification by peat thickness at a 50-cm resolution was not necessary

(see Table 12 below). Therefore, a wider range of peat thickness was used, and the project area was stratified into 15 classes as presented in Table 13 and Map 11.

Table 12. Requirements per VM0007 (version 1.6) Module X-STR.

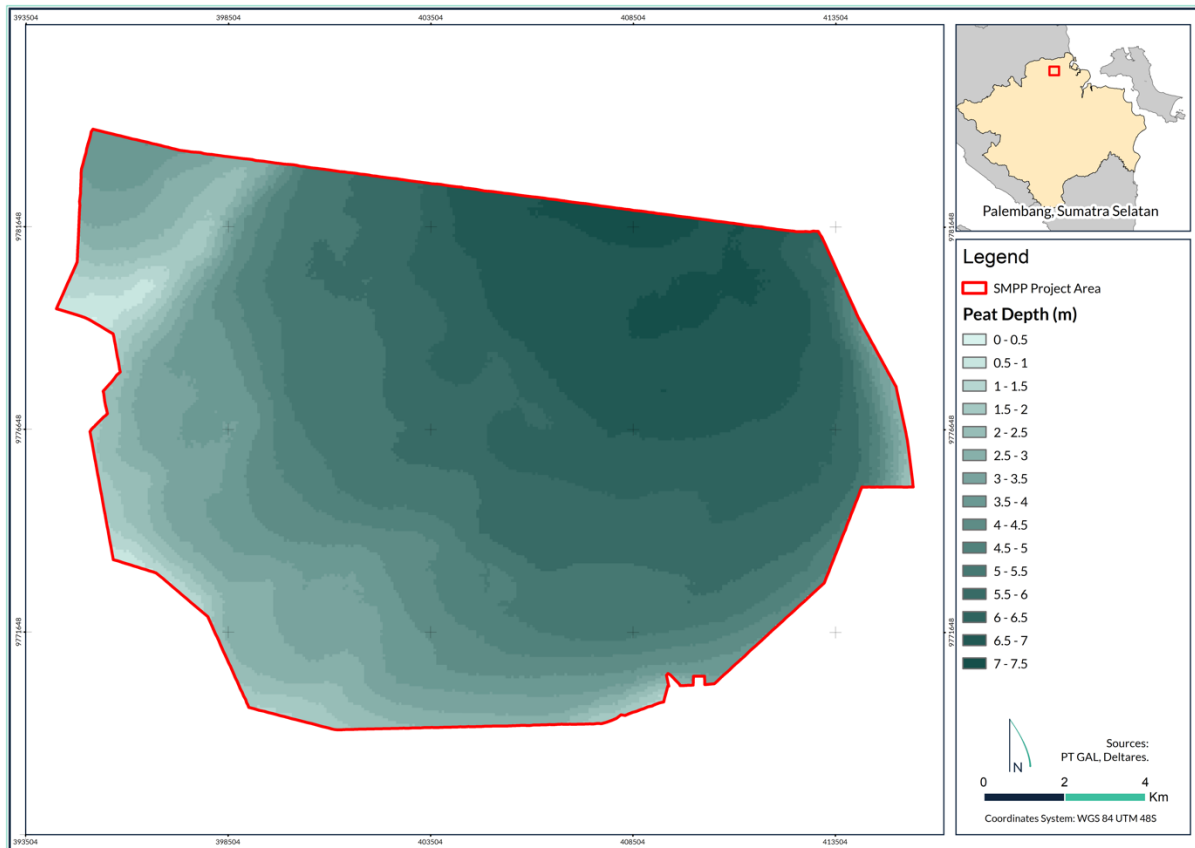
Requirements per VM0007(version 1.6) Module X-STR	Findings	Conclusion
When in > 5% of the project area peat is absent or the thickness of the peat is below a threshold value (50 cm); the map only needs to distinguish where peat thickness exceeds this threshold. It is conservative to treat shallow peat strata as mineral soil strata.	Peat depth $\geq$ 50 cm occupied 99.99% of the project area.	The entire peatland in the project area must be stratified.
When, using a conservative (high) value for subsidence rates, in > 5% of the project area less or equal peat is available at $t = 100$ years in the project scenario than in the same strata in the baseline scenario, the peat thickness map only needs to distinguish these strata.	In 0% of the project area, peat that remains in the project scenario equals that of the baseline scenario at $t = 100$ years.	The peat thickness map does not have to distinguish these strata.
When using a conservative (high) value for subsidence rates, if the project crediting period exceeds the peat depletion time (PDT) in the baseline scenario in more than 5% of the project area, the peat thickness map must distinguish those strata where peat will be depleted within the Crediting Period.	23 % of the project area where project crediting period (47 years) exceeds PDT (Table 14).	The peat thickness map distinguishes the strata with a resolution of 50-cm strata, where peat will be depleted within the project crediting period.
The project proponent must demonstrate that the resolution used in mapping results in a conservative assessment (i.e., it tends to overestimate strata that will be depleted), for example, by assessing variation in peat depth near the critical depth through multiple corings at close distance or by assuming a default conservative error (e.g. 50 cm in (tropical) wood peat with coarse woody remnants).	The peat inventory sampling design weighed the random selection of sample points according to earlier peat depth maps, i.e. more sample points in shallow peat than in deep peat (Annex 5).	The resulting peat depth map is a conservative assessment, as the peat inventory weighed more samples in the shallow peat area and every sampling location had multiple coring data points collected.

Requirements per VM0007(version 1.6) Module X-STR	Findings	Conclusion
Peat strata that will be depleted can be further stratified according to their peat depletion time. Areas where peat will not be depleted need not be further stratified.	23 % of the total peat area has a PDT < crediting period.	The areas that would be depleted within the project crediting period are stratified according to their PDT.

Table 13. Peat thickness, area, and percentage.

Peat thickness (m)	Area (ha)	Percentage area (%)
0 - 0.5	2	0.01%
0.5 - 1	143	0.62%
1 - 1.5	251	1.10%
1.5 - 2	522	2.28%
2 - 2.5	894	3.90%
2.5 - 3	1,407	6.14%
3 - 3.5	1,932	8.43%
3.5 - 4	1,868	8.15%
4 - 4.5	1,508	6.58%
4.5 - 5	1,592	6.95%
5 - 5.5	3,053	13.32%
5.5 - 6	3,362	14.67%
6 - 6.5	2,513	10.97%
6.5 - 7	3,240	14.13%
7 - 7.5	635	2.77%
Total	22,922	100%

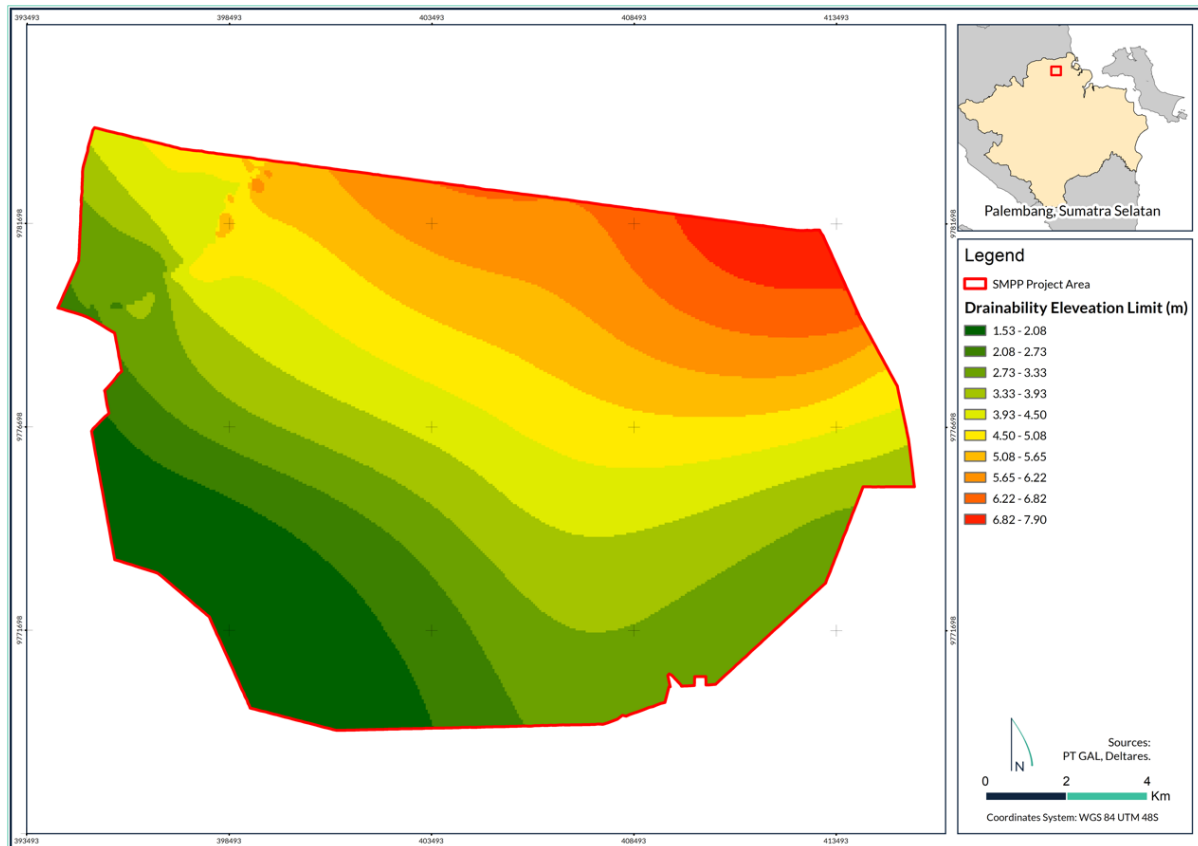
Map 11. Peat depth stratification (by every 50 cm) of the project area.



Digital elevation model and drainability elevation limit

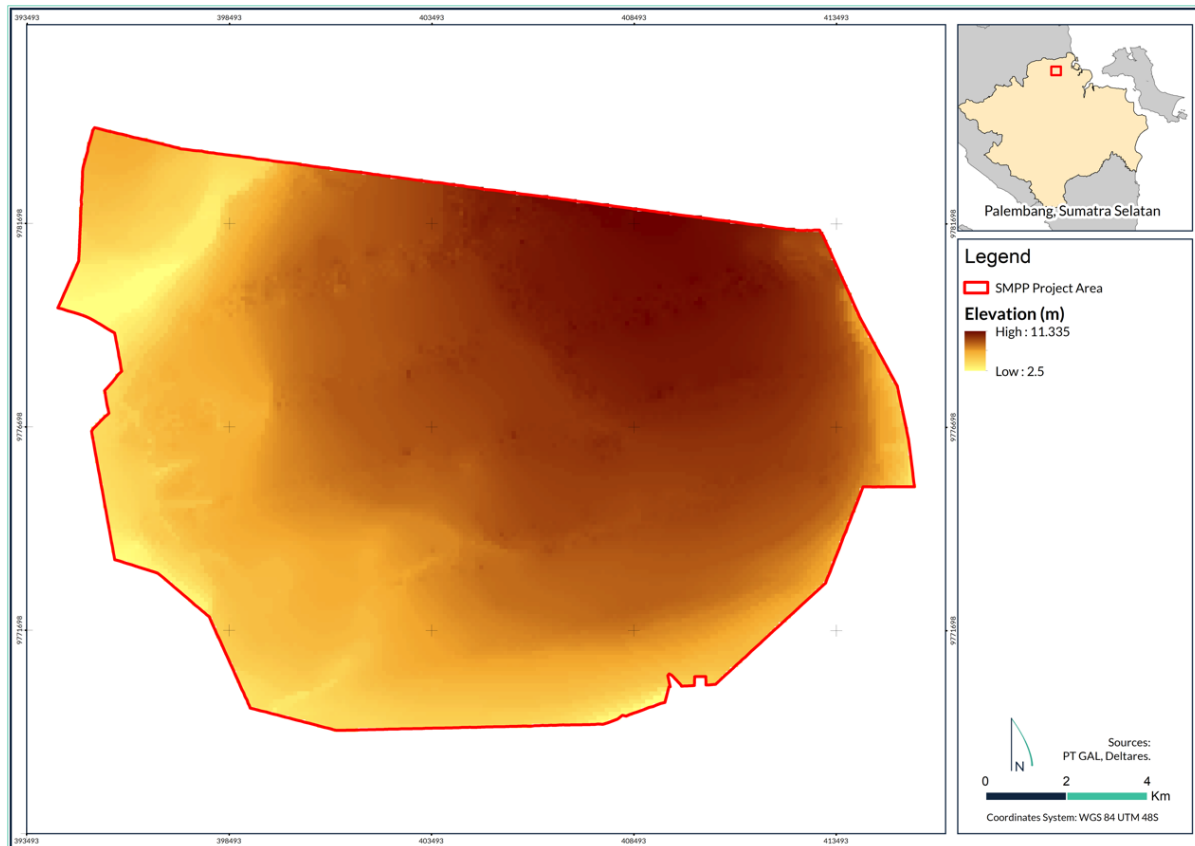
We assumed conservatively that in the baseline scenario, the conversion into Acacia plantations would not require mechanical pumping. Therefore, the Drainability Elevation Limit (DEL) restricts the thickness of peat that may be lost. DEL is defined as the elevation at which the peat cannot be drained any further without mechanical pumping. When subsidence results in the surface of the land reaches DEL, the remaining peat layer would stay waterlogged and no further drainage would be possible. The detailed methods used for creating the DEL map (Map 12) are in Annex 7 for hydrological modeling processes.

Map 12. Drainability elevation limit of the project area.



To ensure that the surface elevation dataset reflects the post-fire status of the project area at the project start date, we obtained a surface elevation map (Digital Terrain Model or DTM) derived from LiDAR (produced and shared by Deltares). Annex 4 describes the specifications of the LiDAR tasks, DTM processing methodology, and accuracy.

Map 13. Digital terrain model of the project area.



We created a map of the peatland subject to microbial decomposition and burning, by combining maps of peat thickness, DEL, and DTM (Map 14), based on the following rules (1) and (2):

$$\text{Peat available for microbial decomposition and burning} = \text{DTM} - \text{DEL} \quad (1)$$

Where:

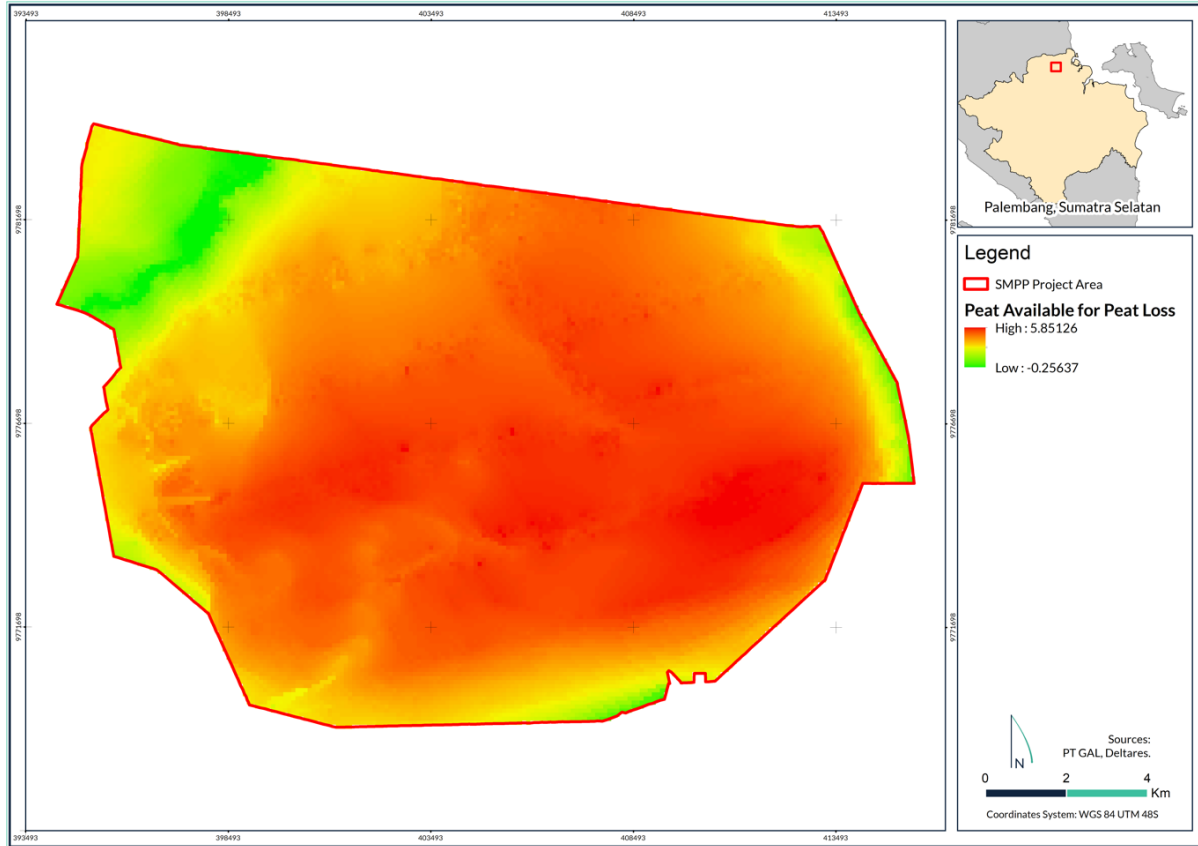
$$\text{DTM} - \text{DEL} \leq \text{Peat Thickness}$$

$$\text{Peat available for microbial decomposition and burning} = \text{Peat Thickness} \quad (2)$$

Where:

$$\text{DTM} - \text{DEL} > \text{Peat Thickness}$$

Map 14. Peatland area subject to microbial decomposition and burning.



Peat depletion time (PDT)

With information from the resulting maps of peat thickness, DTM, and DEL, as well as the peat subsidence calculated in the baseline scenario (see Section 3.2.1), we created a map based on the PDT (Map 15) by using the following equation (3):

$$t_{PDT-BSL,i} = Depth_{peat-BSL,i} / Rate_{peatloss-BSL,i} \quad (3)$$

Where:

$t_{PDT-BSL,i}$	Peat depletion time in the baseline scenario in stratum i in years elapsed since the project start (yr)
$Depth_{peat-BSL,i}$	Average peat depth in the baseline scenario in stratum i at project start (m). In this case = peat thickness available for microbial decomposition
$Rate_{peatloss-BSL,i}$	Rate of peat loss due to subsidence and peat burning in the baseline scenario in stratum i ; (m yr ⁻¹)

In Table 14 present the calculation of PDT stratification of the project area. We found that 23 % of the peatland in the project area is expected to deplete before reaching the 47-year crediting period, while 77 % are likely to exceed the peat depletion time of 100 years.

Map 15. PDT of the project area.

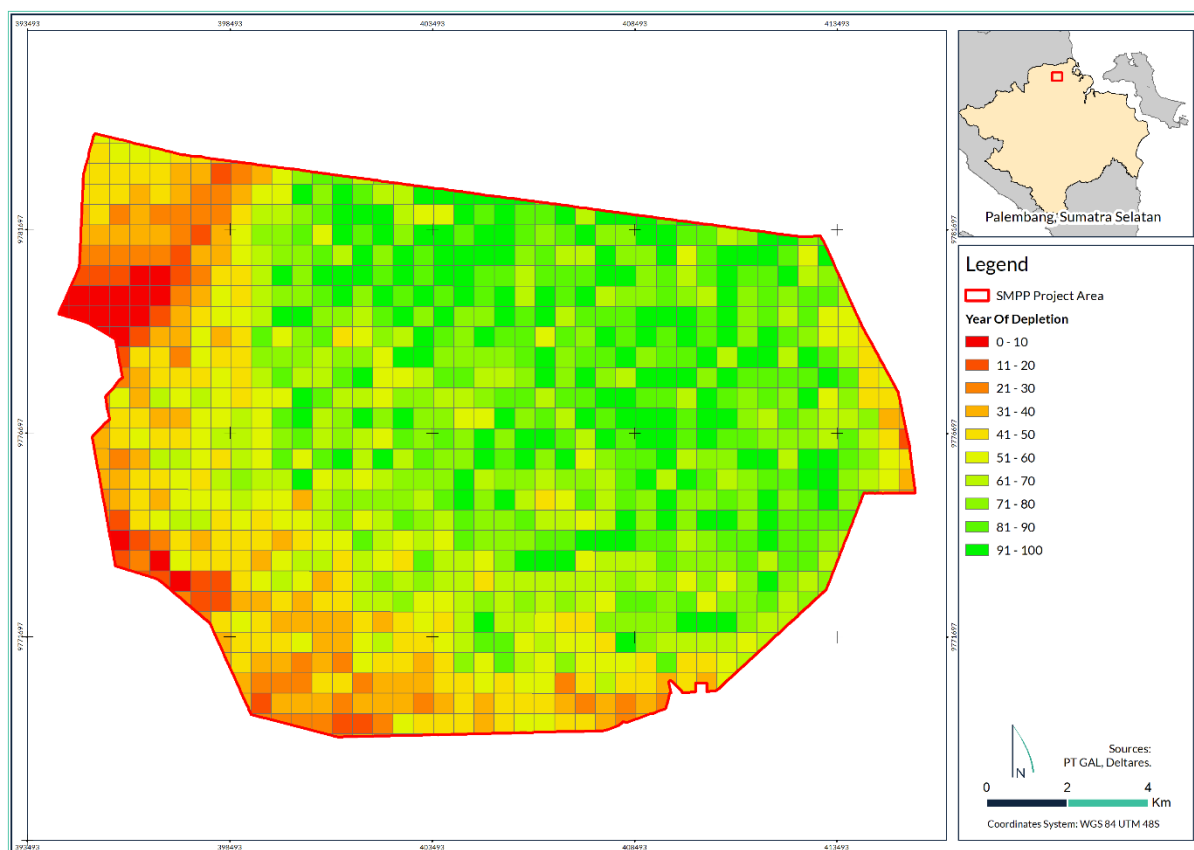


Table 14. Summary of the PDT stratification of the project area.

PDT Class	PDT Range (years)	Area (ha)	Percentage of the project area (%)
PDT-1	< 10	350	1.5%
PDT-2	10-20	476	2.1%
PDT-3	20-30	893	3.9%
PDT-4	30-40	1643	7.2%
PDT-5	40-50	2364	10.3%
PDT-6	50-60	2772	12.1%
PDT-7	60-70	3290	14.4%
PDT-8	70-80	3371	14.7%
PDT-9	80-90	3846	16.8%
PDT-10	90-100	2192	9.6%
PDT-11	> 100	1726	7.5%
Total		22,922	100%

3.1.3.1.4 Stratification based on carbon stock

Peat carbon stock

We calculated the volume of the initial peat carbon (C) stock at the project start date using the map of peat thickness (Map 11), the sampled peat bulk density (BD) and the carbon content of peat in the project area. We found no significant variation in bulk density either across horizontal or vertical directions ($\mu = 149 \text{ kg m}^{-3}$, $\text{SE} = 1.14 \text{ kg m}^{-3}$, $n = 67$, $p = 0.05$). We also found no significant variation in the carbon content ($\mu = 53 \text{ kg C kg}^{-1}$, $\text{SE} = 0.69 \text{ kg m}^{-3}$, $n = 65$, $p = 0.05$). Our measurement methods and analyses are described in detail in Annex 5. We used the following formula to quantify the volume of peat carbon stocks across strata in the in the SMPP (4):

$$C_{\text{stock}-i,t0} = CC_{\text{peat}-i,t0} \times \text{Depth}_{\text{peat}-i,t0} \times BD_{i,t0} \times 10 \quad (4)$$

Where:

$C_{\text{stock}-i,t0}$ Initial carbon stock of stratum i (at $t = 0$) (t C ha^{-1})

$CC_{\text{peat}-i,t0}$ Initial carbon content of peat of stratum i (at $t = 0$) (kg C kg^{-1})

$\text{Depth}_{\text{peat}-i,t0}$ Initial peat thickness of stratum i (at $t = 0$) (m)

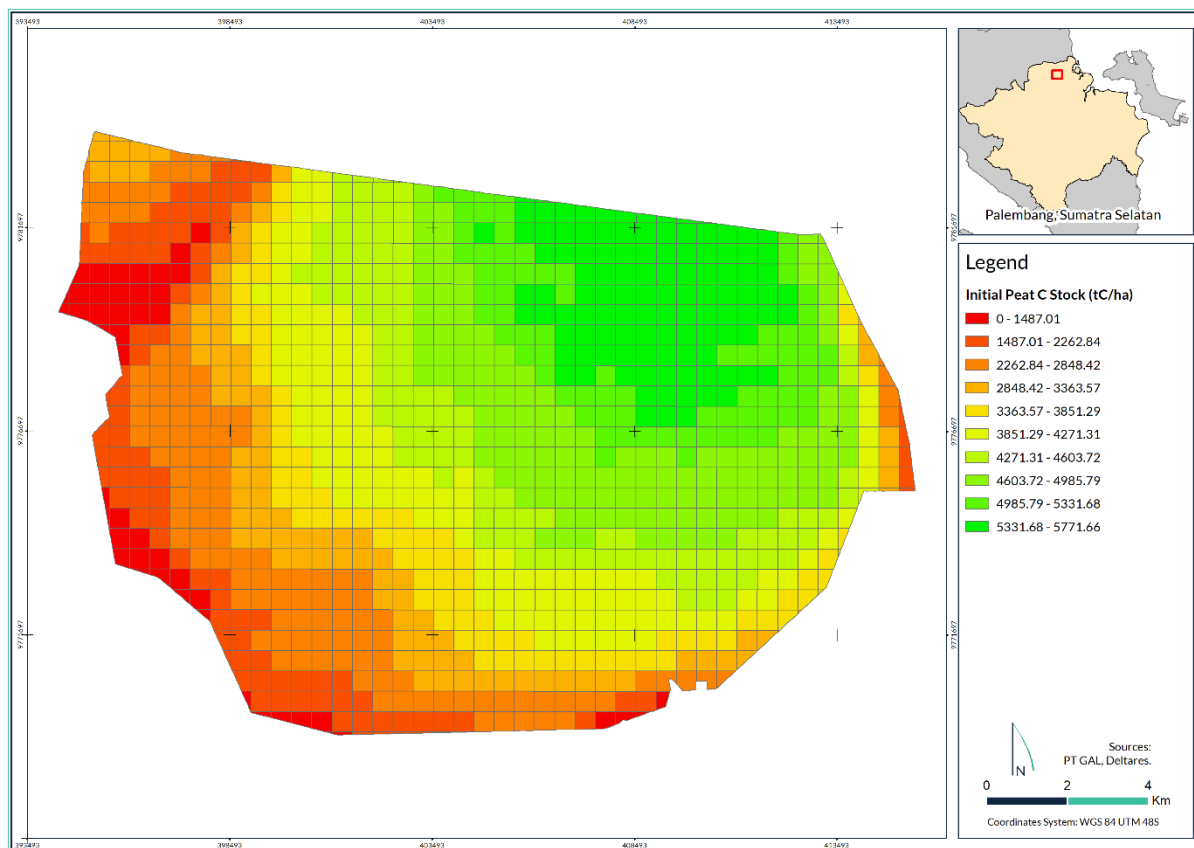
$BD_{i,t0}$ Initial bulk density of peat of stratum i (at $t = 0$) (kg m^{-3})

We found the total peat carbon stock in the project area to be an estimated 88,548,837 t C. There are details of SMPP stratification of peat carbon stock at the project start in Map 16 and this calculation is based on the depth of each stratum described in Table 15 below.

Table 15. Volume of peat carbon stock in the project area at the project start.

Strata	Type	Area (ha)	Average peat carbon stock (t C ha^{-1})	Total peat carbon stock (t C)
IN-UPSF	Undrained Peat Secondary Forest	234.08	4,711.36	1,102,822.79
IN-DPSF	Drained Peat Secondary Forest	15,205.17	3,922.46	59,641,592.73
IN-UDP	Undrained Deforested Peatland	20.26	4,674.07	94,686.65
IN-DDP	Drained Deforested Peatland	7,393.59	3,716.70	27,479,718.10
IN-WB	Water Bodies	69.30	3,318.29	229,967.99
Total		22,922.39	3,862.98	88,548,788.26

Map 16. Stratification of peat carbon stock at the project start.



3.1.3.1.5 Stratification based on emission characteristics

Our emission characteristics are based on the initial and designated land-use and the drainage status of the project area in both the baseline and project scenarios. Different land-use strata and drainage characteristics impose significant differences in emissions and carbon stock. We describe the baseline and project scenarios as well as associated emissions in Sections 3.2.1 and 3.2.2, which serve as a basis for calculating the area eligible for WRC and ARR crediting.

3.1.3.1.6 Eligible area for WRC crediting

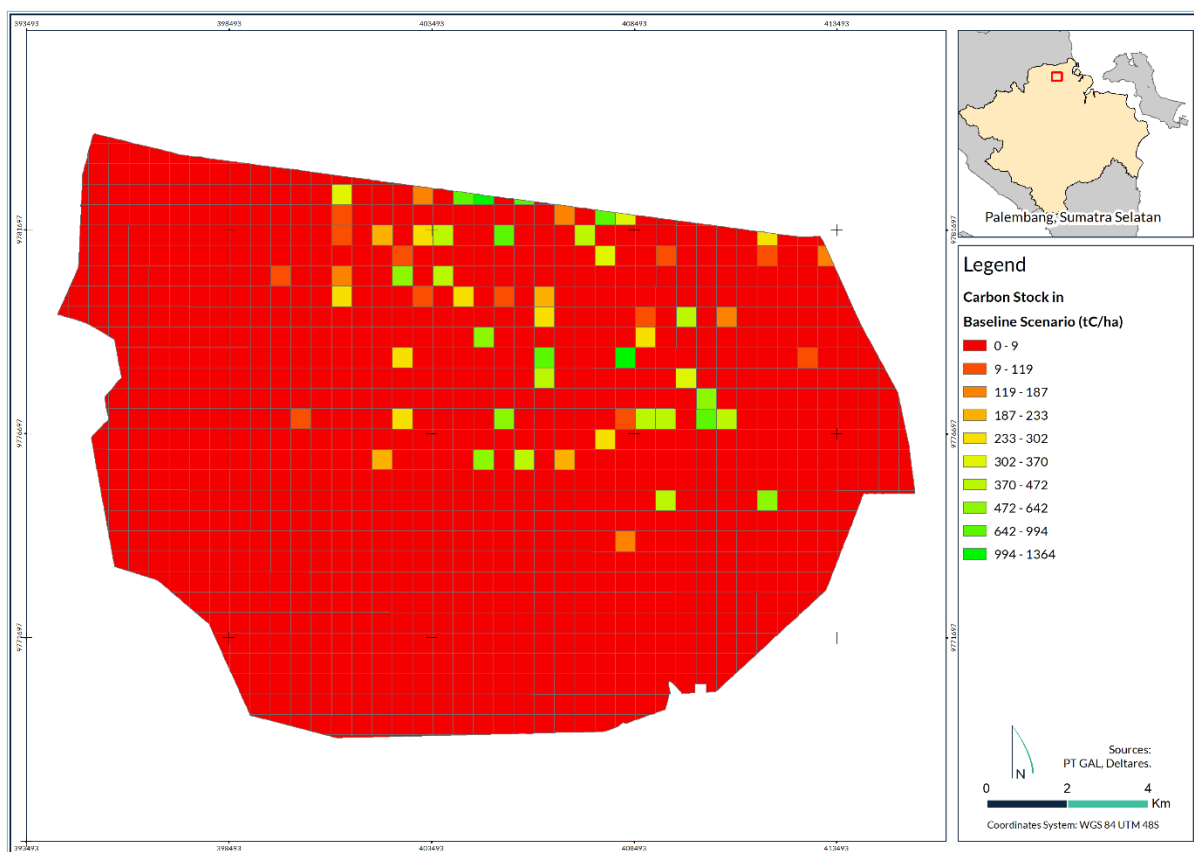
We determined the area eligible for crediting by following the VCS rules as set out in VM0007 Module X-STR Section 5.4, with the Total Stock Approach.

We used the PDT assessment and the assessment of project scenario peat depletion to determine the area eligible for crediting for the baseline for WRC peatland activities. The crediting period under which our project's GHG emission reductions or removals are generated, closely aligns with the area for crediting within the project area.

To delineate the eligible area for crediting within our project, we took a three-step approach. More detail is available in VCS methodology VM0007 Module X-STR, Section 5.4. The steps were as follows:

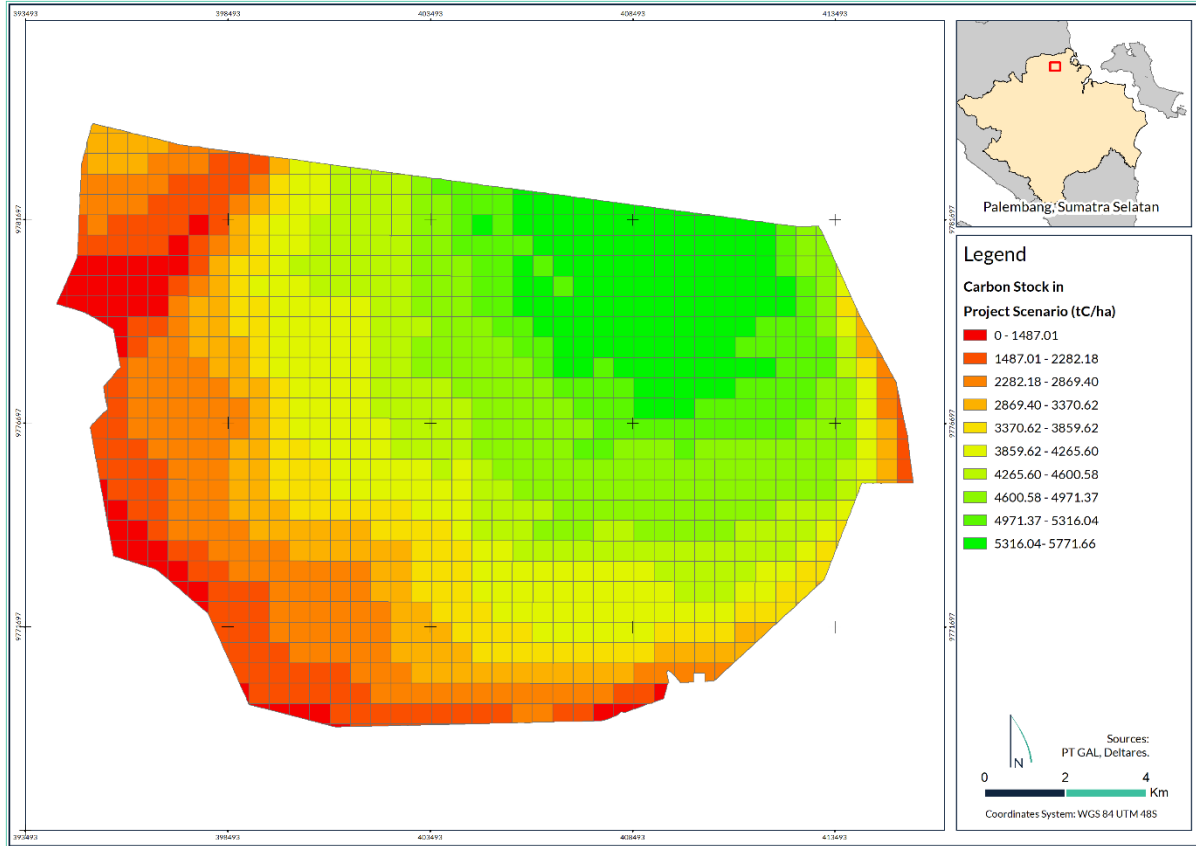
Step 1. We calculated the successive changes of peat carbon stock within each stratum over 100 years with the baseline scenario. We then mapped the remaining carbon stocks at $t = 100$ (Map 17). Our methods for calculating baseline scenario dynamics of carbon stocks over time are given in Section 3.2.1.

Map 17. Peat carbon stock in the baseline scenario at $t = 100$.



Step 2. We calculated the annual peat carbon stock changes within each stratum over 100 years with the project scenario. We then mapped the remaining carbon stocks at $t = 100$. Our methods for calculating project scenario dynamics of carbon stocks over time are given in Section 3.2.2.

Map 18. Peat carbon stock in the project scenario at $t = 100$.



Step 3. To establish the project area eligible for crediting (Map 19), we delineated the areas with a positive difference in peat carbon stock between the baseline and project scenarios at $t = 100$. We estimated these differences using the following equations (5) – (9):

$$C_{WPS-BLS,t100} = \sum_{i=0}^{M_{WPS}} (C_{WPS,i,t100} \times A_{WPS,i}) - \sum_{i=0}^{M_{BSL}} (C_{BSL,i,t100} \times A_{BSL,i}) \quad (5)$$

$$C_{WPS,i,t100} = Depth_{peat-WPS,i,t100} \times C_{vol_lower,WPS} \times 10 \quad (6)$$

$$C_{BSL,i,t100} = Depth_{peat-BSL,i,t100} \times C_{vol_lower,BSL} \times 10 \quad (7)$$

$$Depth_{peat-BSL,i,t100} = Depth_{peat-BSL,i,t0} - Sub_{initial-BSL,i} - \sum_{t=1}^{t=100} Rate_{peatloss-BSL,i,t} \quad (8)$$

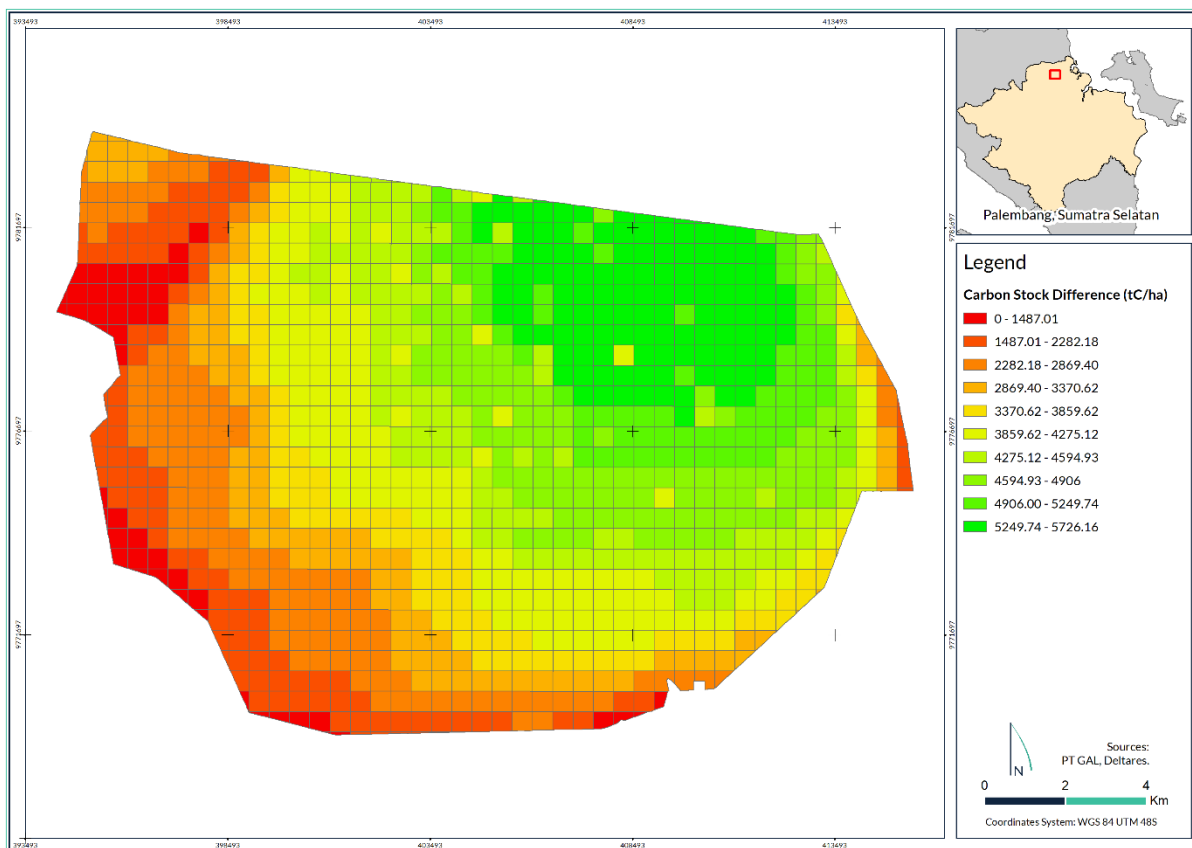
$$Depth_{peat-WPS,i,t100} = Depth_{peat-WPS,i,t0} - \sum_{t=1}^{t=100} Rate_{peatloss-WPS,i,t} \quad (9)$$

Where:

$C_{WPS-BLS,i,t100}$	Difference between peat carbon stock in the project scenario and baseline scenario in peat depth stratum i at $t = 100$ (t C ha ⁻¹)
$C_{WPS,i,t100}$	Peat carbon stock in the project scenario in peat depth stratum i at $t = 100$ (t C ha ⁻¹)
$C_{BSL,i,t100}$	Peat carbon stock in the baseline scenario in peat depth stratum i at $t = 100$ (t C ha ⁻¹)
$A_{WPS,i}$	Area of project stratum i (ha)

$A_{BSL,i}$	Area of baseline stratum i (ha)
$Depth_{peat-BSL,i,t100}$	Average peat depth in the baseline scenario in stratum i at $t = 100$ (m)
$Depth_{peat-WPS,i,t100}$	Average peat depth in the project scenario in stratum i at $t = 100$ (m)
$Depth_{peat-BSL,i,t0}$	Average peat depth in the baseline scenario in stratum i at project start (m)
$Depth_{peat-WPS,i,t0}$	Average peat depth in the project scenario in stratum i at project start (m)
$Sub_{initial-BSL,i}$	Subsidence in the initial years after drainage in stratum i , deemed 0 for RDP projects (m)
$Rate_{peatloss-BSL,i,t}$	Rate of peat loss due to subsidence and fire in the baseline scenario in stratum i in year t ; a conservative (high) value may be applied that remains constant over time; Subsidence in the initial years after drainage is not included in this rate (m yr ⁻¹)
$Rate_{peatloss-WPS,i,t}$	Rate of peat loss due to subsidence and fire in the project scenario in stratum i in year t ; alternatively, a conservative (low) value may be applied that remains constant over time (m yr ⁻¹)
$C_{vol_lower,WPS}$	Volumetric carbon content of the peat below the water table in the project scenario; in case of RDP projects, this is the same as $C_{vol_lower,BSL}$ (kg C m ⁻³)
$C_{vol_lower,BSL}$	Volumetric carbon content of the peat below the water table in the baseline scenario (kg C m ⁻³)
t_{100}	100 years since project start, conversion from kg m ⁻² to t ha ⁻¹

Map 19. Carbon stock difference between the baseline and project scenarios at $t = 100$.



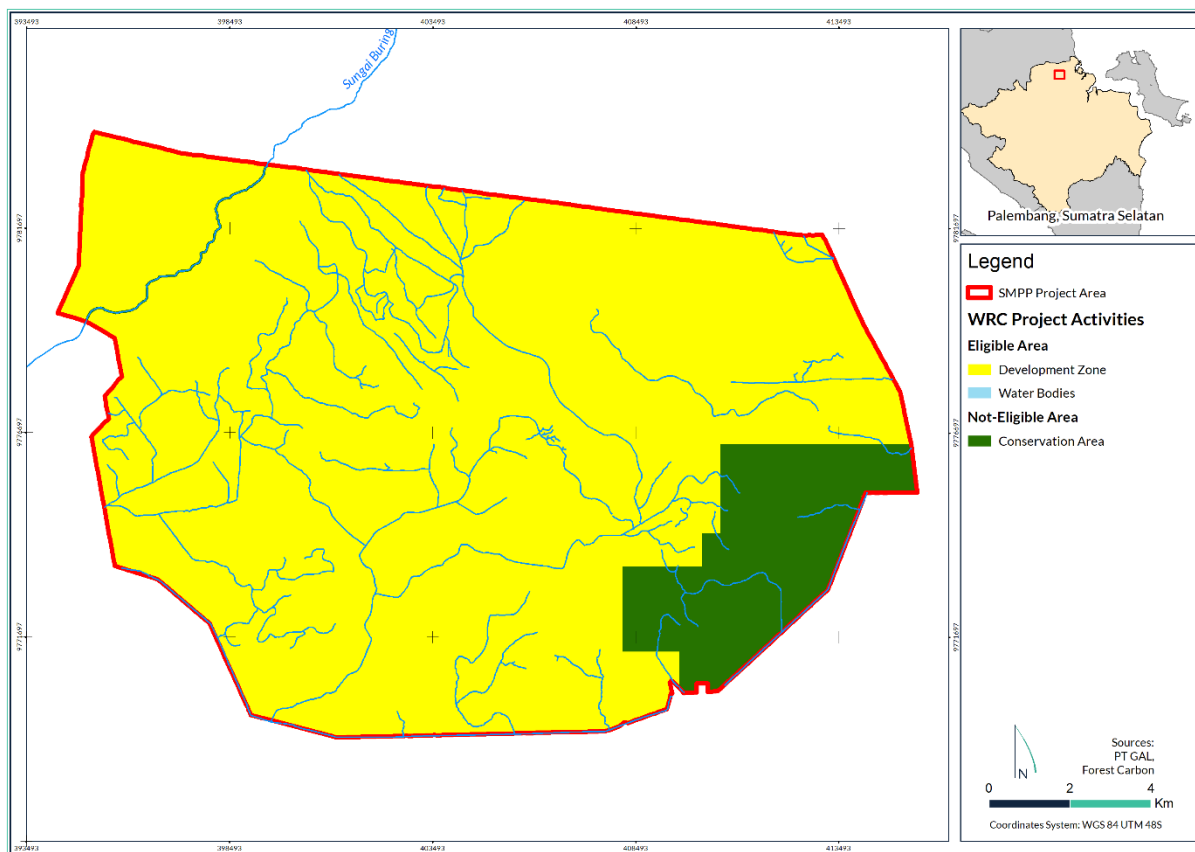
Our spatial analysis indicates that 20,627.25 ha (excluding the conservation area) or 90% of the project area is eligible for crediting from WRC activities (shown in Table 16 and Map 20). Furthermore, as Sub-subsection 3.1.3.1.4 describes, PDT of 77% of the project area (17,764 ha) is expected to exceed the maximum project period of 47 years. For the rest of project area, the approximate years in which the peat layers would be depleted (i.e. eligible period for crediting) were determined.

The hydrological modeling for the project scenario showed that the construction of the peat compaction dams would ensure no alteration of the hydrology from outside the project area. This will be monitored through additional establishment of dip wells outside the project area (see Annex 8 on the Monitoring Plan).

Table 16. Summary of the area eligible for crediting WRC activities.

Description	Area (ha)	Area (%)
Project area	22,922.39	100
Eligible area for crediting for WRC	20,627.25	89.99
Area not eligible for crediting	2,295.14	10.01

Map 20. Area eligible for crediting for WRC project activities.



3.1.3.1.7 Eligible area for ARR crediting

VCS Agriculture, Forestry, and Other Land-Use (AFOLU) requirements state that activities to convert native ecosystems to generate GHG credits are not eligible under the VCS Program. Where conversion within the project area occurs within 10 years prior to the proposed project start date, evidence must be provided to demonstrate that this clearance was not done with the intent to create GHG credits.

Annex 9 provides detailed justification for why the clearance of native ecosystems within the project area within the previous ten years was not for the purposes of generating GHG credits, but instead a result of land-use change trends within the landscape that were out of the control of the project proponent.

Forest cover in the project area was 99.1% in 2006 according to the Ministry of Environment and Forestry's national land-use land cover map. As per the land cover classification results for the project boundary, forest cover at project start was 1.3%. This means an approximate forest loss of 97.8% of the study area during the ten-year historical reference period. The comparison of these two datasets is for rapid evaluation and is not to be considered a definitive land cover change assessment.

During the historical reference period, the only time the project area was under any form of active management was between 2008 and 2011. At that time, the Merang REDD Pilot Project (MRPP) was financed by a donor organization with the intention of developing a REDD project. As such, its intent was to protect the forest cover rather than any intent to deforest the project area for the purposes of developing an ARR project. Funding for the project expired in 2011 and pilot activities were closed out in the area.

Two significant fire (2012 and 2015) occurred when there was no active management of the project area. As per the project start date, January 2016 is when PT GAL's first active management of the project area

began, marked by the construction of the main camp and hiring of staff to live at the site. For both events, losses occurred due to both the presence of fire vectors (illegal loggers, fishermen, etc.) as well as the absence of any active management of the area. In 2015 alone, an estimated 100,000 km² of land burned²⁹ across Indonesia, creating extreme impacts for the economy, human health and forest cover. Fires do not occur naturally in peat swamp forests as they are naturally inundated. However, drainage and deforestation cause peatlands to become drier and more susceptible to fires. This is a trend that has occurred consistently across the project landscape since the early 1990s and with devastating consequences in 2015.

These large-scale, uncontrollable fires were not unique to the project area but a feature of the wider landscape. These losses were incurred despite the presence of local fire teams in neighboring concessions which attempted to manage the fires. These trends and specific project site history all support the conclusion that fires were a landscape trend, rather than a tactic to clear the land for the purposes of subsequently creating GHG credits from an ARR project.

The eligible area for ARR crediting is all the non-forest areas where the project activities would carry out activities to facilitate natural regeneration of vegetation. Based on the spatial analysis, the area eligible for crediting from ARR activities is 20,627.25 ha. Map 21 indicates the ARR eligible area within the project area, and Table 17 below is the summary of the area.

Map 21. Eligible areas for crediting ARR project activities.

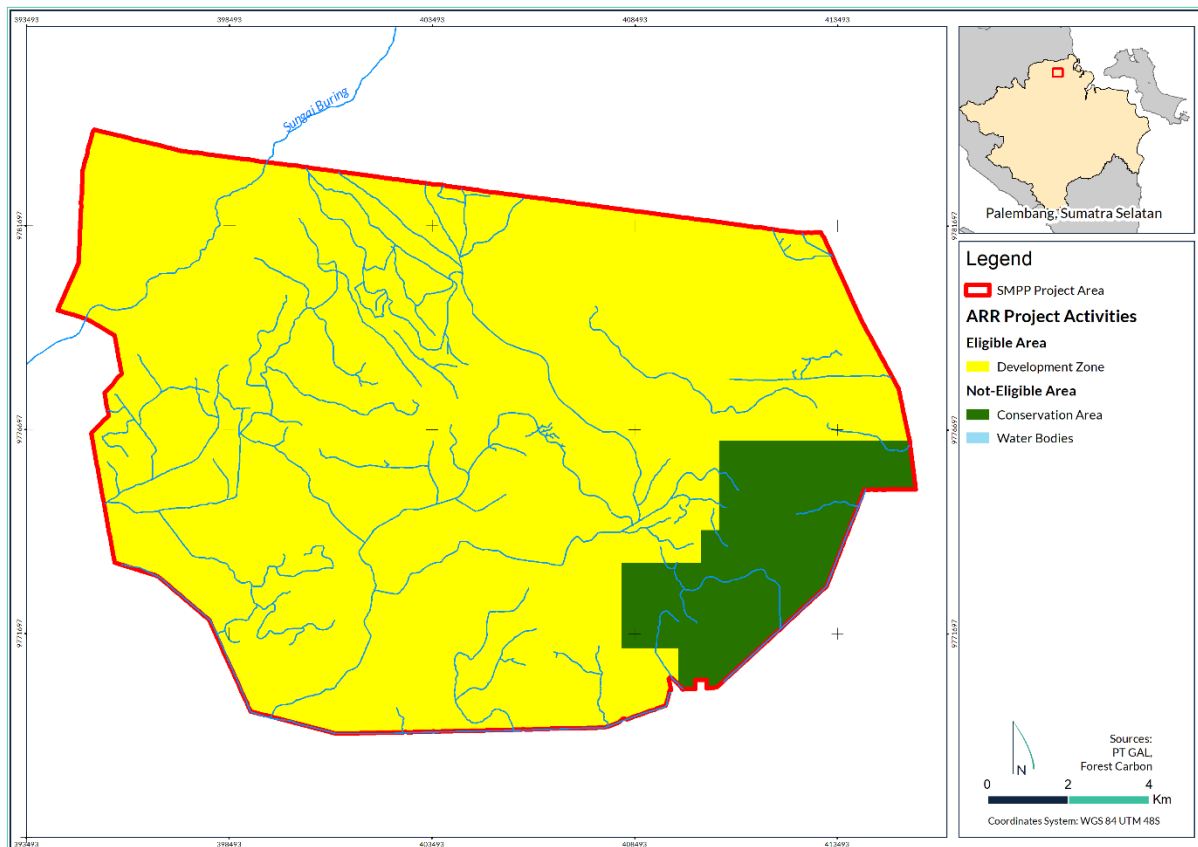


Table 17. Summary of the area eligible for crediting ARR activities.

Description	Area (ha)	Area (%)
Project area	22,922.39	100
Eligible area for crediting for ARR	20,627.25	89.99
Area not eligible for crediting	2,295.14	10.01

3.1.3.2 Temporal boundaries

The temporal boundaries of the project are:

Historical reference period: January 1st, 2006 – December 31st, 2015. This historical reference period is used for the historical fire analysis and to support the identification of deforestation rate as per BL-PL which is in turn used for LK-ASP.

Project crediting period: January 1st, 2016 – December 31st, 2062 (47 years).

Baseline update period: Every 10 years.

3.1.3.3 Carbon pools

In Table 18 we describe the carbon pools included in the project. No significance tests were necessary since all carbon pools not included in the baseline and project scenario have been shown to either increase more or decrease less in the project relative to the baseline scenario or have been conservatively excluded. All mandatory pools have been included.

Table 18. Summary of carbon pools.

Carbon pool	Included?	Justification/Explanation
Aboveground tree biomass	Included	Mandatory pool in ARR project activities.
Aboveground non-tree biomass	Excluded	Pool is expected to increase in the project scenario.
Belowground biomass	Excluded (accounted for in the peat soil component)	Belowground biomass is not distinguished from the soil pool in WRC procedures.
Litter on mineral soil	Excluded	No mineral soil is present in the project area.
Litter on peatland	Excluded	This pool is not mandatory for peatlands. The litter pool is expected to increase in the project scenario compared to the baseline. As such it is conservative to omit this pool.
Dead wood	Excluded	This pool is not mandatory for mineral soil or peatlands. The deadwood pool is expected to increase in the project scenario compared to the baseline. As such it is conservative to omit this pool.
Mineral soil carbon pool	Excluded	No mineral soil is present in the project area.
Peat carbon pool	Included	Pool is expected to increase in the project scenario compared to the baseline.

Carbon pool	Included?	Justification/Explanation
Wood products	Excluded	No timber harvesting for wood products occurs in either the baseline or project scenario.

3.1.3.4 Sources of GHG emissions

In Table 19 and Table 20 below, we describe the sources of GHG emissions included in the project. For further detail of the project zone areas and maps, see Section 2.1.7 and Map 8.

Table 19. GHG sources included in the WRC project boundary.

	Source	Gas	Included?	Justification/Explanation
Baseline	Oxidation of drained peat	CO ₂	Yes	Considered under carbon pools.
		CH ₄	Yes	Required unless de minimis or conservatively omitted.
		N ₂ O	No	Excluded as per applicability condition in Module BL-PEAT.
	Water bodies	CO ₂	Yes	Water bodies comprise 2.35% of the drained peatland landscape in the baseline (Table 27). IPCC DOC values for 'drained' and 'natural' peatlands will be used.
		CH ₄	No	Conservatively assume that all DOC emissions are CO ₂ .
		N ₂ O	No	Conservatively omitted.
	Peat combustion	CO ₂	Yes	Procedures provided in Module E-BPB. Make use of IPCC combustion factors.
		CH ₄	Yes	Procedures provided in Module E-BPB. Make use of IPCC combustion factors.
		N ₂ O	No	Conservatively omitted.
	Combustion of fossil fuels	CO ₂	No	Deemed de minimis in VCS AFOLU Requirements
		CH ₄	No	Deemed de minimis in VCS AFOLU Requirements
		N ₂ O	No	Deemed de minimis in VCS AFOLU Requirements
	Fertilizer application	CO ₂	No	Fertilizer application is higher in the baseline than in the project scenario. As such it is conservative to omit.
		CH ₄	No	Fertilizer application is higher in the baseline than in the project scenario. As such it is conservative to omit.
		N ₂ O	No	Fertilizer application is higher in the baseline than in the project scenario. As such it is conservative to omit.
Project	Oxidation of drained peat	CO ₂	Yes	Considered under carbon pools.
		CH ₄	Yes	Required unless de minimis or conservatively omitted.
		N ₂ O	No	Excluded as per applicability condition in Module BL-PEAT.
	Water bodies	CO ₂	Yes	IPCC DOC values for 'drained' and 'undrained' peatlands are used.

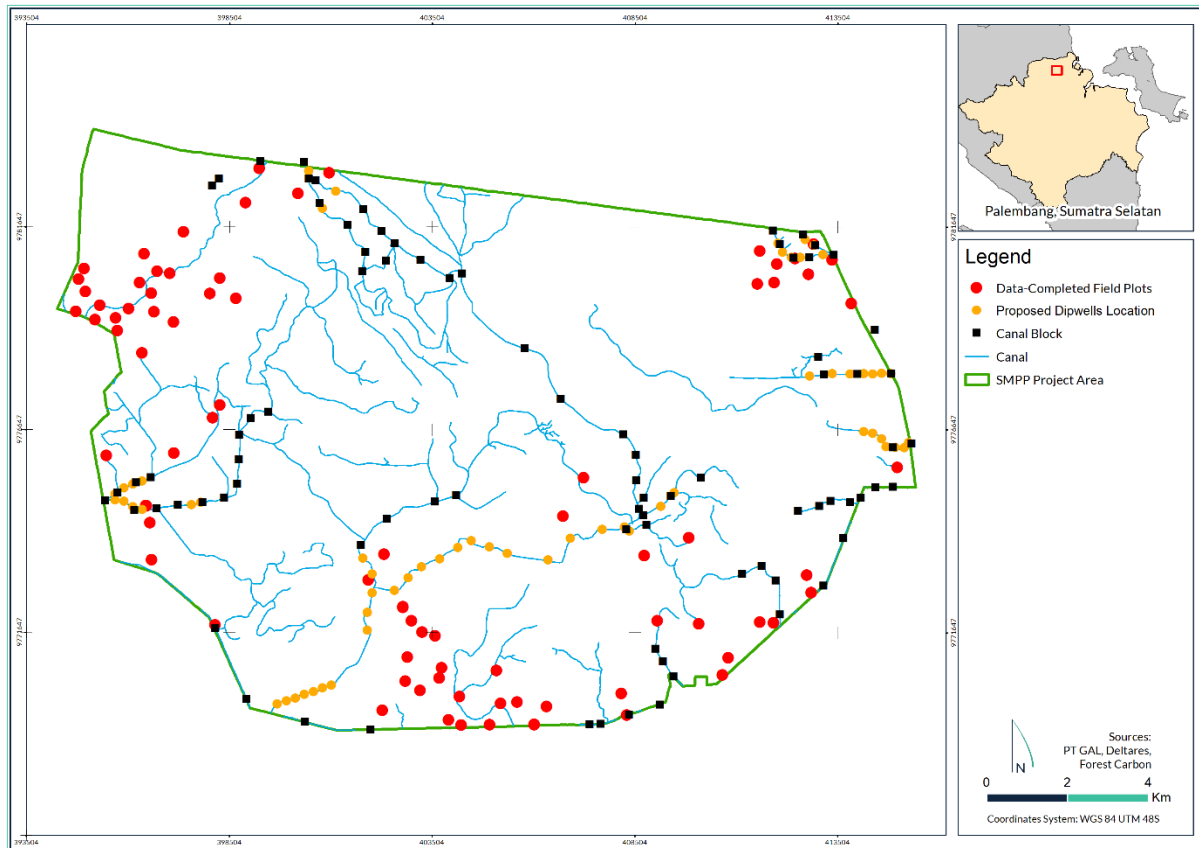
Source		Gas	Included?	Justification/Explanation
		CH ₄	No	Conservatively assume that all DOC emissions are CO ₂ .
		N ₂ O	No	Conservatively omitted.
	Peat combustion	CO ₂	Yes	Procedures provided in Module E-BPB. Make use of IPCC combustion factors.
		CH ₄	Yes	Procedures provided in Module E-BPB. Make use of IPCC combustion factors.
		N ₂ O	No	Conservatively omitted.
	Combustion of fossil fuels	CO ₂	No	Deemed de minimis in VCS AFOLU Requirements.
		CH ₄	No	Deemed de minimis in VCS AFOLU Requirements.
		N ₂ O	No	Deemed de minimis in VCS AFOLU Requirements.
	Fertilizer application	CO ₂	No	Fertilizer application is higher in the baseline than in the project scenario. As such it is conservative to omit.
		CH ₄	No	Fertilizer application is higher in the baseline than in the project scenario. As such it is conservative to omit.
		N ₂ O	No	Fertilizer application is higher in the baseline than in the project scenario. As such it is conservative to omit.

Table 20. GHG sources included in the ARR project boundary.

Source		Gas	Included?	Justification/Explanation
Baseline	Burning of woody biomass	CO ₂	No	Aboveground biomass losses as a result of fire are conservatively assumed to be zero.
		CH ₄	No	Aboveground biomass losses as a result of fire are conservatively assumed to be zero.
		N ₂ O	No	Aboveground biomass losses as a result of fire are conservatively assumed to be zero.
Project	Burning of woody biomass	CO ₂	No	CO ₂ emissions are excluded but carbon stock decreases due to burning are accounted for as a carbon stock change.
		CH ₄	Yes	CH ₄ will be accounted for through the use of IPCC combustion factors if burning occurs in the project scenario.
		N ₂ O	Yes	N ₂ O will be accounted for through the use of IPCC combustion factors if burning occurs in the project scenario.

To show where we have planned to collect data to characterize and quantify GHG emissions, Map 22 below indicates the physical locations of planned hydrological monitoring nearby planned canal blocks and existing peat inventory (to be updated for peat characteristics and subsidence monitoring every 10 years for baseline scenarios), taking place as part of the project activity detailed in Section 2.11.

Map 22. Water table level monitoring and peat inventory locations.



3.1.4 Baseline Scenario

In this section we identify the baseline scenario of the SMPP and demonstrate our project's additionality using the "Combined tool to identify the baseline scenario and demonstrate additionality, Version 07.0".³⁰ Using these tools, we will carry out a preliminary screening (as 'Step 0').

Step 1: Identification of alternative land-use scenarios to the proposed project activity.

Sub-step 1a. We identified credible alternative land-use scenarios to the proposed project activity.

There are a variety of possible without-project land-use scenarios that are outlined in Table 21. We compiled these scenarios as the most likely land conversions or future predictions of the SMPP area without our project, based on a review of the current land-uses across lowland peatlands in Sumatra and other areas of Indonesia.

Table 21. Description of the major alternative land-use scenarios for the project area (Outcome of Step 1a).

Land use scenario	Description
Acacia plantation	<i>Acacia crassicaarpa</i> is among the most common industrial land-uses of lowland peatlands in Indonesia.³¹ The tree crop is managed on 4 to 6 year rotations with the harvested wood used for paper and pulp wood products. A commercial scale plantation requires continuous drainage of the peat to below 70cm depth.³² The industrial Acacia plantation sector grew rapidly in Indonesia in the 2000's and further development was targeted in the Ministry of Forestry development plans: from 10 million ha in 2010, to 13 million ha in 2014.³³ In the project landscape, Acacia plantations are already widespread and have been established in peatland areas to the north, west, south, and east of the project site. There is documentation that shows that applications for establishment of more plantations were lodged for unallocated lands in the Lalan Forest Management Unit where the project is located, in 2007 and 2011 by a number of plantation companies^{34–36} which demonstrates a clear threat of conversion in the project area. The massive expansion of Acacia plantations in Indonesia has already led to high levels of drainage and full conversion of extensive areas of peatlands, demonstrating that this is a high potential land-use in the project area.
Industrial Oil Palm Plantation	An industrial oil palm plantation is a very common agricultural land-use of lowland peatlands in Indonesia,³⁷ despite the fact that peat soils are not ideal for its cultivation.³⁸ The crop is managed on 25 to 35-year rotations and becomes ready for harvest after 4-5 years. Like industrial Acacia plantations, palm oil plantations require continuous drainage of the peat to below 70cm depth.²² The oil palm sector in Indonesia has increased dramatically over the past few decades³⁹ including in South Sumatra. A recent remote-sensing study investigating closed canopy palm oil plantations in the lowlands of Sumatra (3.9 million ha) revealed that by the early 2000s, 6% (or ≈880,000 ha) of tropical peatlands in the region had been converted to palm oil plantations. Further, there is a palm oil concession located in fairly close proximity to the west and south of the project area, including areas that were previously forested peatlands. However industrial oil palm expansion has taken place almost exclusively in areas legally outside of the forest estate (designated as Other Land Utilization, <i>Area Penggunaan Lain</i>, or APL) or within the forest estate in areas ear-marked for conversion (designated Conversion Production Forest, <i>Hutan Produksi Konversi</i>, or HPK). The project area has no area within its boundaries designated as APL or HPK.
Forest with commercial logging	The forested peatlands of South Sumatra were extensively logged by commercial entities from 1970-2000 using selective cutting approach. The project area was also logged by commercial entities over a number of years as well dating back to the 1970's.¹² Currently, none of the production forest on peatland in the project area landscape is subject to active commercial logging today as most timber companies have shut down operations due to changes in the sector that make logging unprofitable. One major change has been a tightening of regulations on management practices, taxation, and labor management. Historically, timber companies were not required to implement long-term management of the areas and instead harvested timber at unsustainable levels which led to the natural forest areas having few remaining timbers within allowable diameter sizes. With

Land use scenario	Description
	little remaining timber, the focus has switched to conversion to oil palm plantations.
Unexploited Forest	There are limited forest areas in Indonesia that are unexploited. However, this is not the norm in Sumatra and generally these forest areas remain unexploited for short periods of time only as a transitional state between phases of commercial exploitation. Unexploited forest areas with no formal management activities, quickly become degraded as outside actors seek to claim land for farming or extract resources like timber. These areas rapidly lose all commercial value as a timber concession and become future targets for conversion to industrial agriculture or industrial forest plantations which has been the case in the district of Musi Banyuasin where the project is located.
Protected Forest	Forest area that is designated as Production Forest can legally be converted into a protected area although it is rare. In regions near the project, there were some former logging concession areas that were converted to national parks, including parts of the Berbak-Sembilang National Parks. Further afield, throughout Indonesia, a number of production forest areas in the highlands were listed as Watershed Protection forest (<i>Hutan Lindung</i>).
Smallholder agriculture	Small holder agriculture on peatlands is not a major activity in the project region due the unsuitability of peat soils for agriculture without commercial scale drainage and the high risk of fire in these areas due to extended dry periods from El Nino weather patterns. The small farms that exist in the landscape are found closer to the rivers and villages where mineral soils allow for a variety of tree and non-tree crops, including rubber, cassava, pineapple, and oil palm. While the project zone has two smallholder farmers located on peat soils that cover an area of 12 hectares, smallholder agriculture is not considered a likely land-use for the project area.
Mining and Natural Gas Extraction	In the project landscape, coal mining and natural gas extraction are present. However, it is not considered a likely land-use for the project as the region was surveyed for gas and coal many years prior to the start of the project and mining concessions were already awarded for the area and have been in existence for considerable time.

In addition to these major credible land-use scenarios, we also considered a number of other land-uses including infrastructure development and industrial aquaculture. However, to be included in the analysis, all were considered to either lack sufficient credibility or precedence.

3.1.5 Additionality

Sub-step 1b. We ensured consistency of credible alternative land-use scenarios in the context of applicable and enforced mandatory laws and regulations.

The major credible land-use scenarios identified under Sub-step 1a were assessed from a legal perspective based on Indonesian laws and regulations. Since the project area is completely designated as ‘Production Forest’ or ‘*Hutan Produksi*’, the analysis focuses on what is legally permissible in this type of land area.

Map 23. Production Forest land status map.

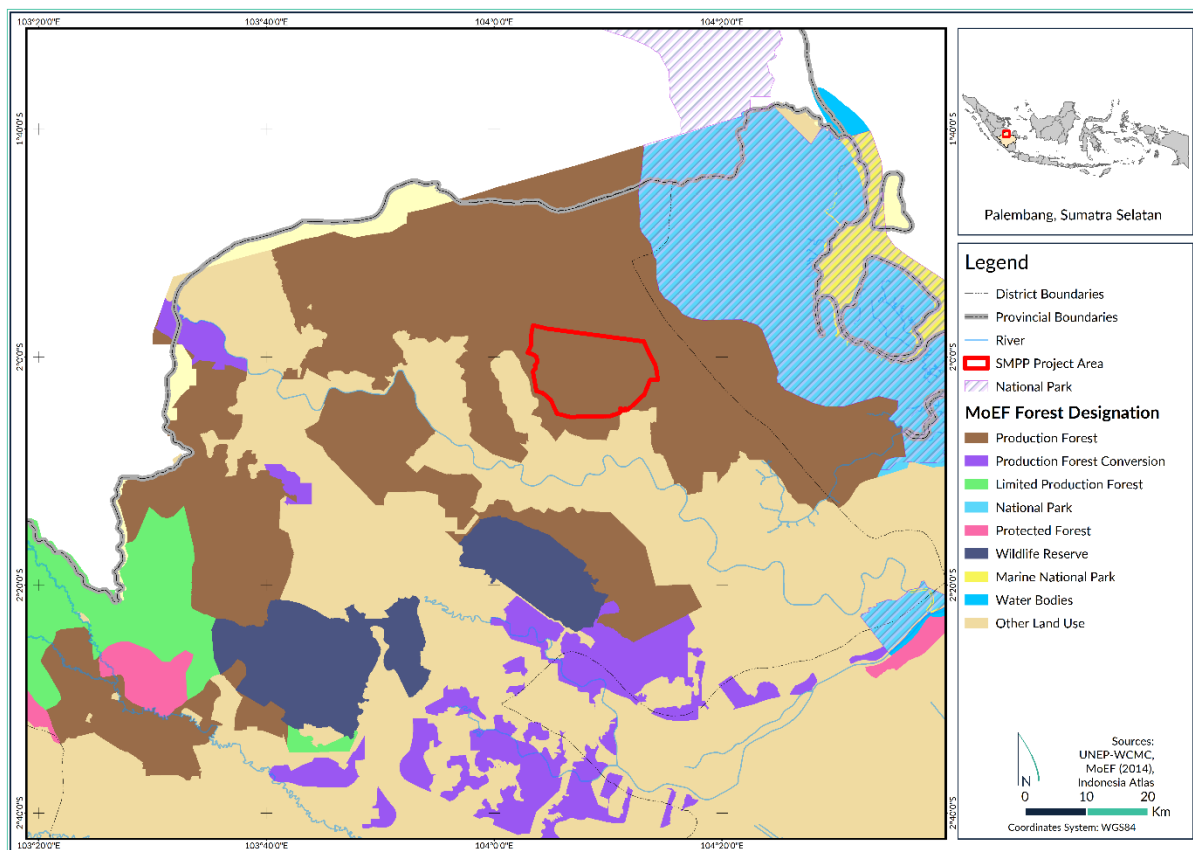


Table 22. Consistency of alternative land-use scenarios with laws and regulations (Outcome of Step 1b).

Land use scenario	Description
Commercial Acacia Plantation	The Forestry Laws No. 41/1999, 19/2004 and later by Ministry of Forestry Decree No. 31/2014 legally allow for the development of commercial Acacia plantations.
Commercial Oil Palm Plantation	The legal designation of the project area is production forest or <i>Hutan Produksi</i> (HP). Legally, a commercial oil palm plantation cannot be established in an area designated as production forest. A commercial palm oil plantation can only be established legally by first removing the area from the forest estate as per Government Decree PP No. 60/2012. Further, only forest areas formally designated as Conversion Production Forest (<i>Hutan Produksi Konversi</i> or HPK) can be removed from the forestry estate. The project area does not include any forest areas designated as HPK, as a result the scenario of commercial conversion to oil palm is not considered a legally viable scenario.
Forest with commercial logging	As per Forestry Laws No. 41/1999 and No. 19/2004, and Ministry of Forestry Decree No. 31/2014, commercial logging is a legally permissible land-use.
Unexploited Forest	The area could remain as unexploited forest if it does not become subject to any license application for logging or conversion to industrial agriculture. Secondly, the site could be subject to an application for management as an ecosystem

Land use scenario	Description
	restoration concession, a form of logging concession permissible on production forest land as regulated and later by Ministry of Forestry Decree No. 31/2014 or a carbon storage and sequestration license.
Protected Forest	Land designated as production forest can be legally converted to some form of protection or conservation forest. However, this re-designation takes considerable time, political support at many levels, and is a long process.
Smallholder agriculture	As per Forestry Laws No. 41/1999 and No. 19/2004, and Ministry of Forestry Decree No. 31/2014, smallholder agriculture is not a legally permissible land-use on areas designated as production forest. However, unexploited forest land which is not actively managed, is often targeted by smallholders via a number of quasi-official routes.
Commercial Coal Mining and Natural Gas Extraction	Commercial coal mining is only legally permissible within the project area with an appropriate license. The granting of these licenses is governed by laws that highly restrict the extent of an area that can be mined and outline the compensation levels which must be paid to existing concession holders. Currently there are no active or exploration mining concessions overlapping with the project area.

As a result of the legal analysis, commercial oil palm plantations are not considered a credible alternative land-use scenario in the project area as it is not legally permissible. While smallholder agriculture is not legally permissible in the project area, it frequently occurs across Indonesia and therefore merits further consideration as part of the barrier analysis.

Step 2: Barrier Analysis

Step 2a. Identification of barriers that would prevent the implementation of at least one alternative land-use scenarios

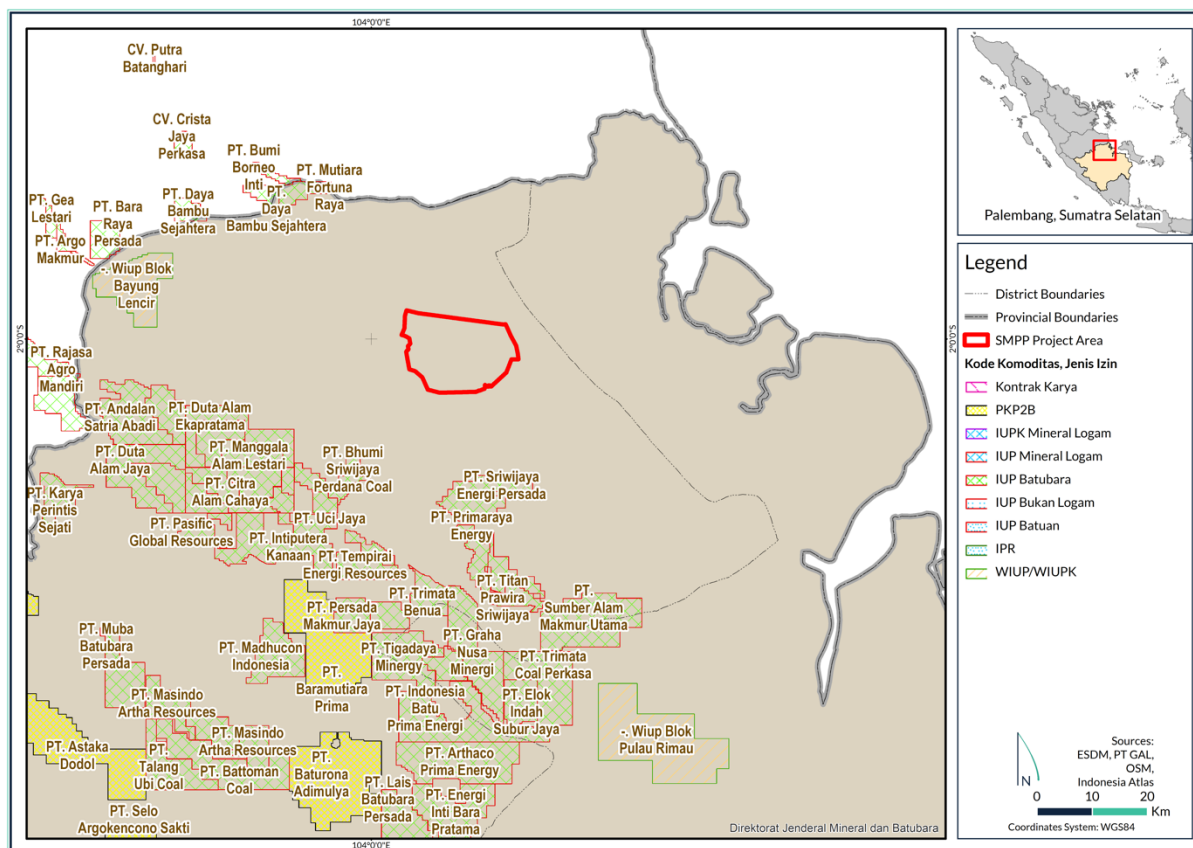
In this section, we assess the remaining barriers of the remaining six credible land-use scenarios in order to determine the most likely land-use scenarios. The results of this analysis are shown in Table 23.

Table 23. Identification of barriers that would prevent the implementation of each scenario (Outcome of Step 2a).

Land use scenario	Description
Commercial Acacia plantation	There are no barriers to the establishment of a commercial Acacia plantation. At the start of the project and until now, the project area has a land designation of production forest which allows it to be converted to a commercial Acacia plantation.
Forest with commercial logging	The primary barrier to this land-use is the lack of commercial-sized timber due to the majority of the site having been logged between 1970-2000. The business model around commercial logging has also changed. When commercial logging first started in the 60's and 70's, a combination of loose regulations on tax collecting, cheap labor, and minimal labor laws allowed companies to operate profitably on marginal forest sites. The market was also conducive as timber prices were high and export markets were very open. This land-use is considerably more difficult as high value export markets are now difficult to access without following strict certification standards and this would be very difficult to obtain for production coming from peatlands.

Land use scenario	Description
Unexploited Forest	There are economic and institutional barriers to this land-use. Since the land is legally designated for production activities, if it stayed without a commercial license, it would not be in line with documented government economic development plans. Politically this would not be popular as the area would not generate tax revenues and economic benefits for the state and local communities. Historical analysis across Indonesia shows that unprotected forest does not remain intact for an extended period of time.
Protected Forest	The creation of a protected forest with the project area would not have political support locally as this would require the local government to use existing state budgets to cover the costs of forest protection for the area. The government would prefer a land-use that would generate tax revenue and local jobs.
Smallholder agriculture	In general, peat soils are not suitable for growing crops and is therefore a major barrier to smallholder agriculture which is further supported by the low levels of smallholder agriculture within peat areas in the region and across Indonesia. ^{5,40} Second, the project area was prone to repeated fires and farmers are reluctant to invest in areas where the farms will be destroyed on a consistent basis. The expansion of smallholder agriculture in areas designated as production forest is rare and occurs primarily when there is no active management license for the area. Since there are no barriers for the development of commercial forest plantations in the project area and the likelihood of the area remaining an unexploited forest for a long period of time is low, smallholder agriculture expansion in the project area is not considered credible.
Mining and Natural Gas Extraction	The main barrier to the expansion of commercial coal mining in the project area is the lack of suitable coal deposits and the peat overburden. This is confirmed by absence of any commercial mining exploitation permits for the area (Map 24). Natural gas extraction is taking place in close proximity to the project area by Conoco Philips. However, the region was previously surveyed and there are no gas fields identified by the government that are overlapping with the project area.

Map 24. Regional mining concessions.



Step 2b. Elimination of land-use scenarios that are prevented by the identified barriers

In conclusion, there are significant barriers that prevent the realization of all the previously listed scenarios leaving a single credible land-use scenario: industrial Acacia plantation. Thus, this alternative was identified as the baseline scenario.

Sub-step 2c. Determination of baseline scenario.

Step 3: Investment analysis

Because a single credible land-use scenario was identified through the analytical steps above, a detailed investment analysis is not required by the A/R CDM additionality tool.³⁰ However, a GGGI study on peatlands supported the identification of Industrial Acacia plantation as being the most profitable and likely land-use on areas legally classified as production forest.

Step 4: Common practice analysis

It is not a common practice for the Indonesian government to have intact forest on land designated for production that is not being commercially exploited and generating tax revenues. However, there are some examples of this that tend to be small donor-backed conservation projects or where large corporates in the extractive industries are paying restoration costs of sites as reparations for areas damaged as part of their operations in other locations. These are not widespread and are typically very small in size.

Conclusion

The project is considered additional, with the most likely and plausible business-as-usual scenario being conversion to industrial Acacia plantation.

3.1.6 Methodology Deviations

The VM0007 methodology underwent a slight deviation for our project. The modifications were only related to the selection of proxy areas for the leakage analysis and did not relate to any other parts of the methodology. The deviation did not negatively impact the conservativeness of the quantification of GHG emission reductions or removals.

Module BL-ARR and Methodology extension AR-ACM0003, do not include specific requirements for the justification of the plantation establishment rate. To justify our conservative baseline conversion/plantation establishment rate (which is not deforestation) and to calculate leakage with a baseline deforestation rate, we followed Module BL-PL. The conservative approaches of BL-PL provided an analytical basis for the plantation establishment rate. Although this analysis was not needed for our baseline rate of conversion, we employed this approach to give our baseline rate more validity. A slight deviation from the requirements of BL-PL took place when justifying deforestation rate used for the subsequent LK-ASP.

For the percentage forest cover used in similarity criteria for the proxy area analysis, we chose to use our site condition in 2013 (the year of license granted) as the reference for comparison for two reasons. First, by using the project area forest cover in 2015 (as the project starting date is 01/01/2016), we could not identify the minimum number of required concessions ($n = 6$) in Indonesia within the last ten years that met the forest cover along with the other similarity criteria. This is because we would have compared the project area after a catastrophic fire event in 2015 to concessions prior to the fire event. The 2015 event made the project area a unique situation and therefore impossible to find enough sites with similar (low) forest cover. Second, by choosing 2013 as the year for comparison we selected a year in which forest cover was higher, thus translating to proxy concessions that had higher initial forest cover (i.e. in the year of license granted). This was a conservative approach as a higher forest cover meant that areas were more difficult to convert and therefore experienced a lower rate of conversion.

3.2 Quantification of GHG Emission Reductions and Removals

We show the estimated GHG emission reductions and removals in Table 24 below (i.e. estimated VCUs). The project is categorized as a large project.⁴¹

Table 24. Project scale and estimated GHG emission reductions or removals (i.e. estimated VCUs).

Project	No
Large project	Yes

Year	Estimated GHG emission reductions or removals (t CO ₂ -e) (estimated VCUs)
2016	336,581
2017	439,999
2018	492,325
2019	487,966
2020	1,081,349
2021	1,107,735

Year	Estimated GHG emission reductions or removals (t CO ₂ -e) (estimated VCUs)
2022	1,210,235
2023	1,276,896
2024	1,362,486
2025	1,378,830
2026	1,485,689
2027	1,512,235
2028	1,643,700
2029	1,613,677
2030	1,622,027
2031	1,585,265
2032	1,687,316
2033	1,549,637
2034	1,585,128
2035	1,545,999
2036	1,658,436
2037	1,553,427
2038	1,525,843
2039	1,548,639
2040	1,598,080
2041	1,525,229
2042	1,484,457
2043	1,449,954
2044	1,529,117
2045	1,440,378
2046	1,449,510
2047	1,391,788
2048	1,510,217
2049	1,381,253
2050	1,374,405
2051	1,332,050
2052	1,429,344
2053	1,350,037

Year	Estimated GHG emission reductions or removals (t CO ₂ -e) (estimated VCUs)
2054	1,333,945
2055	1,281,424
2056	1,359,406
2057	1,253,072
2058	1,267,736
2059	1,250,312
2060	1,270,852
2061	1,192,850
2062	1,165,919
Total	62,912,755

3.2.1 Baseline Emissions

In this section we describe baseline emissions derived from the VCS methodology VM0007 (version 1.6) REDD+ MF and its modules BL-PL, BL-ARR, AR-ACM0003, BL-PEAT, and E-BPB.

3.2.1.1 General assumptions

We used analyses of the most likely baseline scenario, described in Sub-section 3.1.4, to assess baseline emissions as well as the resulting changes on carbon stocks.

These emissions sources included:

1. Changes in aboveground biomass stocks (characterized by conversion to plantations);
2. Peat microbial decomposition;
3. Peat burning; and
4. Dissolved organic carbon from bodies of water.

All of the assumptions and omissions of emissions that we describe here are conservative efforts that result in lower emissions to maintain validity of our calculations and estimates of a baseline scenario.

We assumed that no other events of rewetting would occur in the baseline scenario. Examples of natural events that we excluded in our analysis may include canal collapses, progressive subsidence that could lead to changes in relative water table depths, or reduced CO₂ emission rates with increasingly thinner aerobic soil layers.

We also assumed that regular canal maintenance activities typically carried out for drainage and transportation would stay in place.

As information on the volume and frequency of dredging is unavailable (for example if dredging activities caused the peat to be exposed to aerobic decomposition), we omitted these emissions. This is a conservative omission as water body emissions are lower than those resulting from microbial decomposition in peat, and therefore results in lower emission estimates in the water body stratum than strata at the same location in the project scenario.

In the baseline scenario, we calculated the annual emissions for carbon dioxide (CO₂) and methane (CH₄) as these emissions are impacted directly by changes in land cover classes and drainage status over time. However, we conservatively omitted nitrous oxide (N₂O) and GHG emissions derived from biomass burning.

3.2.1.2 Proxy area analysis

Module BL-ARR and Methodology extension AR-ACM0003, do not include specific requirements for the justification of the plantation establishment rate. To justify our conservative baseline conversion/plantation establishment rate (which is not deforestation) and to calculate leakage with a baseline deforestation rate, we followed Module BL-PL. We do not have a verifiable plan at the project area for the conversion/deforestation rate. Therefore, per BL-PL requirements, we selected a minimum of six areas to determine the baseline rate of conversion/deforestation. These were further used to demonstrate the risk of abandonment.

In this section we describe the analytical processes to determine the conservative baseline rate of plantation establishment as per Module BL-PL which was used subsequently in LK-ASP.

3.2.1.2.1 Data collection and compilation

We selected suitable proxy areas as reference regions through an iterative process of data collection, compilation, review and processing of global or national-level datasets. Our description of the globally and nationally available datasets used for performing iterative analyses to select appropriate proxy areas, as well as detailed methodology and justification is available in Annex 9.

3.2.1.2.2 Similarity analysis to select proxy areas

According to the methodology, all proxy areas must meet the following criteria:

1. Land conversion practices shall be the same as those used by the baseline agent or class of agent;
2. The post-deforestation land-use shall be the same in the reference regions as expected in the project area under business as usual;
3. The reference regions shall have the same management and land-use rights type as the proposed project area under business as usual;
4. If suitable sites exist, they shall be in the immediate area of the project; if an insufficient number of sites exists in the immediate area of the project, sites shall be identified elsewhere in the same country as the project; if an insufficient number of sites exists in the country, sites shall be identified in neighboring countries;
5. Agents of deforestation in reference regions must have deforested their land under the same criteria that the project lands must follow (legally permissible and suitable for conversion);
6. Deforestation in the reference region shall have occurred within the 10 years prior to the baseline period; and

The three following conditions shall be met:

1. The forest types surrounding the reference region or in the reference region prior to deforestation shall be in the same proportion as in the project area ($\pm 20\%$);
2. Soil types that are suitable for the land-use practice used by the agent of deforestation in the project area must be present in the reference region in the same proportion as the project area ($\pm 20\%$). The ratio of slope classes “gentle” (slope $< 15\%$) to “steep” (slope $\geq 15\%$) in the reference regions shall be ($\pm 20\%$) the same of the ratio in the project area; and
3. Elevation classes (500-m classes) in the reference region shall be in the same proportion as in the project area ($\pm 20\%$).

We have described and justified a slight deviation from Module BL-PL in Section 3.1.6. Requirements for the reference regions had to meet the following criteria in Table 25 below.

Table 25. Reference region selection criteria.

Project area at project starting date	Reference region requirement
59.6% forest cover as per MoE&F 2013	39.6-79.6% forest cover
100% peat	At least 80% peat
100% of area in the 0 - 500 m class	At least 80% of the area must fall in the 0-500 m class
100% of area has “gentle” (slope < 15%) slopes	At least 80% of the area must have “gentle” slopes

The selection took place in a step-wise elimination approach by examining one item on the criteria list at a time. After the final step of elimination from the land-use, management practice, elevation, slope, and soil (peat) criteria, 28 shortlisted reference regions remained for the forest cover similarity analysis.

Because the MoE&F dataset was not consistently available on an annual basis (available for 2006, 2009, 2011, 2012, 2013 and 2015) during the ten years prior to our project starting date, not all the potential proxy area license years were covered by the years of MoE&F data. Ten of the 28 shortlisted concessions had their license start in 2007. Since the MoE&F data did not cover this year, we chose to use the MoE&F forest cover in 2006 as a proxy of 2007 with two assumptions met. First, we assumed that large-scale, major planned conversion/deforestation would only begin after the licenses were issued. Second, by only using a single and credible data source, we avoided uncertainty resulting from mixing datasets derived using different methods.

We verified the first assumption by using two independent satellite-derived datasets produced by the Indonesian government and by the project technical team, namely the forest cover (Indonesian National Carbon Accounting System or INCAS) and pixel-based change detection analysis of Landsat-8 NDVI for 2006-2007. INCAS and MoE&F datasets had a mean 78% agreement between forest/non-forest areas.⁴² Because the INCAS dataset used the same satellite platform (Landsat) as the MoE&F and the data development involved standards, inputs and staff from the MoE&F,⁴³ using INCAS data as a verification reference was viable. We first compared the INCAS data of 2006-2007 with the MoE&F 2006 percentage forest cover and eliminated one site that showed very high difference between the two data sources (MoE&F: 5.8%; INCAS: 78.8% in 2006 and 81.6% in 2007) because this discrepancy indicated significant difference in definition of forest or analysis bias/errors. We also confirmed by using the INCAS dataset to examine if there was any major forest cover difference between 2006 and 2007. We eliminated another site that had moderate difference between the two years (INCAS: 90.4% in 2006 and 81.5% in 2007) because this indicated potential industrial deforestation/conversion between 2006-2007.

Next, for the remaining concessions that had > 1% of forest cover difference in INCAS 2006-2007, we conducted change detection analysis by comparing the difference in vegetation reflectance (i.e. NDVI value) between 2006 vs. 2007 using the ENVI software version 5.3. Differencing NDVI (dNDVI) has been a well-known pre-classification change detection method to identify discernible shift in vegetation or land-use types.⁴⁴ We produced a dNDVI map in the cloud-free areas of each 2006-2007 pair, smoothed the output map with a majority filter algorithm, and categorized the standard deviation of dNDVI. The categorization identified multiple spatial clusters that represented several different types of vegetation change: 1) industrial deforestation/conversion; 2) crop/plantation to harvest; 3) plantation rotation cycle; 4) smallholder activities; and 5) no change (i.e. no loss or gain in dNDVI). We cross-checked between the dNDVI category map and Landsat-8 surface reflectance bands (in composite band combination of 6-5-4) to assign the spatial clusters into a dNDVI category by visually inspecting the imagery texture, color, pattern, patch size, patch shape, land features and adjacent patch types.

When the visual interpretation showed possibly different conclusion of forest cover or land-use change among dNDVI, Landsat-8 surface band composite, INCAS and MoE&F datasets, we compared them with two more global satellite-derived datasets in 2007: 1) vegetation loss (Terra-i); or 2) tree cover loss (University of Maryland). We eliminated one more site that had almost 100% forest cover in the INCAS and

MoE&F datasets but showed moderate level of tree cover loss in the University of Maryland data and industrial-level deforestation/conversion in the dNDVI analysis.

The summary comparison of sites analyzed in this process can be found in Annex 9. From this iterative process we confirmed that the remaining seven sites did not show major planned deforestation/ conversion activities from 2006-2007. We concluded that their forest cover shown in the MoE&F 2006 could serve as a good proxy to represent their 2007 cover. We then proceeded forest cover similarity analysis using these seven sites along with other shortlisted sites licensed in different years.

3.2.1.2.3 Conversion/deforestation rate calculation

After the final elimination step using the MoE&F forest cover data, seven proxy areas remained. One concession only had 1.31% average annual forest loss from 2009 (licensed year) to 2015 (prior to our project start date on 01/01/2016), very different from the other six sites. According to our visual inspection by examining Landsat medium-resolution imagery in the licensed year and 2015, this site did not show prominent expansion of large-scale conversion/deforestation and development activities compared to the other sites. Irregular, patchy and small-size deforestation/conversion indicated smallholder activities and/or natural hazards/disasters. It is likely that 1.31% mean annual forest loss might not result from industrial concession operations, but could be a result of smallholder practices, forest succession from hazards, or natural disasters. The land conversion practice and post-deforestation land-use of this site would not meet the similarity criteria when compared to the project area baseline scenario.

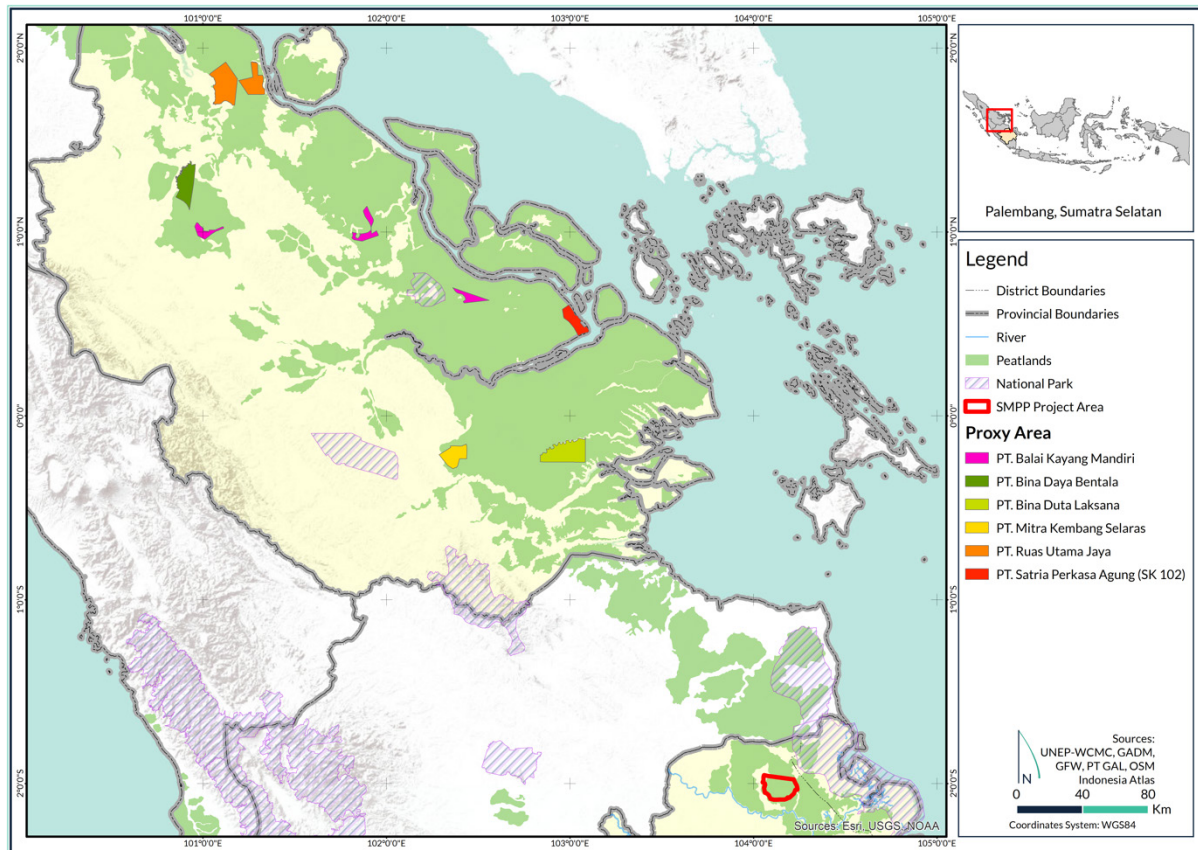
The visual inspection also confirmed that the other six sites showed signs of continuing conversion/deforestation for plantations, thereby not subject to risk of abandonment. Therefore, considering their similarity to the project area's baseline scenario, we selected these six remaining sites as the proxy area for calculating conversion/deforestation rate.

The summary comparison of sites analyzed in this visual inspection process can be found in Annex 9. We summarize the six final reference regions below in Table 26 and Map 25.

Table 26. Summary of suitable reference regions

Province	Concession name	Area (ha)	License year	Peat (%)	Forest area in licensed year or 2006 (2007's proxy) (ha)	Forest area in 2015 (ha)	Total forest loss (%)	Average annual conversion/ deforestation rate (%)
Riau	PT Balai Kayang Mandiri	21,165.29	2007	95.97	14,779.51	9,952.86	32.66	4.08
Riau	PT Bina Daya Bentala	20,007.71	2006	88.66	8,484.97	0	100.00	11.11
Riau	PT Bina Duta Laksana	29,153.01	2006	100.00	17,837.11	7,084.26	60.28	6.70
Riau	PT Mitra Kembang Selaras	14,717.45	2007	100.00	10,031.47	2,740.08	72.69	9.09
Riau	PT Ruas Utama Jaya	44,794.62	2007	99.94	20,934.68	4,674.85	77.67	9.71
Riau	PT Satria Perkasa Agung (SK 102)	11,863.52	2006	100.00	5,271.74	2,235.25	57.60	6.40

Map 25. Location of the project area and the six reference regions selected for proxy areas.



3.2.1.2.4 Conversion/deforestation analysis

The annual conversion/deforestation was calculated with the equation (10):

$$D\%_{planned,i,t} = \left(\sum_{pn=1}^n \left(D\%_{pn} / Yrs_{pn} \right) \right) / n \quad (10)$$

Where:

$D\%_{planned,i,t}$	Projected annual proportion of land that will be deforested in stratum i during year t . If actual annual proportion is known and documented (e.g. 25% per year for 4 years), set to proportion; %
$D\%_{pn}$	Percent of deforestation in land parcel pn of a proxy area as a result of planned deforestation as defined in this module; %
Yrs_{pn}	Number of years over which conversion/deforestation occurred in land parcel pn in proxy area; years
n	Total number of land parcels examined

pn	1, 2, 3, ... n^* land parcels examined in proxy area
i	1, 2, 3, ... M strata

We estimated the average annual conversion/deforestation rate for these six proxy areas to be 7.85%. Our review of common Industrial Plantation Forest (*Hutan Tanaman Industri* or HTI) concession practices based on document research and concession manager interviews indicated a typical conversion/deforestation rate of 12-13%. Since we took conservative approaches analytically during the similarity analysis to set an estimated rate lower than known practices, the baseline rate of conversion/deforestation uncertainty was set to zero.

Likelihood of deforestation and risk of abandonment

Because HTI concessions are designated in zoning for deforestation and are not under any particular government control while licensed, we assumed the likelihood of deforestation ($L-D_i$) to be 100%.

We assessed the risk of abandonment using the six proxy areas selected above for calculating the average annual conversion/deforestation rate. After confirming the criteria in the proxy area analysis, we accessed and visually interpreted Landsat satellite images to determine if any of them experienced abandonment for forest regrowth. All proxy areas showed clear signs of continued conversion/deforestation and plantation activities for 2006-2015, therefore the BL-PL Module is applicable.

Area of conversion/deforestation

The annual area of conversion/deforestation in the baseline case is described in the equation (11):

$$AA_{planned,i,t} = (A_{planned,i} \times D\%_{planned,i,t}) \times L - D_i \quad (11)$$

Where:

$AA_{planned,i,t}$	Annual area of baseline planned deforestation for stratum i at time t ; ha
$D\%_{planned,i,t}$	Projected annual proportion of land that will be deforested in stratum i during year t . If actual annual proportion is known and documented (e.g. 25% per year for 4 years), set to proportion; %
$A_{planned,i}$	Total area of planned deforestation over the baseline period for stratum i ; ha
$L-D_i$	Likelihood of deforestation for stratum i ; %

3.2.1.3 Projection of conversion under baseline scenario

We allocated the project area spatially to produce a map based on the calculation of total annual area converted in the baseline ($AA_{planned,i,t}$). We stratified the project area into five strata, determined using an iterative, spatially explicit delineation process with four land-use types, two drainage statuses, and one water body class. A baseline scenario map is shown in Map 26. The spatial allocation consisted of the following steps:

1. We defined the maximum area allowed for development. According to MoE&F,^{45,46} 10% of the project area must be set aside for conservation, while the remaining 90% could be developed.
2. Of 90% of the project area available for development, maximum 5% could be designated as ground facilities and infrastructure (camps, guard posts, access roads, canals, and log collection ports), based on common practices obtained through interviews.

3. Delineation of water bodies:

- a. Delineation of water bodies present at the project start date (i.e. natural river such as Buring river). The natural water body stratum does not change for the entire project period.
- b. Delineation of secondary (≤ 7 m) and tertiary (≤ 2 m) canals that existed prior to the project start date. These canals are then converted into 1) baseline primary canals, 2) partly baseline secondary canals, 3) partly baseline tertiary canals based on their locations in the zoning design and the conversion year, or 4) Acacia planting zone. The widths of canals were based on observations from the field, and Google Earth high-resolution imagery of the project area.
- c. Delineation of baseline primary canals (12 m) converted in the first year of baseline scenario, widened from the existing secondary canals and aimed to serve for water surface control, log, seedling, and workers transportation.
- d. Delineation of 7-m wide baseline secondary canals that enclosed planting blocks. We divided the secondary canal development into the first four years of conversion, corresponding to review of common practices.
- e. Delineation of 2-m wide baseline tertiary canals that enclosed one planting block. The tertiary canals were assumed to be developed in the same year as the corresponding planting zone's conversion.

4. Delineation of drained/undrained areas:

- a. Studies showed that close proximity to canals influenced water table level, peat subsidence, burned area depth and probability of high frequency fire events. Observed impact of canal proximity varied across different regions, from 300 m (size class of secondary canals),⁴⁷ 600 m (size class of primary canals),⁴⁸ up to 1,300 m.^{48–50} Based on the literature, we employed a conservative approach to assume that areas within a 300-m distance from secondary canals and a 600-m distance from primary canals would be drained. Lacking literature that studied the distance impact of canals in the size class of tertiary canals, we took a conservative approach to prorated an assumed distance (150 m) within which drainage would occur.
- b. We created a 600-m, 300-m, and 150-m buffer around both sides of the primary, secondary, and tertiary canals, respectively, to account for peatland drained at the project start date and in the subsequent years of baseline scenario.
- c. The distinction between drained and undrained areas was taken into account for emission characteristics and calculations.

5. Delineation of conservation area:

- a. Delineation of intact dense forest and nearby closed or open canopy tree/shrub mix areas and the surroundings at the project start date. Summary and details of the land cover classification are available respectively in Section 3.1.3.1.1 and Annex 3.
- b. A 25-m buffer zone on both sides of the natural water bodies was added to the conservation area according to MoE&F.⁵¹

6. Delineation of ground facilities:

- a. We created a 100-m buffer around camps and guard posts.

7. Delineation of planting zones:

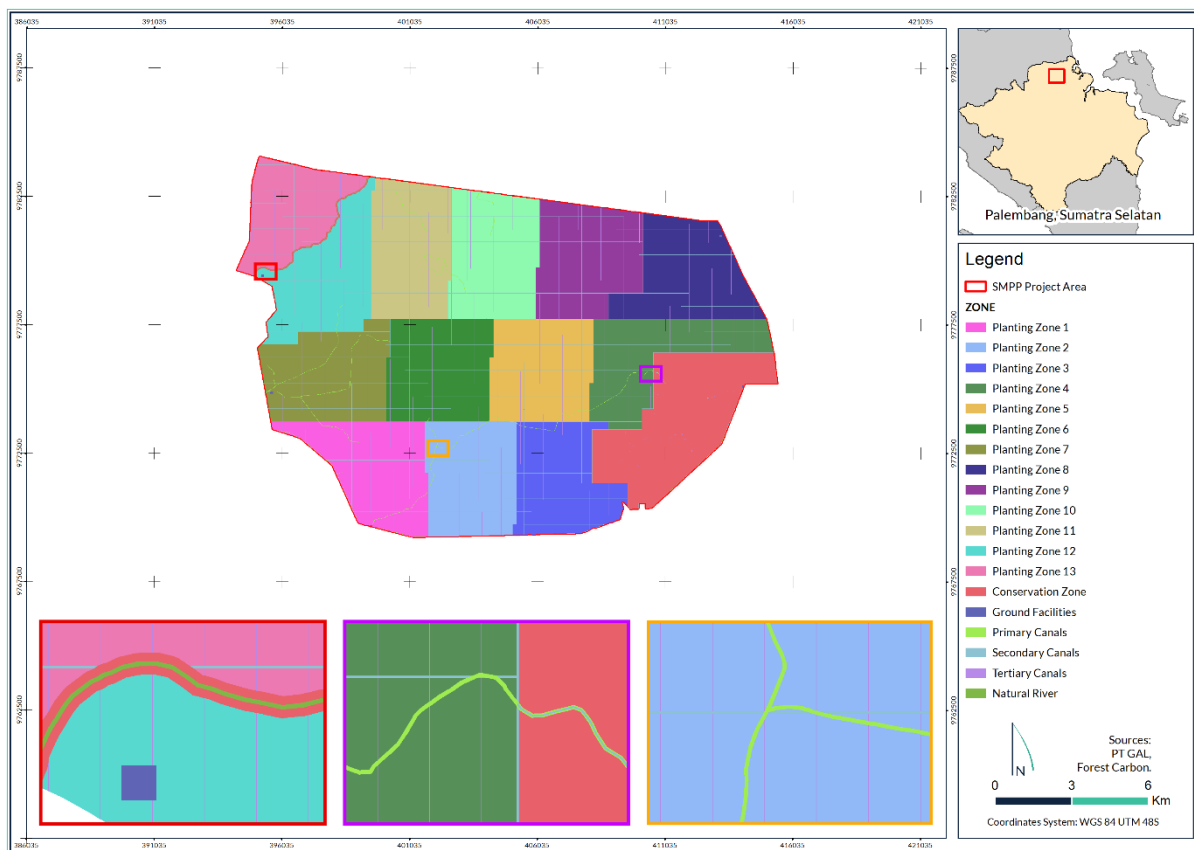
- a. Conversions to canals, ground facilities and planting zones followed an annual conversion rate of 7.85% (from the proxy area analysis in Section 3.2.1.2). The remaining project area

after deducting conservation area, water bodies and ground facilities was available for planting zones. We delineated a total of 13 planting zones, including a few zones to accommodate conversions to ground facilities and secondary canal development.

- b. Each planting zone consisted of multiple 150 x 500 m (75 ha) planting blocks based on common practices observed in the neighboring concession planting blocks using Google Earth high-resolution imagery.
8. Annual land-use change:
- a. Ground facilities (camps, posts, log ponds) were constructed on year 1, based on known common practices.
 - b. Baseline primary canals were developed on year 1, expanded from existing secondary canals prior to the project start.
 - c. Baseline secondary canals were developed in four stages (year 1 to 4).
 - d. Baseline tertiary canals were developed in the year of the planting zone development at which the tertiary canals were located.
 - e. Existing secondary and tertiary canals that overlapped with a planting zone were converted to planting zone at the year of zone development. Canals that overlapped with baseline secondary canals were converted to secondary canals at the year of secondary canal development. Canals that overlapped with baseline tertiary canals were converted to tertiary canals at the year of corresponding zone development. Canals inside the conservation area remained unchanged for the project period.
 - f. One planting zone was converted and planted immediately per year.
 - g. Each planting zone was harvested and immediately replanted every four years, following the Acacia planting cycles known from common practices. For example, year 1 conversion was also set as the same year to plant and in year 5 the harvest was also set for replanting immediately.

The baseline strata of emission characteristics are shown in the baseline scenario designation map (Map 26) by incorporating (1) spatial coverage of land-use and drainage status; and (2) year of land-use and drainage status change.

Map 26. Baseline scenario map of the project area.



3.2.1.4 Emission characteristics in the baseline scenario

3.2.1.4.1 Emission characteristics stratification for WRC activities under the baseline scenario

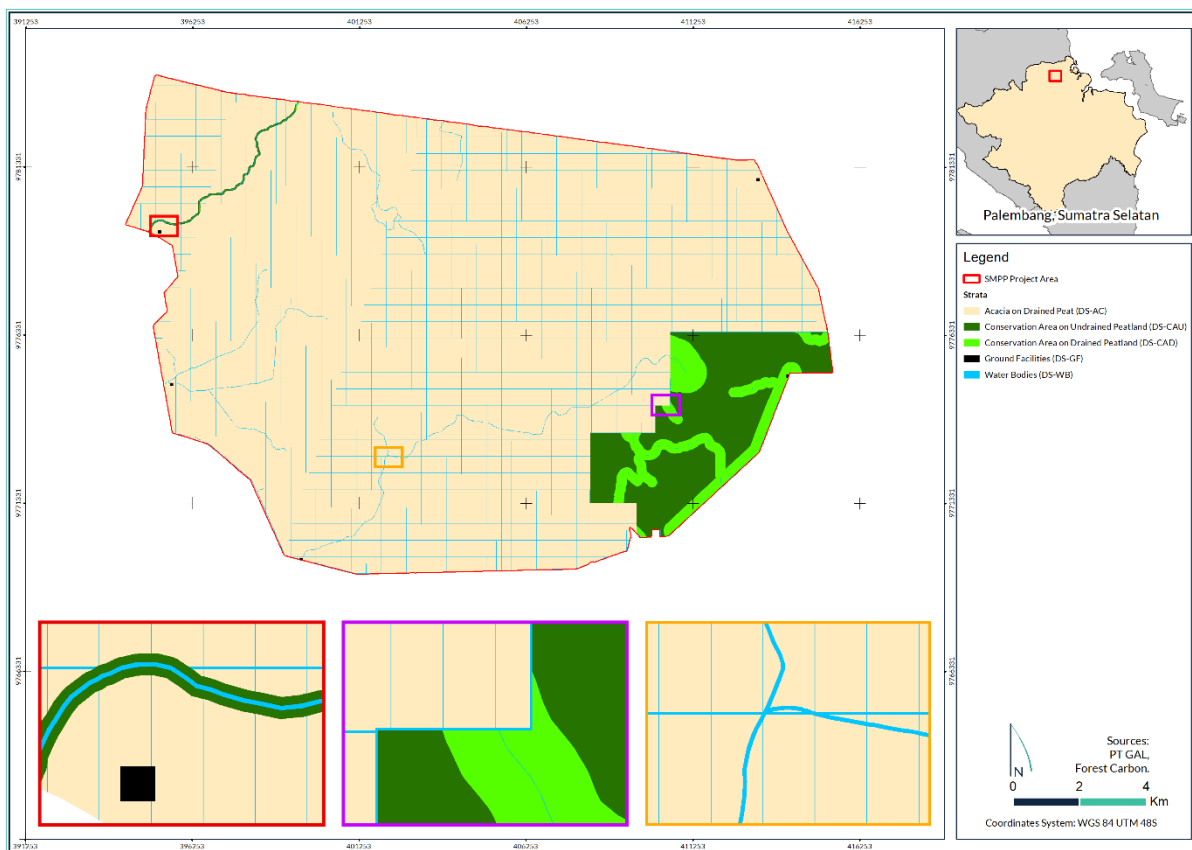
Table 27 present the baseline stratification summary based on emission characteristics. A summary of dynamics of these strata is shown in Annex 10.

Table 27. Baseline stratification of peatlands and water bodies based on emission characteristics.

Strata	Type	Description	Area (ha)	Percentage of project area
DS-CAU	Conservation Area on Undrained Peatland	Peatlands where forest covers are not removed, and drainage is absent. This stratum remains unchanged since the project start date. The locations are in areas where dense forest was present at the project start date, river buffer surrounding natural water body (Buring river), and deforested area surrounding the dense forest.	1,652.10	7.21

Strata	Type	Description	Area (ha)	Percentage of project area
DS-CAD	Conservation Area on Drained Peatland	Peatlands where forest covers are not removed, and drainage is present. This stratum remains unchanged since the project start date. The locations are in areas where dense forest was present at the project start date, and deforested area surrounding the dense forest.	643.04	2.81
DS-WB	Water Body	This stratum represents river and drainage canals. River remains unchanged during the project period. Initial secondary and tertiary canals existed at the project start date. Baseline primary canals are built in year 1, expanded from initial secondary canals. Baseline secondary canals are built in year 1-4. Baseline tertiary canals are built in the year of planting zone development. Existing canals that are on baseline secondary canals are converted to secondary canals according to the secondary canals' development phase. Existing canals that are on baseline tertiary canals are converted to tertiary canals in the year of planting zone development. Existing canals that are on a planting zone are converted to planting zone according to the year of zone development.	707.51	3.09
DS-GF	Infrastructure	Infrastructures on drained peatland. This stratum represents lands used for concession operations, such as base camps, station camps, log yards, and access roads between planting blocks. The locations are as close as possible to transportation access (rivers).	4.09	0.02
DS-AC	Planting Zone	Acacia plantation on drained peatland. Acacia planting starts in the same year as conversion. The development of drainage constructions is assumed to happen just before- or in the same year as conversion/planting.	19,915.65	86.88
Total			22,922.39	100.00

Map 27. Baseline stratification of the project area based on emission characteristics.



3.2.1.4.2 Emission characteristics stratification for ARR activities under the baseline scenario

The baseline aboveground carbon stock accumulation and subsequent loss related to Acacia planting and harvesting is accounted for under the ARR component. As detailed in Sub-subsection 3.2.1.3, a total of 19,915.65 ha of the project area will be converted to Acacia plantation with a rotation cycle of 4 years (Table 28). A summary of dynamics is shown in Annex 10.

Table 28. Land use strata change in the baseline scenario for ARR

Strata	Land use	Area (ha)	Planting Start year
DS-AC	Acacia	19,915.65	2016

3.2.1.5 Baseline emissions from microbial decomposition of peat, peat burning, and water bodies

3.2.1.5.1 Spatial and temporal variability

We quantified GHG emissions from microbial decomposition of peat, peat burning, and water bodies across spatial and temporal scales. Each baseline stratum included a small unit of land parcels with a combination of variables (described in Table 29).

We conducted calculations yearly to determine annual strata changes, variability of GHG emission factors, and any restrictions to GHG emissions (Table 29). We accounted for spatial and temporal scales with our GHG emission factors.

Table 29. Variables used for quantifying baseline GHG emissions from microbial decomposition of peat, peat burnings and dissolved organic carbon from water bodies.

Variables	Description
(A) Spatial Variables	
(A1) Soil Type	Distinction between peat or non-peat. This was used to exclude all non-peat parcels from GHG calculation (99.99% of the project area includes peat with depth $\geq$ 50cm).
(A2) Initial peat thickness available for microbial decomposition and burnings	Derived from DTM, DEL and Peat Thickness maps as described in Sub-subsection 3.1.3.1.4. These maps were used to determine the initial condition for subsequent calculations of the remaining peat layer available for microbial decomposition and burning.
(A3) Initial stratum	Stratum of the corresponding parcel at the project start date (as derived in Annex 10) before conversion into the baseline stratum takes effect. This was used to determine the correct emission factor for the corresponding parcel for the duration before B1 and B2 (see below) take effect.
(A4) Peat burning tag	This was used to identify whether the corresponding parcel was marked as a possible area for peat burning and the frequency of total years of historical and simulated burns.
(B) Temporal Variables	
(B1) Year of drainage	Determines the onset of conversion from initial stratum to a drained stratum and set all the drainage related parameters/variables accordingly, such as initial consolidations, bulk density changes, etc. This does not take effect if the initial stratum of the parcel was already a drained stratum. Together with B2 this was used to determine the correct emission factor for the corresponding parcel.
(B2) Year of conversion/planting of the baseline land cover	Determines the onset of conversion of initial stratum to converted/planted stratum. Together with B1 this was used to determine the correct emission factor for the corresponding parcel.
(B3) PDT	The PDT defines the period of time that it takes to deplete the remaining peat layer by microbial decomposition and burning. Once the PDT is reached in a given stratum all GHG emissions in that stratum are set to zero.
(B4) Year tag for burning	Determines whether the corresponding parcel was marked to catch peat burning for the corresponding year and counting the number of burn scars (and any repetitions) of the parcel since year 1. This was used to set the correct burn scar depth and other related

Variables	Description
	burning parameters for the corresponding parcel accordingly.
(B5) Burning restriction	If the corresponding parcel was marked for burning in the corresponding year (as being checked in B4), this restriction further checked whether GHG emissions from burning would still be possible based on variables: B1 (Year of drainage), B2 (Year of conversion/planting) and B3 (Remaining peat thickness available for microbial decomposition and burning).

3.2.1.5.2 Emission calculations

We calculated the net carbon dioxide equivalent (CO₂-e) emissions from the peat (microbial decomposition and burning) and water body as per VCS Module BL-PEAT in the equation (12):

$$GHG_{BSL-WRC} = \sum_{t=1}^{t^*} \sum_{i=1}^M (E_{peatsoil-BSL,i,t} + E_{peatditch-BSL,i,t} + E_{peatburn-BSL,i,t}) \quad (12)$$

Where:

$GHG_{BSL-WRC}$	Net GHG emissions in the CUPP baseline scenario up to year t^* (t CO ₂ -e)
$E_{peatsoil-BSL,i,t}$	GHG emissions from the peat soil within the project boundary in the baseline scenario in stratum i at year t (t CO ₂ -e yr ⁻¹)
$E_{peatditch-BSL,i,t}$	GHG emissions from water bodies in the baseline scenario in stratum i at year t (t CO ₂ -e yr ⁻¹)
$E_{peatburn-BSL,i,t}$	GHG emissions from burning of peat in the base line scenario in stratum i at year t (t CO ₂ -e yr ⁻¹)
i	1, 2, 3, ... M strata in the baseline scenario (unitless)
t	1, 2, 3, ... t^* times elapsed since the project start (yr)

For all strata i where the project duration exceeds the peat depletion time (PDT or t_{PDT}), for $t > t_{PDT-BSL,i}$ the following equations (13) apply:

$$\begin{aligned} E_{peatsoil-BSL,i,t} &= 0 \\ E_{peatditch-BSL,i,t} &= 0 \\ E_{peatburn-BSL,i,t} &= 0 \end{aligned} \quad (13)$$

Where:

$t_{PDT-BSL,i}$	Peat Depletion Time in the baseline scenario in stratum i in years elapsed since the project start (yr)
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$E_{peatsoil-BSL,i,t}$	GHG emissions from the peat soil within the project boundary in the baseline scenario in stratum i at year t (t CO ₂ -e yr ⁻¹)
$E_{peatditch-BSL,i,t}$	GHG emissions from water bodies at year t (t CO ₂ -e yr ⁻¹)
$E_{peatburn-BSL,i,t}$	GHG emissions from burning of peat in the base line scenario in stratum i at year t (t CO ₂ -e yr ⁻¹)
i	1, 2, 3, ... M_{BSL} strata in the baseline scenario (unitless)
t	1, 2, 3, ... t^* time elapsed since the project start (yr)

GHG emissions from peat soils, water bodies and peat burning are elaborated in detail in the following Sub-sections 3.2.1.5.4, 3.2.1.5.5, and 3.2.1.5.6. A summary of the quantified GHG emissions from peat microbial decomposition, uncontrolled peat burning and water body under the baseline scenario are presented in Table 30.

Table 30. A summary of the annual GHG emissions from peat microbial decomposition, uncontrolled peat burning and water bodies in the project area under the baseline scenario since the start of the project in 2016.

Year	CO ₂ from peat microbial decomposition (t CO ₂ -e yr ⁻¹)	CH ₄ from peat microbial decomposition (t CO ₂ -e yr ⁻¹)	CO ₂ from peat burning (t CO ₂ -e yr ⁻¹)	CH ₄ from peat burning (t CO ₂ -e yr ⁻¹)	CO ₂ from DOC (t CO ₂ -e yr ⁻¹)	Total (t CO ₂ -e yr ⁻¹)
2016	202,975	9,597	461,630	44,168	587	718,957
2017	295,154	8,624	472,764	45,234	916	822,692
2018	391,718	7,676	455,458	43,578	1,224	899,653
2019	495,247	6,923	383,685	36,711	1,597	924,163
2020	599,638	6,488	436,408	41,755	1,644	1,085,933
2021	707,391	6,041	397,247	38,008	1,692	1,150,380
2022	822,665	5,983	409,758	39,205	1,747	1,279,358
2023	936,656	5,308	402,033	38,466	1,801	1,384,264
2024	1,050,043	4,622	302,552	28,948	1,858	1,388,023
2025	1,160,467	4,364	346,323	33,136	1,899	1,546,190
2026	1,270,260	4,190	388,024	37,126	1,945	1,701,545
2027	1,369,672	3,690	350,904	33,574	1,994	1,759,834
2028	1,442,974	3,074	332,007	31,766	2,042	1,811,863
2029	1,437,623	3,069	306,300	29,306	2,042	1,778,340
2030	1,432,329	3,063	322,657	30,872	2,042	1,790,964
2031	1,428,965	3,059	287,278	27,486	2,042	1,748,830
2032	1,420,661	3,051	311,792	29,832	2,042	1,767,378
2033	1,418,927	3,047	255,421	24,438	2,042	1,703,875
2034	1,416,243	3,044	298,196	28,531	2,042	1,748,057

Year	CO ₂ from peat microbial decomposition (t CO ₂ -e yr ⁻¹)	CH ₄ from peat microbial decomposition (t CO ₂ -e yr ⁻¹)	CO ₂ from peat burning (t CO ₂ -e yr ⁻¹)	CH ₄ from peat burning (t CO ₂ -e yr ⁻¹)	CO ₂ from DOC (t CO ₂ -e yr ⁻¹)	Total (t CO ₂ -e yr ⁻¹)
2035	1,412,756	3,041	260,417	24,916	2,042	1,703,173
2036	1,408,274	3,037	292,461	27,982	2,042	1,733,796
2037	1,400,980	3,030	275,838	26,392	2,042	1,708,282
2038	1,397,352	3,024	252,540	24,163	2,042	1,679,122
2039	1,393,037	3,017	281,238	26,909	2,042	1,706,243
2040	1,388,636	3,013	246,353	23,571	2,042	1,663,616
2041	1,384,777	3,009	260,720	24,945	2,042	1,675,493
2042	1,374,240	2,999	229,736	21,981	2,042	1,630,998
2043	1,367,824	2,993	199,541	19,092	2,042	1,591,492
2044	1,353,437	2,979	205,323	19,645	2,042	1,583,425
2045	1,348,443	2,974	203,865	19,506	2,042	1,576,829
2046	1,339,149	2,962	224,708	21,500	2,042	1,590,362
2047	1,324,958	2,946	176,979	16,933	2,042	1,523,857
2048	1,314,088	2,936	221,217	21,166	2,042	1,561,449
2049	1,299,202	2,918	186,110	17,807	2,042	1,508,080
2050	1,289,686	2,909	190,196	18,198	2,042	1,503,031
2051	1,274,453	2,880	159,736	15,283	2,042	1,454,395
2052	1,265,557	2,868	179,745	17,198	2,042	1,467,410
2053	1,260,362	2,845	188,499	18,035	2,042	1,471,782
2054	1,240,903	2,826	191,856	18,357	2,042	1,455,984
2055	1,227,516	2,813	148,908	14,247	2,042	1,395,526
2056	1,205,843	2,777	160,106	15,319	2,042	1,386,087
2057	1,198,679	2,762	141,966	13,583	2,042	1,359,032
2058	1,183,618	2,722	173,970	16,645	2,042	1,378,997
2059	1,162,689	2,703	175,158	16,759	2,042	1,359,351
2060	1,146,675	2,688	120,210	11,502	2,042	1,283,117
2061	1,137,848	2,680	133,649	12,787	2,042	1,289,006
2062	1,117,888	2,659	125,964	12,052	2,042	1,260,605
Total	55,518,478	175,923	12,527,442	1,198,613	90,380	69,510,836

3.2.1.5.3 Subsidence related to initial compression, microbial decomposition, and peat burning

We assume that the initial peat thickness in the baseline scenario is equal to the initial peat thickness as mapped at the project starting date (Sub-subsection 3.1.3.1.4).

We calculated peat loss due to initial compression and microbial decomposition by using the stratification of the project area on initial drainage, the year of conversion, and specific subsidence rates that took into account the compaction after initial drainage (See Annex 11 on Emission Factors). For the peat loss due to burning, we first assessed the number of times the individual pixels of the fire simulation burnt in the 10-year period before project start date and subsequently applied the associated burn scar depth (Annex 11 on Emission Factors). We quantified the annual peat loss rates in the baseline scenario as the sum of the burn scar depth (in area where peat burning was simulated to take place) and the subsidence rate, using the equation (14):

$$Rate_{peatloss-BSL,i,t} = D_{peatburn-BSL,i,t} + Sub_{i,t} \quad (14)$$

Where:

$Rate_{peatloss-BSL,i,t}$	Rate of peat loss due to microbial decomposition and burning in baseline scenario of stratum i at year t (m yr ⁻¹)
$D_{peatburn-BSL,i,t}$	Burn scar depth under baseline scenario in stratum i at year t (m)
$Sub_{i,t}$	Subsidence rate in stratum i in year t (m)
i	1, 2, 3, ... M_L strata in the baseline scenario (unitless)
t	1, 2, 3, ... t^* time elapsed since the project start (yr)

We assessed the remaining peat depth annually for the project period based on the rate of peat loss due to microbial decomposition of and burning incidents using the equation (15):

$$Depth_{peat-BSL,i,t^*} = Depth_{peat-BSL,i,t_0} - \sum_{t=1}^{t^*} Rate_{peatloss-BSL,i,t} \quad (15)$$

Where:

$Depth_{peat-BSL,i,t^*}$	Remaining peat thickness in the baseline scenario in stratum i at year t^* (m)
$Depth_{peat-BSL,i,t_0}$	Peat thickness at the baseline scenario in stratum i at year t_0 = project start date (initial peat thickness) (m)
$Rate_{peatloss-BSL,i,t}$	Rate of peat loss due (subsidence) due to microbial decomposition of peat and peat burning in the baseline scenario in stratum i in year t (m yr ⁻¹)
i	1, 2, 3, ... M_L strata in the baseline scenario (unitless)
t	1, 2, 3, ... t^* time elapsed since the project start (yr)

By tracking annual peat thickness in the baseline scenario, we assured that no GHG emissions have been accounted for within any parcel of each stratum once the available carbon stock in peat has been depleted.

3.2.1.5.4 Emissions from microbial decomposition

We assumed that the annual rate of conversion of undrained to drained peatland in the baseline scenario was based on the rate of conversion/deforestation agents as described in Subsection 3.2.1.2 and Annex 9

(7.85% a year). The temporal variability of the emissions from peat microbial decomposition are directly related to land-use and drainage changes in the baseline scenario.

Table 31 below provide details on the WRC-related baseline stratification per stratum.

Table 31. The stratification used for the calculation of GHG emissions per stratum, the area (ha) per each stratum and the CO₂ and CH₄ default factors used for the specific land-use

Strata	Description	Area (ha)	IPCC default factor for CO ₂ (t CO ₂ -e ha ⁻¹ yr ⁻¹)	IPCC default factor for CH ₄ (t CO ₂ -e ha ⁻¹ yr ⁻¹)	IPCC default factor for ΔDOC (t CO ₂ -e ha ⁻¹ yr ⁻¹)
Initial					
IN-UPSF	Undrained Dense Peatland Forest	234.08	0	1.02	
IN-UDP	Undrained Deforested Peatland	15205.17	5.5	0.66	
IN-DPSF	Drained Dense Peatland Forest	20.26	19.43	0.12	
IN-DDP	Drained Deforested Peatland	7393.59	19.43	0.12	
IN-WB	Water bodies (river and canals) present at project start	69.30			2.09
After conversion					
DS-AC	Acacia on drained peatland	19,915.65	73.33	0.07	
DS-CAU	Conservation area on undrained peatland	1,652.10	0	1.02	
DS-CAD	Conservation area on drained peatland	643.04	19.43	0.12	
DS-GF	Ground facilities on drained peatland	4.09	19.43	0.12	
DS-WB	Water bodies (river and canals)	707.51			3.01
Note: Annex 11 on Default Factors for Quantification of GHG emissions in the baseline and project scenarios provides more details on the emission factors used and the respective references.					

We calculated baseline GHG emissions for different emission strata by using the conservative TIER 1 IPCC default emission factors for each stratum, following the equations defined by the Module BL-PEAT (16):

$$E_{peatsoil-BSL,i,t} = E_{CO_2-BSL,i,t} + E_{CH_4-BSL,i,t} \quad (16)$$

Where:

$E_{CO_2-BSL,i,t}$	CO ₂ emissions from the peat soil within the project boundary in the baseline scenario in stratum i at year t (t CO ₂ -e yr ⁻¹)
$E_{CH_4-BSL,i,t}$	CH ₄ emissions from the peat soil within the project boundary in the baseline scenario in stratum i at year t (t CO ₂ -e yr ⁻¹)
i	1, 2, 3, ... M_{BSL} strata in the baseline scenario (unitless)
t	1, 2, 3, ... t^* time elapsed since the project start (yr)

We calculated the CO₂ emissions from microbial decomposition for each stratum of the peat within the SMPP using the equation (17):

$$E_{peatsoil-BSL,CO_2,i,t} = A_{i,t} \times EF_{CO_2,i,t} \quad (17)$$

Where:

$E_{peatsoil-BSL,CO_2,i,t}$	CO ₂ emissions from the peat soil within the project boundary in the baseline scenario in stratum i at year t (t CO ₂ -e yr ⁻¹)
$EF_{CO_2,i,t}$	Emission factor for CO ₂ emissions corresponds to each stratum i , as provided by IPCC (t CO ₂ -e yr ⁻¹)
$A_{i,t}$	Area of stratum i at time t (ha)
i	1, 2, 3, ... M_{BSL} strata in the baseline scenario (unitless)
t	1, 2, 3, ... t^* time elapsed since the project start (yr)

We calculated the CH₄ emissions from the peat soil for each stratum of the peat within the SMPP using the equation (18):

$$E_{peatsoil-BSL,CH_4,i,t} = A_{i,t} \times GWP_{CH_4} \times EF_{CH_4,i,t} \quad (18)$$

Where:

$E_{peatsoil-BSL,CH_4,i,t}$	CH ₄ emissions from the peat soil within the project boundary in the baseline scenario in stratum i at year t (t CO ₂ -e yr ⁻¹)
$EF_{CH_4,i,t}$	Emission factor for CH ₄ emissions corresponds to each stratum i , as provided by IPCC (t CO ₂ -e ha ⁻¹ yr ⁻¹)
$A_{i,t}$	Area of stratum i at time t (ha)

GWP_{CH_4}

 Global Warming Potential for CH₄
i

 1, 2, 3, ... M_{BSL} strata in the baseline scenario (unitless)

t

 1, 2, 3, ... t^* time elapsed since the project start (yr)

The annual GHG emissions from microbial decomposition in the baseline scenario are shown below in Table 32.

Table 32. GHG emissions from microbial decomposition of peat in the baseline scenario.

Year	CO ₂ from peat microbial decomposition (t CO ₂ -e ha ⁻¹ yr ⁻¹)	CH ₄ from peat microbial decomposition (t CO ₂ -e ha ⁻¹ yr ⁻¹)	Total (t CO ₂ -e ha ⁻¹ yr ⁻¹)
2016	202,975	9,597	212,572
2017	295,154	8,624	303,778
2018	391,718	7,676	399,393
2019	495,247	6,923	502,170
2020	599,638	6,488	606,126
2021	707,391	6,041	713,432
2022	822,665	5,983	828,648
2023	936,656	5,308	941,964
2024	1,050,043	4,622	1,054,665
2025	1,160,467	4,364	1,164,831
2026	1,270,260	4,190	1,274,450
2027	1,369,672	3,690	1,373,362
2028	1,442,974	3,074	1,446,049
2029	1,437,623	3,069	1,440,692
2030	1,432,329	3,063	1,435,393
2031	1,428,965	3,059	1,432,024
2032	1,420,661	3,051	1,423,712
2033	1,418,927	3,047	1,421,974
2034	1,416,243	3,044	1,419,288
2035	1,412,756	3,041	1,415,797
2036	1,408,274	3,037	1,411,311
2037	1,400,980	3,030	1,404,010
2038	1,397,352	3,024	1,400,376
2039	1,393,037	3,017	1,396,054
2040	1,388,636	3,013	1,391,649
2041	1,384,777	3,009	1,387,787
2042	1,374,240	2,999	1,377,239

Year	CO ₂ from peat microbial decomposition (t CO ₂ -e ha ⁻¹ yr ⁻¹)	CH ₄ from peat microbial decomposition (t CO ₂ -e ha ⁻¹ yr ⁻¹)	Total (t CO ₂ -e ha ⁻¹ yr ⁻¹)
2043	1,367,824	2,993	1,370,817
2044	1,353,437	2,979	1,356,415
2045	1,348,443	2,974	1,351,417
2046	1,339,149	2,962	1,342,111
2047	1,324,958	2,946	1,327,904
2048	1,314,088	2,936	1,317,024
2049	1,299,202	2,918	1,302,120
2050	1,289,686	2,909	1,292,595
2051	1,274,453	2,880	1,277,333
2052	1,265,557	2,868	1,268,424
2053	1,260,362	2,845	1,263,207
2054	1,240,903	2,826	1,243,729
2055	1,227,516	2,813	1,230,329
2056	1,205,843	2,777	1,208,620
2057	1,198,679	2,762	1,201,440
2058	1,183,618	2,722	1,186,340
2059	1,162,689	2,703	1,165,391
2060	1,146,675	2,688	1,149,363
2061	1,137,848	2,680	1,140,528
2062	1,117,888	2,659	1,120,546
Total	55,518,478	175,923	55,694,401

3.2.1.5.5 Emissions from peat burning

According to Module E-BPB, GHG emissions from biomass burning can result from:

1. Conversion of forest land to non-forest land using fire;
2. Periodic burning of grassland or agricultural land after deforestation;
3. Controlled burning in forest land remaining forest land;
4. Uncontrolled fire in drained peat swamp forest; and
5. Uncontrolled peat burning in (abandoned) drained peat sites.

We assumed that there was no controlled peat burning during plantation activities, as burning to clear forests on Acacia plantations is illegal. Therefore, we only accounted for emissions from unintentional or uncontrolled burnings in the baseline scenario. In addition, we omitted AGB lost by combustion.

To quantify GHG emissions from uncontrolled peat burnings, we followed procedures from the VCS methodology VM0007 Module E-BPB with the following equation (19):

$$E_{peatburn-BSL,i,t} = \sum_{g=1}^G \left((A_{peatburn-BSL,i,t} \times P_{BSL,i,t} \times P_{BSL,g,i}) \times 10^{-3} \right) \times GWP_g \quad (19)$$

Where:

$E_{peatburn-BSL,i,t}$	Greenhouse emissions due to peat burning under baseline scenario in stratum i in year t of each GHG (CO ₂ , CH ₄) (t CO ₂ -e)
$A_{peatburn-BSL,i,t}$	Area peat burnt under baseline scenario in stratum i in year t (ha)
$P_{BSL,i,t}$	Average mass of peat burnt (dry matter or DM) under baseline scenario in stratum i , year t (t DM ha ⁻¹)
$G_{g,i}$	Emission factor in stratum i for gas g (kg t ⁻¹ DM burnt)
GWP_g	Global warming potential for gas g (t CO ₂ t ⁻¹ g ⁻¹)
g	1, 2, 3, ... G greenhouse gases including carbon dioxide, methane, and nitrous oxide (unitless)
i	1, 2, 3, ... M strata (unitless)
t	1, 2, 3, ... t time elapsed since the start of the project activity (year)

For repeated burns, scar depths of the 1st, 2nd, 3rd and 4th/subsequent burnings are assumed as 0.17 cm, 0.1 cm, 0.06 cm, and 0.02 cm, respectively. Detailed parameters for quantifying GHG emissions from uncontrolled burning are available in Annex 11. We estimated the average mass of peat burnt for a particular stratum using the equation (20):

$$P_{BSL,i,t} = D_{peatburn-BSL,i,t} \times BD_{upper} \times 10^{-4} \quad (20)$$

Where:

$P_{BSL,i,t}$	Average mass of peat burnt under baseline scenario in stratum i , year t (t DM ha ⁻¹)
$D_{peatburn-BSL,i,t}$	Average burn scar depth under baseline scenario in stratum i in year t (m)
$BD_{upper,i}$	Bulk density of the upper peat in stratum i (g cm ⁻³)
i	1, 2, 3, ... M strata
t	1, 2, 3, ... t time elapsed since the start of the project activity (years)

Emissions from peat burning in the baseline are derived from the mass of peat lost by combustion and emission factors from scientific literature (see Annex 11 for the default values used for the calculations of baseline carbon losses and emissions from burning).

For fire emissions, we assumed that the likelihood of random, uncontrolled or repeated peatland burnings would be higher in areas with greater probability of fire risks. To identify areas of greater fire risk in the baseline of the project area, we performed spatially explicit habitat suitability modeling to examine the distribution of fire probability.

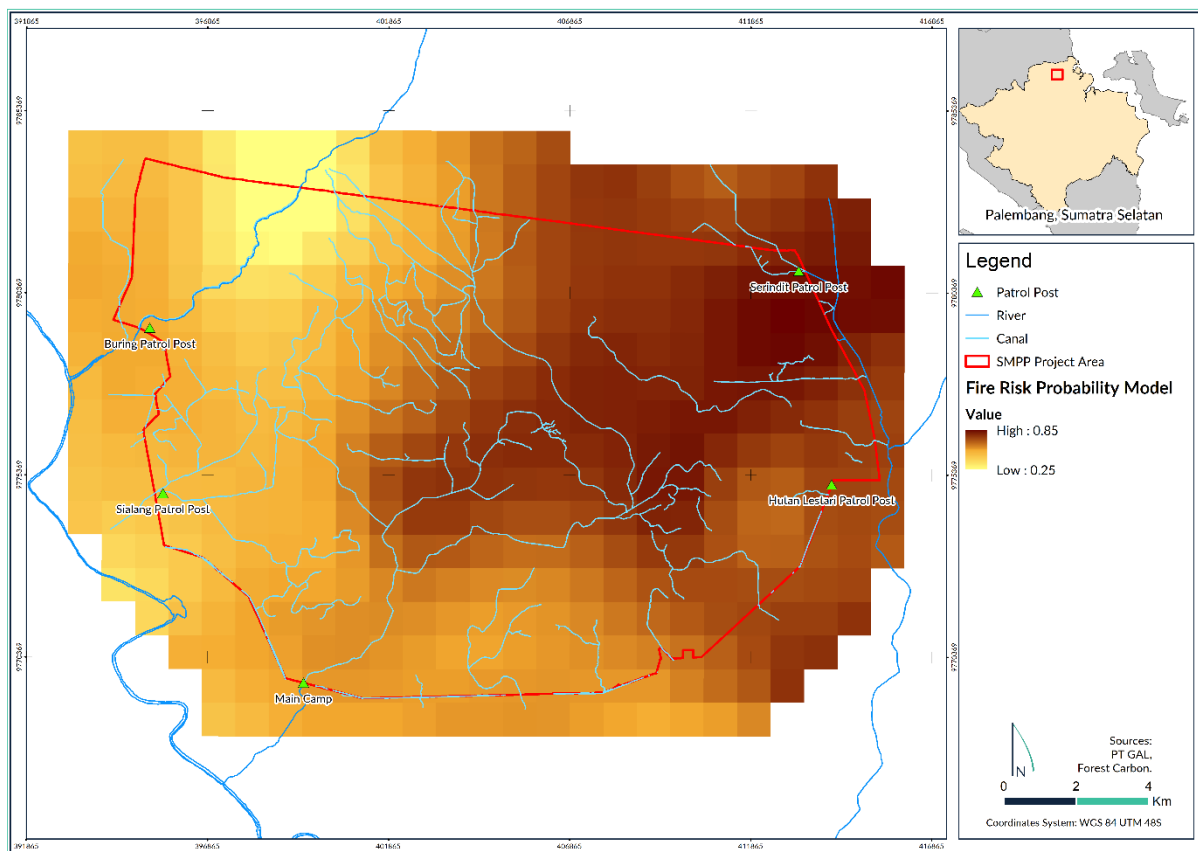
Previous fire probability models showed that in general, higher fire likelihood is related to predictor variables of human development activities, climate, topography, vegetation and ignition. In particular, human population, distance to roads, bioclimate, annual precipitation, elevation, slope, and land cover types

associated with agricultural activities had the greatest model contribution and are the strongest predictors of fire occurrence probability. Many models of fire risk used historical fire detection data derived from satellite imagery products to calibrate. For our study purpose of aligning period of fire risk probability modeling and burn scar area calculation (for estimating average burn area per year), we decided to use remote sensing data of 10 years prior to project start (2006-2015).

The initial input data included point locations and 31 environmental variables, including NASA MODIS and VIIRS 2006-2015 hotspots, WorldClim bioclimatic variables, NASA SRTM elevation and derived slope and aspect, LandScan population count, distance to road, distance to river, and land cover change produced by the Ministry of Environment and Forestry for 2006-2015. Land cover type, precipitation and seasonality, population, and distance to roads were the most important contributing variables to the final model.

We document detailed fire risk probability data compilation, model inputs preparation, iterative modeling process, model evaluation and final model result in Annex 12.

Map 28. Fire occurrence suitability that predicted risk probability.



We then calculated annual percentage of burn rate in the study area for 2006-2015, by using historical MODIS and VIIRS hotspot data. We assumed each hotspot occurrence with a conservative burn area estimate or estimate coefficient based on literature values. The calculation produced the average 6.12% of burnt area (1,402.85 ha) per year. This value was used as a parameter in estimating the annual area burnt threshold in the baseline scenario.

We assumed that uncontrolled burnings in peatlands repeat randomly on places that are 'high risk' areas. To determine where the 'high risk areas' are in the baseline of the project area, we used the fire occurrence risk probability model as well as the average annual burnt area estimate above, to simulate the spatial

position of burning for 100 years. This simulation did not show the “actual area burnt” in the baseline scenario, rather showing possible locations where peat burning can be expected to occur randomly.

The location of possible burnt area in each year of the baseline scenario was simulated as using the probable areas of fire risk from the model as weight, by randomly selecting parcels annually over 100 years in such a way that the annual average area of the selected parcels approximately equaled (but did not exceed) the area of average annual burnt. Parcels that had higher fire risk probability had greater chance to be randomly selected in the simulation model.

We examined the hotspot history based on MODIS and VIIRS data from year 2006-2015 to document the number of times when a selected parcel was burnt. We then examined the 100-year fire simulation of burn frequency and combined with the 2006-2015 data to record the overall history/projection of burning. If a parcel had no hotspot record in 2006-2015 and was selected randomly in the first time of simulation, the parcel was marked as “catching the 1st burning”. If it had a hotspot record and was randomly selected once over the 100 years, it was marked as “catching the 2nd burning”, and so forth.

The detailed methodologies, justifications and calculations of annual burnt area and 100-year fire simulations can be found in Annex 13.

The peat burning baseline will be re-assessed every 10 years based on observations of burning frequency and extent in reference region and/or based on the latest scientific findings of ‘repeated burnings’ pattern.

The total GHG emission from uncontrolled peat burning in the baseline scenario per stratum are shown in Table 33 below, and annual emissions and total emission per stratum are shown in Table 34.

Table 33. Total GHG emissions from uncontrolled peat burning in the baseline scenario per stratum.

Strata	Description	Total area burnt in 47 years (ha)	Average area burnt in 47 years (ha yr ⁻¹)	GHG emissions from peat burning in 47 years (t CO ₂ -e)
IN-UPSF/ DS-CAU	Dense Forest (undrained)	4,452.67	94.74	987,616.95
IN-UDP	Deforested peatland (undrained)	3,843.03	81.77	1,317,926.07
IN-DPSF	Dense Forest (drained)	1,469.91	31.27	372,504.59
IN-DDP	Deforested peatland (drained)	3,543.25	75.39	1,218,815.39
DS-AC	Acacia (drained peatland)	46,379.22	986.79	9,485,852.53
DS-GF	Ground facilities (drained peatland)	7.75	0.16	4,054.76
WB	Water bodies (river and canals)	1,542.82	32.83	339,286.68
Total		61,238.64	1,302.95	13,726,056.96

Table 34. Annual GHG emissions from uncontrolled peat burning in the baseline scenario in t CO₂-e yr⁻¹.

Year	CO ₂ from peat burning (t CO ₂ -e ha ⁻¹ yr ⁻¹)	CH ₄ from peat burning (t CO ₂ -e ha ⁻¹ yr ⁻¹)	Total
2016	461,630	44,168	505,798
2017	472,764	45,234	517,998
2018	455,458	43,578	499,036
2019	383,685	36,711	420,396
2020	436,408	41,755	478,163
2021	397,247	38,008	435,255
2022	409,758	39,205	448,963
2023	402,033	38,466	440,499
2024	302,552	28,948	331,500
2025	346,323	33,136	379,459
2026	388,024	37,126	425,150
2027	350,904	33,574	384,478
2028	332,007	31,766	363,773
2029	306,300	29,306	335,606
2030	322,657	30,872	353,529
2031	287,278	27,486	314,764
2032	311,792	29,832	341,624
2033	255,421	24,438	279,859
2034	298,196	28,531	326,727
2035	260,417	24,916	285,333
2036	292,461	27,982	320,443
2037	275,838	26,392	302,230
2038	252,540	24,163	276,703
2039	281,238	26,909	308,147
2040	246,353	23,571	269,924
2041	260,720	24,945	285,665
2042	229,736	21,981	251,717
2043	199,541	19,092	218,633
2044	205,323	19,645	224,968
2045	203,865	19,506	223,371
2046	224,708	21,500	246,208
2047	176,979	16,933	193,912
2048	221,217	21,166	242,383

Year	CO ₂ from peat burning (t CO ₂ -e ha ⁻¹ yr ⁻¹)	CH ₄ from peat burning (t CO ₂ -e ha ⁻¹ yr ⁻¹)	Total
2049	186,110	17,807	203,917
2050	190,196	18,198	208,394
2051	159,736	15,283	175,019
2052	179,745	17,198	196,943
2053	188,499	18,035	206,534
2054	191,856	18,357	210,213
2055	148,908	14,247	163,155
2056	160,106	15,319	175,425
2057	141,966	13,583	155,549
2058	173,970	16,645	190,615
2059	175,158	16,759	191,917
2060	120,210	11,502	131,712
2061	133,649	12,787	146,436
2062	125,964	12,052	138,016
Total	12,527,442	1,198,613	13,726,055

3.2.1.5.6 Emissions from water bodies

The only type of open water bodies present in the baseline scenario are river and drainage canals, as we assumed that the baseline agent would not create ponds and/or lakes. The area of river and canals in the baseline scenario was determined based on common practice observed in the adjacent Acacia concessions, as well as direct measurements from high-resolution satellite imagery. The water bodies were temporally and spatially stratified, as set out in Section 3.2.1.4. In short, primary canals were set as existing canals before new conversion, whereas secondary and tertiary canals were to be constructed when new canals appeared starting in Year 1 and when converting an area into a planting zone, respectively. IPCC does not provide default emission factors for CO₂ and CH₄ emissions from water bodies, thus we used the default values for dissolved organic carbon (Δ DOC) (for detail see Annex 11).

The only natural river in the project area is the Buring river, hence in the baseline this is the only WB area, on which the default value for natural water bodies is applied (0.57 t C ha⁻¹ yr⁻¹). For all other water bodies, i.e. canals, the default values for drained peatland (0.82 t C ha⁻¹ yr⁻¹) was applied.

We used the approach as set out in the VCS methodology VM0007 Module BL-PEAT (equation 21), and replaced $E_{peatditch-CO_2,i,t} + E_{peatditch-CH_4,i,t}$ with into CO₂-equivalents converted DOC emission default factors:

$$E_{peatditch-BSL,i,t} = A_{ditch-BSL,i,t} \times EF_{DOC-BSL,i} \quad (21)$$

Where:

$E_{peatditch-BSL,i,t}$	GHG emissions from canals and other open water stratum i at year t in the baseline scenario (t CO ₂ -e ha ⁻¹ yr ⁻¹)
$A_{ditch-BSL,i,t}$	Total area of canals and other open water stratum i at year t in the baseline scenario (ha)
$EF_{DOC-BSL,i}$	PCC emission factor for Dissolved Organic Carbon from canal and open in the baseline scenario in stratum i (t CO ₂ -e ha ⁻¹ yr ⁻¹)

i 1, 2, 3, ...*M* strata

t 1, 2, 3, ...*t* time elapsed since the start of the project activity (years)

Annual GHG emissions from Dissolved Organic Carbon in water bodies in baseline scenario are shown in Table 35.

Table 35. GHG emissions from Dissolved Organic Carbon in water bodies in the baseline scenario.

Year	CO ₂ from DOC (t CO ₂ -e ha ⁻¹ yr ⁻¹)
2016	587
2017	916
2018	1,224
2019	1,597
2020	1,644
2021	1,692
2022	1,747
2023	1,801
2024	1,858
2025	1,899
2026	1,945
2027	1,994
2028	2,042
2029	2,042
2030	2,042
2031	2,042
2032	2,042
2033	2,042
2034	2,042
2035	2,042
2036	2,042
2037	2,042
2038	2,042
2039	2,042
2040	2,042
2041	2,042
2042	2,042
2043	2,042
2044	2,042
2045	2,042

Year	CO ₂ from DOC (t CO ₂ -e ha ⁻¹ yr ⁻¹)
2046	2,042
2047	2,042
2048	2,042
2049	2,042
2050	2,042
2051	2,042
2052	2,042
2053	2,042
2054	2,042
2055	2,042
2056	2,042
2057	2,042
2058	2,042
2059	2,042
2060	2,042
2061	2,042
2062	2,042
Total	90,380

3.2.1.6 Baseline emissions from ARR activities

Under the baseline scenario, the area designated for Acacia plantation, would sequester carbon in trees through growth (emission removals) and release it again after harvesting. We accounted for the growth of Acacia as baseline ARR activities. As detailed in Sub-subsection 3.2.1.3 the conversion and thus planting of Acacia would be carried out sequentially during the first 13 years of the project, resulting in a total planted area of 19,915.65 ha. We assumed a rotation cycle of 4 years. The annual area changes under the baseline scenario are detailed in Annex 10, and summarized in Table 36 below.

Table 36. The assumed annual planting and harvesting under ARR activities within the project period.

Year	Planting	Harvesting
2016	1,569.10	-
2017	1,505.38	-
2018	1,464.87	-
2019	3,092.11	1,569.10
2020	3,028.80	1,505.38
2021	3,034.54	1,464.87
2022	4,697.28	3,092.11
2023	4,608.13	3,028.80
2024	4,648.69	3,034.54

Year	Planting	Harvesting
2025	6,311.05	4,697.28
2026	6,189.40	4,608.13
2027	6,189.77	4,648.69
2028	7,536.48	6,311.05
2029	6,189.40	6,189.40
2030	6,189.77	6,189.77
2031	7,536.48	7,536.48
2032	6,189.40	6,189.40
2033	6,189.77	6,189.77
2034	7,536.48	7,536.48
2035	6,189.40	6,189.40
2036	6,189.77	6,189.77
2037	7,536.48	7,536.48
2038	6,189.40	6,189.40
2039	6,189.77	6,189.77
2040	7,536.48	7,536.48
2041	6,189.40	6,189.40
2042	6,189.77	6,189.77
2043	7,536.48	7,536.48
2044	6,189.40	6,189.40
2045	6,189.77	6,189.77
2046	7,536.48	7,536.48
2047	6,189.40	6,189.40
2048	6,189.77	6,189.77
2049	7,536.48	7,536.48
2050	6,189.40	6,189.40
2051	6,189.77	6,189.77
2052	7,536.48	7,536.48
2053	6,189.40	6,189.40
2054	6,189.77	6,189.77
2055	7,536.48	7,536.48
2056	6,189.40	6,189.40
2057	6,189.77	6,189.77
2058	7,536.48	7,536.48
2059	6,189.40	6,189.40

Year	Planting	Harvesting
2060	6,189.77	6,189.77
2061	7,536.48	7,536.48
2062	6,189.40	6,189.40

Net GHG emissions and removal in the baseline ARR scenario were estimated using the procedure provided in AR-ACM0003 Afforestation and reforestation lands except wetlands and associated pool,⁵² as outlined in Module BL-ARR, using the equation (22):

$$\Delta C_{BSL-ARR} = \sum_{t=1}^{t^*} (\Delta C_{BSL,t,ACM003}) \quad (22)$$

Where:

$\Delta C_{BSL-ARR}$ Net GHG removals under the ARR baseline scenario up to time t (t CO₂-e)

$\Delta C_{BSL,t,ACM003}$ Baseline net GHG removal by sinks in year t (from AR-ACM0003) (t CO₂-e)

$EF_{DOC-BSL,i}$ IPCC emission factor for Dissolved Organic Carbon from canal and open in the baseline scenario in stratum i (t CO₂-e ha⁻¹ yr⁻¹)

t 1, 2, 3, ... t^* time elapsed since the start of the project activity (years)

Net GHG removals under the ARR baseline scenario within the project period are estimated to be 978,846 t CO₂-e. Annual GHG removals and emissions under ARR are shown in Table 37 below. Details on calculations are provided in Annex 6.

Table 37. Baseline net GHG removal from ARR activities in project area within project period.

Year	NET GHG removal from ARR (t CO ₂ -e yr ⁻¹)
2016	30,475
2017	59,712
2018	88,163
2019	117,743
2020	25,430
2021	60,867
2022	95,190
2023	121,347
2024	30,764
2025	63,464
2026	94,565
2027	121,988
2028	21,149

Year	NET GHG removal from ARR (t CO ₂ -e yr ⁻¹)
2029	22,537
2030	25,451
2031	26,064
2032	(74,052)
2033	22,537
2034	25,451
2035	26,064
2036	(74,052)
2037	22,537
2038	25,451
2039	26,064
2040	(74,052)
2041	22,537
2042	25,451
2043	26,064
2044	(74,052)
2045	22,537
2046	25,451
2047	26,064
2048	(74,052)
2049	22,537
2050	25,451
2051	26,064
2052	(74,052)
2053	22,537
2054	25,451
2055	26,064
2056	(74,052)
2057	22,537
2058	25,451
2059	26,064
2060	(74,052)
2061	22,537
2062	25,451
Total	978,846

3.2.1.7 Significant sources of baseline emissions

We have determined that all sources of carbon not included in the baseline or project scenarios can be conservatively excluded. Significance tests were not necessary as all of the required pools of carbon and other GHG emissions within the SMPP have already been included in our calculations.

3.2.2 Project Emissions

To determine project scenario emissions and changes in carbon stocks within the SMPP from a combination of field-based data, proxy analyses, and default emissions factors from the IPCC.⁵³

We accounted emissions in the project scenario from:

1. Aboveground biomass (AGB) stock changes due to ARR activities (from 2019 as this is the first year the project will conduct an AGB inventory);
2. Peat microbial decomposition; and
3. Water table level changes due to WRC activities.

Our project activities specifically related to climate are described in Section 2.1.11 and include rewetting drained peatland areas, conservation of existing natural peat areas, natural regeneration of vegetation, and fire control measures with a target of zero burning in the SMPP.

We have operated consistent fire patrols since the start of the SMPP, and we also have an online satellite-based early warning system (EWS) in place to detect possible fires as quickly as possible. Our project activities will also consist of fire prevention trainings and as a result of the project there will be a reduction of human activity in the project area. If any uncontrolled burning does occur in the SMPP during the project period, we have extensive fire monitoring plans in place, and we will adjust our calculations to account for these emissions.

We also plan to construct compacted peat dams over all the existing canals throughout the SMPP area, so we assumed there will not be any non-human induced rewetting in the project scenario.

3.2.2.1 Emission characteristics stratification for WRC activities under the project scenario

For the project scenario, we stratified the project area based on two land cover classes (forest and non-forest), two drainage statuses (drained and undrained) and one water body class. through a spatially explicit delineation process. A project scenario map is provided in

Map 29. The mapping process involved the following steps:

1. Delineation of water bodies:
 - a. Delineation of natural water bodies present at the project start (i.e. natural river such as Buring river). The natural water body stratum does not change for the entire project period.
 - b. Delineation of secondary and tertiary canals that existed prior to the project start and do not change for the entire project period. The widths of canals were based on observations from the field and Google Earth high-resolution imagery of the project area.
2. Delineation of drained/undrained areas:
 - a. Following the literature studies of canal proximity impact on peatland (as discussed in Section 3.2.1.3), we employed a conservative approach to assume that areas within a 300-m distance from secondary canals and 150-m distance from tertiary canals would be drained.
 - b. We created a 300-m and 150-m buffer around both sides of the secondary and tertiary canals, respectively, to account for peatland drained at the project start date. The

distinction between drained and undrained areas at project start date was taken into account for emission characteristics and calculation.

3. Delineation of forested area:

- a. Delineation of dense forest at the project start date was based on the land cover classification summarized in Section 3.1.3.1.1 and detailed in Annex 3.

4. Annual status change:

- a. As described in Section 2.1.11 and detailed in Annex 8, the project plans to construct and implement dense compacted peat dams over canals across the project area in 2019. Based on the planned canal blocking locations recommended by EMM and other biophysical parameters, we constructed hydrological models of water table level at the project start date, and annually until the predicted water table level reached saturation (see details in Annex 7).

For areas delineated as “drained” or “undrained” at project start date (see above), we defined annual rewetting efficacy by calculating the ratio of each year’s water table level increase from the initial water table level over the maximum of total water table level increase as a proxy. This ratio served as basis to adjust emission factors. The hydrological models estimated that maximum water table level was reached in the fifth year since rewetting. Therefore, we predicted all “drained” areas would become “undrained” after this. Table 38 and Map 29 below show stratification of the project area based on emission characteristics. Table 39 lists dynamics in strata.

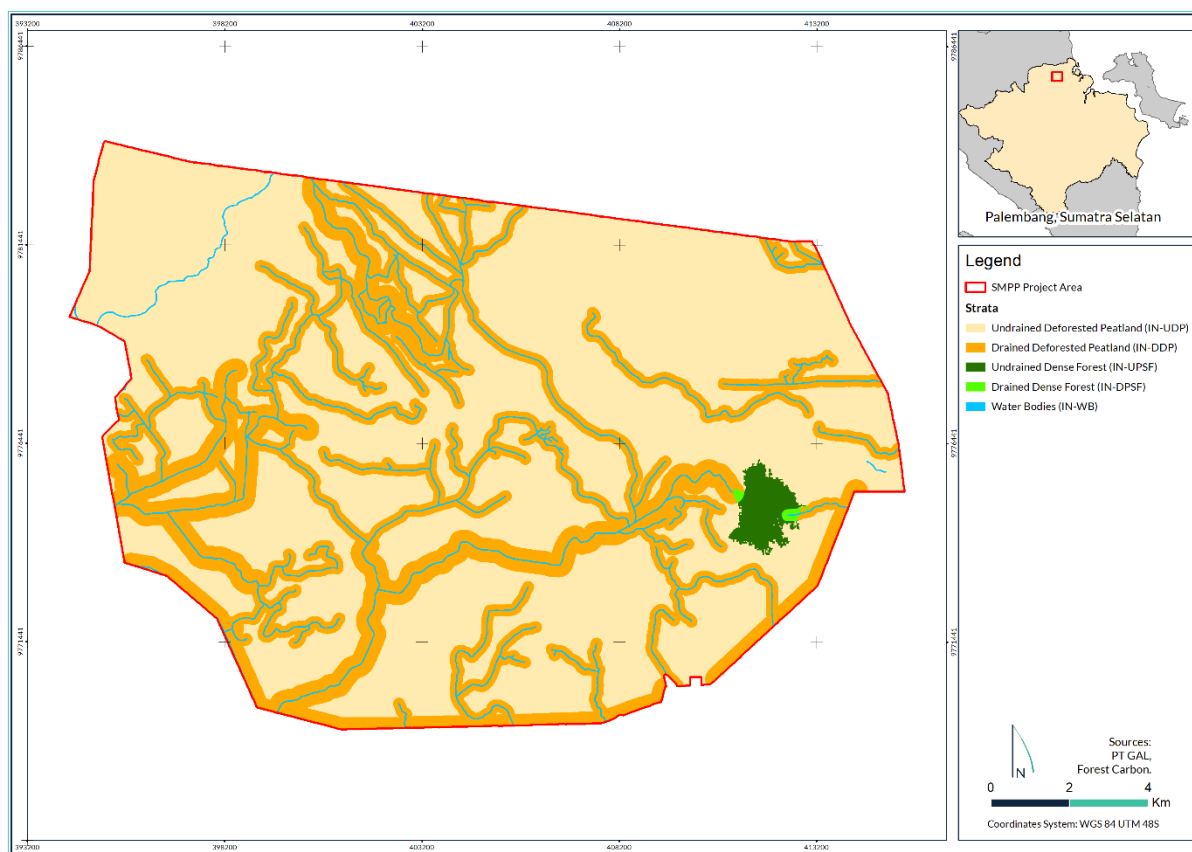
Table 38. Stratification of project area based on emission characteristics from peat and water bodies at project start date.

Strata	Type	Description	Area (ha)	Percentage of project area
IN-UDP	Undrained Deforested Peatland	Mostly open canopy tree/shrub/herb mix and closed canopy tree/shrub/herb mix on undrained peatland	15,205.17	66.33
IN-DDP	Drained Deforested Peatland	Mostly open canopy tree/shrub/herb mix and closed canopy tree/shrub/herb mix on drained peatland	7,393.59	32.25
IN-UPSF	Undrained Dense Forest	Intact dense peatland forest on undrained peatland	234.08	1.02
IN-DPSF	Drained Dense Forest	Intact dense peatland forest on drained peatland	20.26	0.09
IN-WB	Water Bodies	Rivers and secondary or tertiary canals that existed before project start date	69.30	0.30
Total			22,922.39	100.00

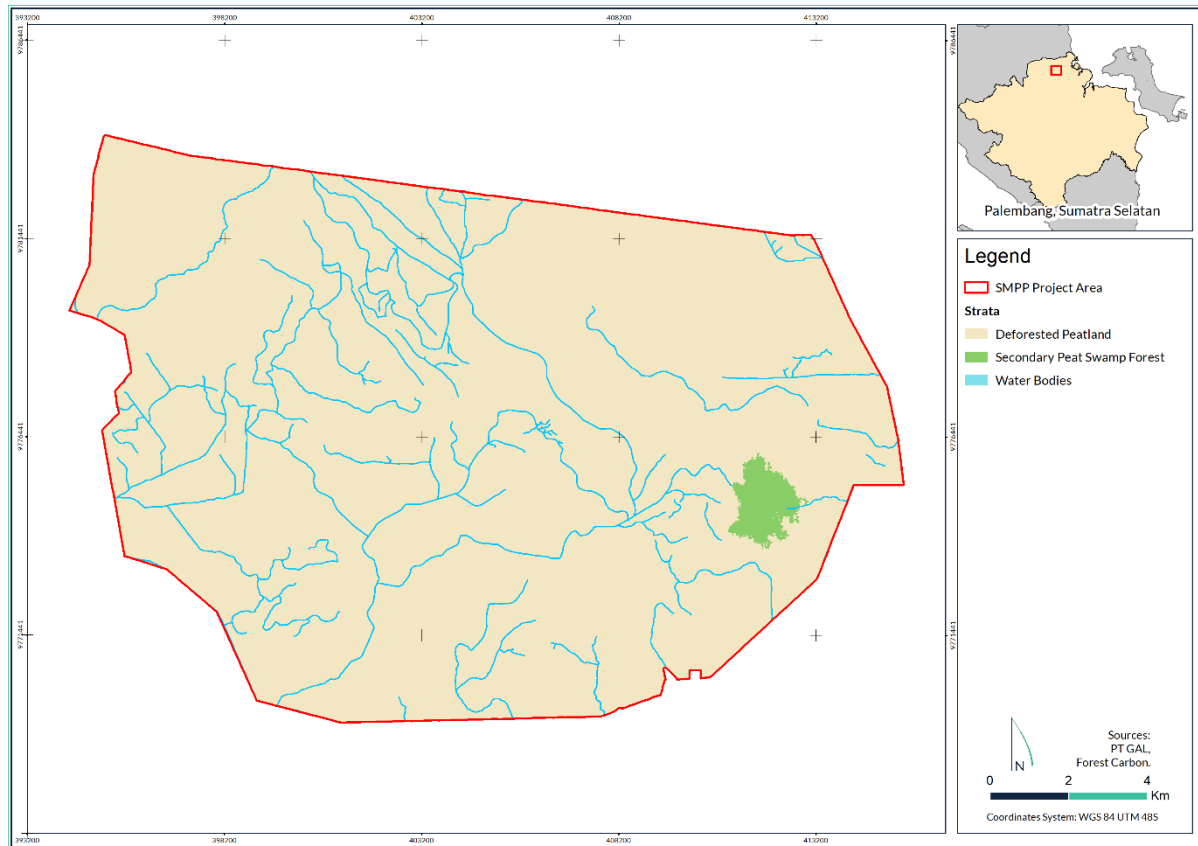
Table 39. Changes in strata based on emission characteristics from peat and water bodies in the project scenario.

Strata transition	Description	Area (ha)	Activity description
IN-DDP → PS-UDP	Deforested peatland (drained) to Deforested peatland (undrained)	7,393.59	Rewetting from canal blocking activities will be effective from 2019 onwards.
IN-DPSF → PS-UPSF	Dense Forest (drained) to Dense Forest (undrained)	20.26	
IN-UDP → PS-UDP	Deforested peatland (undrained) to Deforested peatland (undrained)	15,205.17	Various project activities will facilitate natural regeneration from non-forest vegetation to forest.
IN-UPSF → PS-UPSF	Dense Forest (undrained) to Dense Forest (undrained)	234.08	
IN-WB → PS-WB	Water bodies to water bodies	69.30	

Map 29. Initial stratification based on emission characteristics for WRC.



Map 30. Strata changes in the project scenario.



We will collect site-specific hydrological monitoring data to predict spatially and temporally explicit estimates of water table level and flow under the project scenario. Sufficient direct measurements from the field will serve as a proxy to calculate GHG emissions. Rewetting efficacy may change for the strata with the most dynamic water table levels (rewetted strata drained at project start date). The hydrological monitoring plan is detailed in Annex 7.

Together, land cover stratification based on updated land cover classification and change detection from remote sensing imagery and site-specific emission proxies will be used to re-stratify non-forest, if any changes occur. Strata with less dynamic water table levels (undrained forest stratum at project start date) will not be re-stratified (unless significant changes in emission characteristics are observed) and GHG quantification method remains unchanged.

3.2.2.2 Emission characteristics stratification for ARR activities under the project scenario

Although the project activities will include reforestation (nursery and replanting, see Section 2.1.11), for delineating ARR emission characteristics we only accounted for natural regeneration of vegetation. The eligible area for ARR crediting is all the non-forest areas where the project activities would carry out activities to facilitate natural regeneration of vegetation, including rewetting, fire avoidance, etc. Based on the spatial analysis, the area eligible for crediting from ARR activities is 20,601.37 ha, as shown in Section 3.1.3.1.7.

3.2.2.3 Emissions from peat and water bodies (WRC)

The 2016 land cover classification (detailed in Annex 3) and water body data collected by PT GAL served as a basis for developing strata for WRC activities (see Table 38).

The strata for the project scenario analysis include:

1. Drained forested peatland;
2. Undrained forested peatland;
3. Drained non-forested peatland;
4. Undrained non-forested peatland; and
5. Water bodies.

We then quantified the GHG emissions from microbial decomposition of peat and DOC loss through water bodies in peatlands on spatial and temporal scales.

3.2.2.3.1 Spatial and temporal variability

Each stratum in the project scenario are outlined in Table 38. Temporal variability in project emissions was based on annual time steps. Table 40 outlines the variables that determined strata changes, temporal variability of GHG emission factors, and restrictions to GHG emissions. We accounted for spatial and temporal scales with our GHG emission factors.

Table 40. Variables used in the schematization of quantification of GHG emissions from microbial decomposition of peat and dissolved organic carbon from water bodies in peatlands in the project scenario.

Variables	Description
(A) Spatial Variables	
(A1) Soil Type	Distinction between peat or non-peat. This was used to exclude all non-peat parcels from GHG calculation. 99.99% of the project area has predicted peat depth ≥ 50 cm.
(A2) Initial peat thickness available for microbial decomposition and burnings	Derived from DEM, DEL and Peat Thickness maps as described in Sub-subsection 3.1.3.1.4. These maps were used to determine the initial condition for subsequent calculations of the remaining peat layer available for microbial decomposition.
(A3) Initial stratum	Stratum of the corresponding parcel at the project start date (as derived in Annex 10) before change into rewetted stratum takes effect. This was used to determine the correct emission factor for the corresponding parcel for the duration before B1 and B2 (in this table, below) take effect.
(B) Temporal Variables	
(B1) Year of rewetting	Determines the onset of conversion from initial stratum to rewetted stratum and sets the drainage related parameter, i.e. emission factor for the corresponding parcel.
(B2) PDT	The PDT is the period of time that it takes to deplete the remaining peat layer by microbial decomposition. Once the PDT is reached in a given stratum all GHG emissions in that stratum are set to zero.

3.2.2.3.2 Emission calculations

We estimated the net CO₂-equivalent emissions from the peat microbial decomposition and water bodies for each parcel, spatially and temporally explicitly as detailed in Table 38 and Table 39. Using the procedures provided in Module BL-PEAT and Module M-PEAT, we eliminated the term $E_{\text{peatburn-WPS},i,t}$ and established the equation (23):

$$GHG_{WPS-WRC} = \sum_{t=1}^{t^*} \sum_{i=1}^M (E_{\text{peatsoil-WPS},i,t} + E_{\text{peatditch-WPS},i,t}) \quad (23)$$

Where:

$GHG_{WPS-WRC}$	Net CO ₂ equivalent peat GHG emissions in the project scenario up to year t^* (t CO ₂ -e)
$E_{\text{peatsoil-WPS},i,t}$	GHG emissions from microbial decomposition of the peat soil within the project boundary in the project scenario in stratum i in year t (t CO ₂ -e yr ⁻¹)
$E_{\text{peatditch-WPS},i,t}$	GHG emissions from water bodies within the project boundary in the project scenario in stratum i in year t (t CO ₂ -e yr ⁻¹)
i	1, 2, 3, ... M strata
t	1, 2, 3, ... t^* time elapsed since the start of the project activity (years)

Our procedures for quantifying the dynamics of carbon stock and peat losses are similar to those applied in the baseline scenario (see section 3.2.1.5.1). The only differences include stratification, temporal sequence of strata change, and the assumed absence of peat burning.

GHG emissions from peat soils, and water bodies are elaborated in detail in section 3.2.2.3.1. A summary of the quantified GHG emissions from peat microbial decomposition, uncontrolled peat burning and water bodies under the baseline scenario are presented in Table 41.

Table 41. A summary of the annual GHG emissions from peat and water bodies under the project scenario up to 2062.

Year	CO ₂ from peat microbial decomposition (t CO ₂ -e ha ⁻¹ yr ⁻¹)	CH ₄ from peat microbial decomposition (t CO ₂ -e ha ⁻¹ yr ⁻¹)	CO ₂ from DOC (t CO ₂ -e ha ⁻¹ yr ⁻¹)	Total (t CO ₂ -e ha ⁻¹ yr ⁻¹)
2016	227,767	11,106	145	239,018
2017	227,767	11,106	145	239,018
2018	227,767	11,106	145	239,018
2019	227,767	11,106	145	239,018
2020	252,228	12,288	145	264,660
2021	250,511	12,333	145	262,988
2022	227,885	10,427	145	238,456
2023	228,728	10,821	145	239,694
2024	223,868	10,499	145	234,512
2025	-	-	145	145
2026	-	-	145	145
2027	-	-	145	145
2028	-	-	145	145

Year	CO ₂ from peat microbial decomposition (t CO ₂ -e ha ⁻¹ yr ⁻¹)	CH ₄ from peat microbial decomposition (t CO ₂ -e ha ⁻¹ yr ⁻¹)	CO ₂ from DOC (t CO ₂ -e ha ⁻¹ yr ⁻¹)	Total (t CO ₂ -e ha ⁻¹ yr ⁻¹)
2029	-	-	145	145
2030	-	-	145	145
2031	-	-	145	145
2032	-	-	145	145
2033	-	-	145	145
2034	-	-	145	145
2035	-	-	145	145
2036	-	-	145	145
2037	-	-	145	145
2038	-	-	145	145
2039	-	-	145	145
2040	-	-	145	145
2041	-	-	145	145
2042	-	-	145	145
2043	-	-	145	145
2044	-	-	145	145
2045	-	-	145	145
2046	-	-	145	145
2047	-	-	145	145
2048	-	-	145	145
2049	-	-	145	145
2050	-	-	145	145
2051	-	-	145	145
2052	-	-	145	145
2053	-	-	145	145
2054	-	-	145	145
2055	-	-	145	145
2056	-	-	145	145
2057	-	-	145	145
2058	-	-	145	145
2059	-	-	145	145
2060	-	-	145	145
2061	-	-	145	145
2062	-	-	145	145

Year	CO ₂ from peat microbial decomposition (t CO ₂ -e ha ⁻¹ yr ⁻¹)	CH ₄ from peat microbial decomposition (t CO ₂ -e ha ⁻¹ yr ⁻¹)	CO ₂ from DOC (t CO ₂ -e ha ⁻¹ yr ⁻¹)	Total (t CO ₂ -e ha ⁻¹ yr ⁻¹)
Total	2,094,285	100,793	6,808	2,201,886

3.2.2.3.3 Subsidence related to microbial decomposition of peat

As no drainage would take place in the project scenario, there would be no initial compaction. Similarly, we assumed no burning in the project period, and therefore there would not be any peat loss from peat fires. The annual peat loss rates in the project scenario equal the subsidence rate and are calculated using the equation (24):

$$Rate_{peatloss-WPS,i,t} = Sub_{i,t} \quad (24)$$

Where:

$Rate_{peatloss-WPS,i,t}$	Rate of peat loss due to microbial decomposition in project scenario of stratum i at year t (m yr ⁻¹)
$Sub_{i,t}$	Subsidence rate in stratum i in year t (m)
i	1, 2, 3, ... M_L strata in the baseline scenario (unitless)
t	1, 2, 3, ... t^* time elapsed since the project start (yr)

We assessed the remaining peat depth annually for the project period based on the rate of peat loss due to microbial decomposition using equation (25):

$$Depth_{peat-WPS,i,t^*} = Depth_{peat-WPS,i,t_0} - \sum_{t=1}^{t^*} Rate_{peatloss-WPS,i,t} \quad (25)$$

Where:

$Depth_{peat-WPS,i,t^*}$	Remaining peat thickness in the project scenario in stratum i at year t^* (m)
$Depth_{peat-WPS,i,t_0}$	Peat thickness at the project scenario in stratum i at year t_0 = project start date (initial peat thickness) (m)
$Rate_{peatloss-WPS,i,t}$	Rate of peat loss due (subsidence) due to microbial decomposition of peat in the project scenario in stratum i in year t (m yr ⁻¹)
i	1, 2, 3, ... M_L strata in the baseline scenario (unitless)
t	1, 2, 3, ... t^* time elapsed since the project start (yr)

By tracking annual peat thickness estimated in the project scenario, we assured that no GHG emissions would be accounted for within any parcel of each stratum, once the available carbon stock/peat has been depleted.

3.2.2.4 Emissions from microbial decomposition of peat

We calculated the project GHG emissions for different emission strata using the conservative and scientifically robust (TIER 1) IPCC default emission factors for each stratum i (Annex 11 on Emission Factors), following the equations defined by the VCS methodology VM0007 Module M-PEAT (26):

$$E_{\text{peatsoil-WPS},i,t} = E_{\text{CO}_2\text{-WPS},i,t} + E_{\text{CH}_4\text{-WPS},i,t} \quad (26)$$

Where:

$E_{\text{CO}_2\text{-WPS},i,t}$	CO ₂ emissions from the peat soil within the project boundary in the baseline scenario in stratum i at year t (t CO ₂ -e yr ⁻¹)
$E_{\text{CH}_4\text{-WPS},i,t}$	CH ₄ emissions from the peat soil within the project boundary in the baseline scenario in stratum i at year t (t CO ₂ -e yr ⁻¹)
i	1, 2, 3, ... M_{WPS} strata in the baseline scenario (unitless)
t	1, 2, 3, ... t^* time elapsed since the project start (yr)

For each stratum, the CO₂ emissions from microbial decomposition of the peat within the project boundary are calculated by using the equation (27):

$$E_{\text{peatsoil-WPS,CO}_2,i,t} = A_{i,t} \times EF_{\text{CO}_2,i,t} \quad (27)$$

Where:

$E_{\text{peatsoil-WPS,CO}_2,i,t}$	CO ₂ emissions from the peat soil within the project boundary in the baseline scenario in stratum i at year t (t CO ₂ -e yr ⁻¹)
$EF_{\text{CO}_2,i,t}$	Emission factor for CO ₂ emissions corresponds to each stratum i , as provided by IPCC (t CO ₂ -e yr ⁻¹)
$A_{i,t}$	Area of stratum i at time t (ha)
i	1, 2, 3, ... M_{WPS} strata in the baseline scenario (unitless)
t	1, 2, 3, ... t^* time elapsed since the project start (yr)

For each stratum, the CH₄ emission from the peat soil within the project boundary are calculated by using the equation (28):

$$E_{\text{peatsoil-WPS,CH}_4,i,t} = A_{i,t} \times GWP_{\text{CH}_4} \times EF_{\text{CH}_4,i,t} \quad (28)$$

Where:

$E_{\text{peatsoil-WPS,CH}_4,i,t}$	CH ₄ emissions from the peat soil within the project boundary in the baseline scenario in stratum i at year t (t CO ₂ -e yr ⁻¹)
------------------------------------	---

$EF_{CH_4,i,t}$	Emission factor for CH ₄ emissions corresponds to each stratum i , as provided by IPCC (t CO ₂ -e ha ⁻¹ yr ⁻¹)
$A_{i,t}$	Area of stratum i at time t (ha)
GWP_{CH_4}	Global Warming Potential for CH ₄
i	1, 2, 3, ... M_{WPS} strata in the baseline scenario (unitless)
t	1, 2, 3, ... t^* time elapsed since the project start (yr)

Table 42 below provides details on the WRC related project emission factors and stratification.

Table 42. The stratification used for the calculation of GHG emissions per stratum, the area (ha) per each stratum and the CO₂ and CH₄ default factors used for the specific land-use.

Strata	Type	Description	Area (ha)	Percentage of project area (%)
PS-UPSF	Undrained Dense Forest	Intact dense forest on undrained peatland	234.08	1.02
PS-DPSF	Drained Dense Forest	Intact dense forest on drained peatland	20.26	0.09
PS-DDP	Drained Deforested Peatland	Mostly open canopy tree/shrub/herb mix and closed canopy tree/shrub/herb mix on drained peatland	7,393.59	32.25
PS-UDP	Undrained Deforested Peatland	Mostly open canopy tree/shrub/herb mix and closed canopy tree/shrub/herb mix on undrained peatland	15,205.17	66.33
PS-WB	Water Bodies	River and secondary or tertiary canals that existed before project start date.	69.30	0.30
Total			22,922.39	100%

3.2.2.4.1 Current projections for project emissions at the start of the project

With sufficient long-term, field-based measurements of peat-related emissions not yet available for estimating the overall emissions, GHG emission factors provided in Annex 11 were used as a conservative approach. The effect of rewetting was taken into account by multiplying the emission factor for each stratum by an efficacy factor derived from the annual water table changes predicted by the hydrological models (for details see Annex 7). As stated earlier, the model predicted that complete rewetting will be achieved in 2024, five years after the completed dam construction. We further assumed that once the carbon stock in the vegetation is equal to the carbon stock of secondary peat swap forest,⁵⁴ the emission profile changes from the PS-UCP stratum to the PS-UPSF stratum. Projected annual GHG emissions from microbial decomposition of peat is shown in Table 43.

Table 43. GHG emissions from microbial decomposition of peat in the project scenario.

Year	CO ₂ from peat microbial decomposition (t CO ₂ -e ha ⁻¹ yr ⁻¹)	CH ₄ from peat microbial decomposition (t CO ₂ -e ha ⁻¹ yr ⁻¹)	Total (t CO ₂ -e ha ⁻¹ yr ⁻¹)
2016	227,767	11,106	238,873
2017	227,767	11,106	238,873
2018	227,767	11,106	238,873
2019	227,767	11,106	238,873
2020	252,228	12,288	264,516
2021	250,511	12,333	262,843
2022	227,885	10,427	238,312
2023	228,728	10,821	239,549
2024	223,868	10,499	234,367
2025	-	-	-
2026	-	-	-
2027	-	-	-
2028	-	-	-
2029	-	-	-
2030	-	-	-
2031	-	-	-
2032	-	-	-
2033	-	-	-
2034	-	-	-
2035	-	-	-
2036	-	-	-
2037	-	-	-
2038	-	-	-
2039	-	-	-
2040	-	-	-
2041	-	-	-
2042	-	-	-
2043	-	-	-
2044	-	-	-
2045	-	-	-
2046	-	-	-
2047	-	-	-

Year	CO ₂ from peat microbial decomposition (t CO ₂ -e ha ⁻¹ yr ⁻¹)	CH ₄ from peat microbial decomposition (t CO ₂ -e ha ⁻¹ yr ⁻¹)	Total (t CO ₂ -e ha ⁻¹ yr ⁻¹)
2048	-	-	-
2049	-	-	-
2050	-	-	-
2051	-	-	-
2052	-	-	-
2053	-	-	-
2054	-	-	-
2055	-	-	-
2056	-	-	-
2057	-	-	-
2058	-	-	-
2059	-	-	-
2060	-	-	-
2061	-	-	-
2062	-	-	-
Total	1,906,216	100,793	2,195,079

3.2.2.4.2 Future approaches for calculating project emissions

To determine carbon and GHG fluxes from peat microbial decomposition in the project scenario, we will take approaches with varying levels of resolution (IPCC TIER 1 – TIER 3).⁵³ Throughout project implementation, we will conduct measurements in the field (IPCC TIER 2 and TIER 3) and collect data to reduce emission uncertainties and account for spatial and temporal variation in the water tables.⁵³

We will develop site-specific TIER 3 emission factors (in 2020) and apply these to estimate project emissions. These methods work together to thoroughly reduce uncertainty (see Annex 14).

We began initial, preliminary water table level monitoring in the project area in 2018 and will expand to the whole project area in 2019 following canal blocking implementation (see Annex 8). Soil subsidence measurements will start in 2019. Monitoring of all variables will be continued throughout 47-year project duration.

3.2.2.5 Emissions from water bodies in peatlands

3.2.2.5.1 Current projections for project emissions

The water bodies present in the project scenario are rivers and pre-existing drainage canals. The project emissions from DOC are shown in Table 44. As a conservative estimate both water bodies are treated the same, and the DOC IPCC default factor for natural water bodies was applied using the equation (29):

$$E_{peatditch-WPS,t} = A_{ditch-WPS,t} \times EF_{DOC-WPS} \quad (29)$$

Where:

$E_{\text{peatditch-BSL},i,t}$	GHG emissions from canals and other open water at year t in the baseline scenario ($\text{t CO}_2\text{-e ha}^{-1} \text{ yr}^{-1}$)
$A_{\text{ditch-BSL},i,t}$	Total area of canals and other open water at year t in the baseline scenario (ha)
$EF_{\text{DOC-BSL},i}$	IPCC emission factor for Dissolved Organic Carbon from canal and open in the baseline scenario ($\text{t CO}_2\text{-e ha}^{-1} \text{ yr}^{-1}$)
t	1, 2, 3, ... t time elapsed since the start of the project activity (years)

3.2.2.5.2 Future approaches for calculating project emissions

In 2020 either CO_2 and CH_4 or DOC measurements from water bodies will be carried out and site-specific emission factors will be developed. GHG emission estimates from water bodies will be re-assessed annually during the project period. Any change in the area of open water will be taken into account if it significantly influences project GHG emissions.

Table 44. GHG emissions from Dissolved Organic Carbon in water bodies in the project scenario.

Year	CO_2 from DOC ($\text{t CO}_2\text{-e yr}^{-1}$)
2016	145
2017	145
2018	145
2019	145
2020	145
2021	145
2022	145
2023	145
2024	145
2025	145
2026	145
2027	145
2028	145
2029	145
2030	145
2031	145
2032	145
2033	145
2034	145
2035	145
2036	145
2037	145

Year	CO ₂ from DOC (t CO ₂ -e yr ⁻¹)
2038	145
2039	145
2040	145
2041	145
2042	145
2043	145
2044	145
2045	145
2046	145
2047	145
2048	145
2049	145
2050	145
2051	145
2052	145
2053	145
2054	145
2055	145
2056	145
2057	145
2058	145
2059	145
2060	145
2061	145
2062	145
Total	6,808

3.2.2.6 Emissions from uncontrolled burning

We are implementing a variety of project activities to address burning, such as peatland rewetting and best-practice fire management, with goals of zero burning, fire control, and fire prevention (Section 2.1.11). Therefore, we assumed that uncontrolled burning is absent in the project scenario.

We have operated consistent fire patrols since the start of the SMPP, and we also have an online satellite-based early warning system (EWS) in place to detect possible fires as quickly as possible. If uncontrolled burning does occur in the SMPP during the project period, we will map the area of the fire scar and the burn scar depth soon after the burning event. We have compiled historical tracking of hotspots and direct observation data in the project area to determine the repetition of burning in the SMPP. We will quantify equivalent GHG emissions from uncontrolled burning and deduct these from our emission reductions.

In addition, we calculate GHG emissions that result from peat burning using dry mass loss based on burn scars, depth, bulk density of peat, combustion factors, and GHG potential of GHG species. We determine GHG emissions from biomass loss from burning using land cover type, combustion factors, and GHG potential of GHG species. Bulk density of peat is assumed constant throughout the project period and was found to be relatively homogeneous throughout horizontal and vertical peat soil profiles (Annex 5 on peat inventory).

In cases where there were repeated burns within the SMPP, scar depths of the 1st, 2nd, 3rd, 4th, and subsequent burnings are assumed as 0.17 cm, 0.1 cm, 0.06 cm, and 0.02 cm, respectively. The detailed parameters we used to quantify GHG emissions from uncontrolled burning are given in Annex 11.

To quantify GHG emissions from uncontrolled peat burnings, we followed procedures in the VCS methodology VM0007 Module E-BPB using the following equation (30):

$$E_{peatburn-WPS,i,t} = \sum_{g=1}^G \left((A_{peatburn-WPS,i,t} \times P_{WPS,i,t} \times P_{WPS,g,i}) \times 10^{-3} \right) \times GWP_g \quad (30)$$

Where:

$E_{peatburn-WPS,i,t}$	Greenhouse emissions due to peat burning under project scenario in stratum i in year t of each GHG (CO ₂ , CH ₄) (t CO ₂ -e)
$A_{peatburn-WPS,i,t}$	Area peat burnt under project scenario in stratum i in year t (ha)
$P_{WPS,i,t}$	Average mass of peat burnt under project scenario in stratum i , year t (t DM ha ⁻¹)
$G_{g,i}$	Emission factor in stratum i for gas g (kg t ⁻¹ DM burnt)
GWP_g	Global warming potential for gas g (t CO ₂ t ⁻¹ g ⁻¹)
g	1, 2, 3, ... G greenhouse gases including carbon dioxide, methane and nitrous oxide (unitless)
i	1, 2, 3, ... M strata (unitless)
t	1, 2, 3, ... t time elapsed since the start of the project activity (year)

We estimated the average mass of peat burnt for a particular stratum using the equation (31):

$$P_{WPS,i,t} = D_{peatburn-WPS,i,t} \times BD_{upper} \times 10^{-4} \quad (31)$$

Where:

$P_{WPS,i,t}$	Average mass of peat burnt under project scenario in stratum i , year t (t DM ha ⁻¹)
$D_{peatburn-WPS,i,t}$	Average burn scar depth under project scenario in stratum i in year t (m)
$BD_{upper,i}$	Bulk density of the upper peat in stratum i (g cm ⁻³)
i	1, 2, 3, ... M strata
t	1, 2, 3, ... t time elapsed since the start of the project activity (years)

3.2.2.7 Project emissions from ARR activities

As stated under subsection 3.2.2.2 the project activities will include reforestation (nursery and replanting, see Section 2.1.11), however for delineating ARR emission characteristics we only accounted for the natural regeneration of vegetation.

All ex-ante GHG emissions and removals follow Module M-ARR in the AR-ACM0003 procedures for afforestation and reforestation lands. Net GHG removals under the ARR project scenario up to time t^* ; t CO₂-e ($\Delta C_{WPS-ARR}$) equal the summation from $t = 1$ to t^* of the baseline net GHG removals by sinks in year t ; (ΔC) in AR-ACM0003. We assume that non-CO₂ GHG emissions under the project scenario are zero, and shrubs, dead wood, and litter are not significant in the C pool calculations.

Net GHG emission related to WRC activities in the project scenario in ARR area (GHGWPS-WRC) are presented separately in the peat Section 5.3.1. Net GHG removals under the ARR project scenario are calculated using the equation (32):

$$\Delta C_{WPS-ARR} = \sum_{t=1}^{t^*} (\Delta C_{ACTUAL,i,ACM0003}) = \sum_{t=1}^{t^*} (\Delta C_{TREE,PROJ,t}) \quad (32)$$

Where:

$\Delta C_{WPS-ARR}$	Net GHG removals under the ARR project scenario up to time t ; t CO ₂ -e
$\Delta C_{ACTUAL,t,ACM0003}$	Actual net GHG removal by sinks in year t (from AR-ACM0003) (t CO ₂ -e)
$C_{TREE,PROJ,t}$	Change in carbon stock in tree biomass in project, in year t ; t CO ₂ -e
i	1, 2, 3, ... M strata
t	1, 2, 3, ... t^* time since project start

IPCC default factors for annual C stock increment were used in the calculation (see Annex 11). Cumulative net GHG removals related to ARR activities in the project scenario within the project period were estimated to be 183,260,692 t CO₂-e. Annual GHG removals are shown in Table 45 below. Changes in carbon stock in the project scenario are not accounted for in the first four years of the project, as an AGB inventory will only be implemented in 2020. As such, this will represent the first year from which actual gains can be monitored and accounted for. The project will conduct annual inventories from 2020 onwards.

Table 45. Project scenario net GHG removals by ARR activity within the project period.

Year	Change in carbon stocks in the ARR area (t CO ₂ -e)
2016	-
2017	-
2018	-
2019	-
2020	461,539
2021	461,539
2022	461,539
2023	461,539
2024	461,539
2025	120,710
2026	120,710
2027	120,710
2028	120,710

Year	Change in carbon stocks in the ARR area (t CO ₂ -e)
2029	120,710
2030	120,710
2031	120,710
2032	120,710
2033	120,710
2034	120,710
2035	120,710
2036	120,710
2037	120,710
2038	120,710
2039	120,710
2040	120,710
2041	120,710
2042	120,710
2043	120,710
2044	120,710
2045	120,710
2046	120,710
2047	120,710
2048	120,710
2049	120,710
2050	120,710
2051	120,710
2052	120,710
2053	120,710
2054	120,710
2055	120,710
2056	120,710
2057	120,710
2058	120,710
2059	120,710
2060	120,710
2061	120,710
2062	120,710

3.2.3 Leakage

We determined leakage according to the requirements in Module LK-ASP in the VCS methodology VM0007 REDD+ MF. As expressed in Section 3.2.1, baseline scenario activity in the SMPP includes planned conversion to industrial Acacia plantations and resulting peatland drainage. Our project activities combine Avoiding Planned Deforestation (APD), Reforestation (ARR), in combination with Conservation of Undrained and Partially-drained Peatland (CUPP) and Rewetting of Drained Peatland (RDP).

Accordingly, we may see potential sources of leakage emissions from displacement of planned deforestation activities and pre-project activities on non-forest land. These potential sources and the corresponding applicable modules for quantifying total leakage emissions are listed in Section 3.1.2 and Table 46 below.

Table 46. Applicability of leakage modules

Module	Applicability
Estimation of emissions from activity shifting for avoiding planned deforestation and planned degradation (LK-ASP)	Applicable. The project may cause activity shifting of avoided planned deforestation.
Estimation of emissions from activity shifting for avoiding unplanned deforestation (LK-ASU)	Not applicable. The project is not categorized as avoiding unplanned deforestation.
Estimation of emissions from displacement of fuelwood extraction (LK-DFW)	Not applicable. The project is not categorized as avoiding unsustainable fuelwood extraction.
Estimation of emissions from displacement of pre-project agricultural activities (LK-ARR)	Applicable. The project is categorized as afforestation, reforestation, and revegetation and may cause displacement of pre-project agricultural activities.
Estimation of emissions from market-effects (LK-ME)	Not applicable. The project does not reduce the production of timber, fuelwood, or charcoal.
Estimation of emissions from ecological leakage (LK-ECO)	Applicable. The project is categorized as WRC and may cause ecological leakage

3.2.3.1 *Estimation of emissions from activity shifting for avoiding planned deforestation and planned degradation (LK-ASP)*

As discussed in Section 3.1.4, the most likely agent of deforestation in the baseline scenario is conversion to industrial Acacia plantations. Section 5.2 of the LK-ASP Module describes three options for estimating emissions associated with changes in land-use activity. We chose to use the most applicable option here, Approach 1. The steps below follow Section 5.1 of the LK-ASP Module. For considering the leakage potential in peatland areas, we followed the steps in Section 5.3 of the LK-ASP Module.

3.2.3.1.1 Steps to estimate activity shifting leakage for avoiding planned deforestation

STEP 1: Determination of the baseline rate of forest clearance by the class of deforestation agents

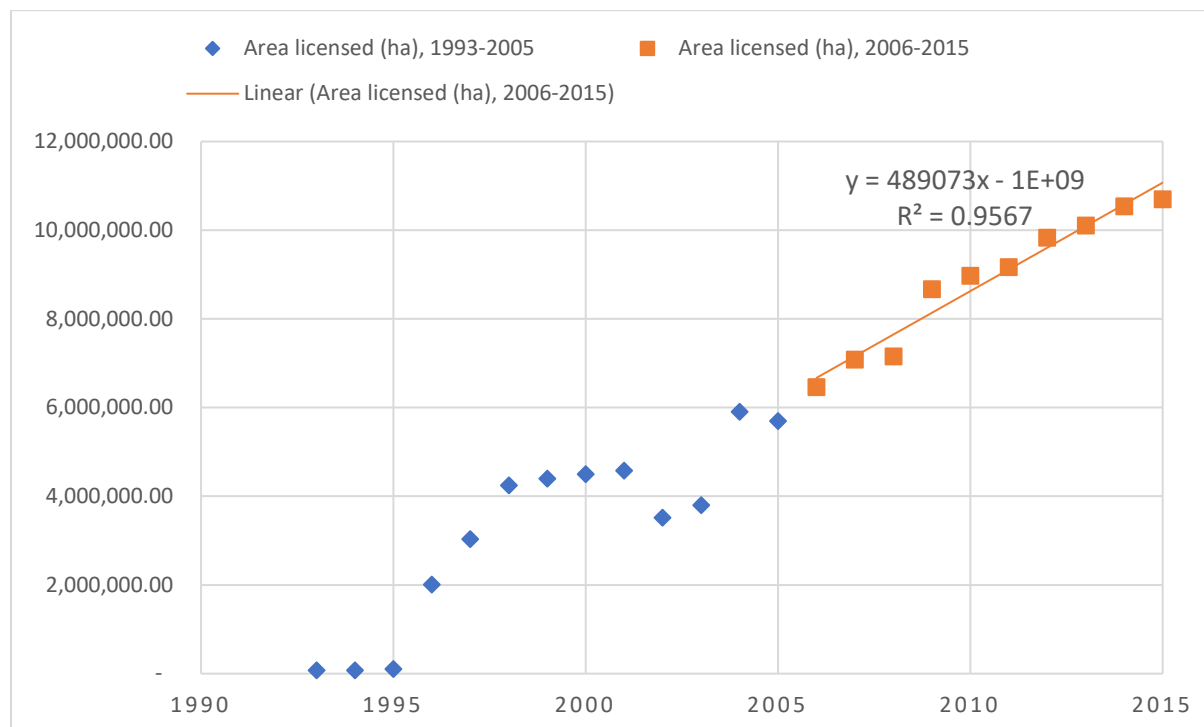
Of the three options in Module LK-ASP for estimating the baseline rate of forest clearance by the deforestation agent, we used Option 1.1. We determined the national historic trend for areas licensed for HTI to provide insight regarding plantation establishment, so we could determine baseline scenario deforestation (see Table 47). Without official government data indicating clearance in these concessions and according to Module LK-ASP, we defined the rate of clearance to the baseline rate of deforestation (D%) as 7.85% as derived from proxy area and analysis further outlined in Section 3.2.1.

Table 47. Official data on historic HTI concession licenses granted.^{55,56}

Year	HTI concessions licensed	Area licensed (ha)
1993	2	80,000.00
1994	2	80,000.00
1995	5	110,000.00
1996	27	2,010,000.00
1997	63	3,040,000.00
1998	94	4,250,000.00
1999	98	4,400,000.00
2000	100	4,501,375.00
2001	102	4,578,697.00
2002	91	3,523,256.00
2003	94	3,804,912.00
2004	112	5,910,295.00
2005	115	5,697,410.00
2006	133	6,467,515.00
2007	162	7,087,812.00
2008	165	7,154,832.00
2009	206	8,673,016.00
2010	218	8,975,375.00
2011	215	9,169,040.00
2012	238	9,834,744.43
2013	254	10,106,540.43
2014	277	10,539,210.33
2015	280	10,700,842.33

We conducted a regression analysis to test the significance of the historic trend in the cumulative area licensed for conversion to HTI plantations between 2006 and 2015 (Figure 4). The regression had a p -value of < 0.000001 and an adjusted R^2 of 0.95, which met requirements in the LK-ASP Module ($p \leq 0.05$ and adjusted R^2 of ≥ 0.75). We then multiplied the projected annual area licensed by the estimated deforestation rate of 7.85% from the baseline proxy analysis to derive the estimated annual area converted to plantations between 2016 and 2062.

Figure 4. Results of the regression analysis to test the significance of the historic trend in the cumulative area licensed for conversion to HTI plantations between 2006 and 2015.



The regression estimated annual area licensed in Table 48. The total area of HTI plantations in 2062 is projected to be 34,058,177.76 ha. We estimated that an average area of 489,073 ha would be licensed annually for HTI plantations between 2016 and 2062. Applicable laws and common practices suggest that 10% of the total licensed concession area would be reserved for conservation while the remaining 90% would be converted. Then by applying the 7.85% baseline deforestation rate as mandated by the LK-ASP, we employed the Module Option 1.1 to determine the annual area of clearance by the class of agents in the absence of the project.

$WoPR = \text{annual area licensed} \times 90\% \times 7.85\%$

Table 48. Annual area of clearance by the class of agents in the absence of the project.

Year	Area licensed (ha), 2016-2062	$WoPR_{i,t}$
2016	11,560,796.98	816,770.31
2017	12,049,870.47	851,323.35
2018	12,538,943.97	885,876.39
2019	13,028,017.46	920,429.43
2020	13,517,090.96	954,982.48
2021	14,006,164.45	989,535.52
2022	14,495,237.95	1,024,088.56
2023	14,984,311.44	1,058,641.60
2024	15,473,384.94	1,093,194.65

Year	Area licensed (ha), 2016-2062	WoPR _{i,t}
2025	15,962,458.43	1,127,747.69
2026	16,451,531.93	1,162,300.73
2027	16,940,605.42	1,196,853.77
2028	17,429,678.92	1,231,406.82
2029	17,918,752.41	1,265,959.86
2030	18,407,825.91	1,300,512.90
2031	18,896,899.41	1,335,065.94
2032	19,385,972.90	1,369,618.99
2033	19,875,046.40	1,404,172.03
2034	20,364,119.89	1,438,725.07
2035	20,853,193.39	1,473,278.11
2036	21,342,266.88	1,507,831.16
2037	21,831,340.38	1,542,384.20
2038	22,320,413.87	1,576,937.24
2039	22,809,487.37	1,611,490.28
2040	23,298,560.86	1,646,043.32
2041	23,787,634.36	1,680,596.37
2042	24,276,707.85	1,715,149.41
2043	24,765,781.35	1,749,702.45
2044	25,254,854.84	1,784,255.49
2045	25,743,928.34	1,818,808.54
2046	26,233,001.83	1,853,361.58
2047	26,722,075.33	1,887,914.62
2048	27,211,148.82	1,922,467.66
2049	27,700,222.32	1,957,020.71
2050	28,189,295.82	1,991,573.75
2051	28,678,369.31	2,026,126.79
2052	29,167,442.81	2,060,679.83
2053	29,656,516.30	2,095,232.88
2054	30,145,589.80	2,129,785.92
2055	30,634,663.29	2,164,338.96
2056	31,123,736.79	2,198,892.00
2057	31,612,810.28	2,233,445.05
2058	32,101,883.78	2,267,998.09
2059	32,590,957.27	2,302,551.13
2060	33,080,030.77	2,337,104.17
2061	33,569,104.26	2,371,657.22

Year	Area licensed (ha), 2016-2062	$WoPR_{i,t}$
2062	34,058,177.76	2,406,210.26

STEP 2: Estimation of new projection of forest clearance by the baseline class of deforestation agents with project implementation at which no leakage is occurring

We subtracted the annual area of clearance by the class of agents in the absence of the project by the total annual area of planned baseline deforestation, to calculate the new area of annual deforestation by the baseline class of deforestation agents (Table 49), at which no leakage occurs ($NewR_{i,t}$) (33):

$$NewR_{i,t} = WoPR_{i,t} - (D\%_{planned,i,t} \times A_{planned,i}) \quad (33)$$

Where:

$NewR_{i,t}$ New calculated forest clearance in stratum i in year t by the baseline agent of the planned deforestation where no leakage is occurring (ha)

$WoPR_{i,t}$ Deforestation by the baseline agent of the planned deforestation in stratum i in year t in the absence of the project (ha)

$D\%_{planned,i,t}$ Projected annual proportion of land that will be deforested in project stratum i in year t (percent)

$A_{planned,i}$ Total area of planned deforestation over the baseline period for project stratum i (ha)

i 1, 2, 3, ... M strata (unitless)

t 1, 2, 3, ... t^* time elapsed since the projected start of the project activity (years)

Table 49. New area of annual deforestation by the baseline class of deforestation agents at which no leakage is occurring

Year	$WoPR_{i,t}$	$NewR_{i,t}$
2016	816,770.31	815,150.84
2017	851,323.35	849,703.88
2018	885,876.39	884,256.92
2019	920,429.43	918,809.97
2020	954,982.48	953,363.01
2021	989,535.52	987,916.05
2022	1,024,088.56	1,022,469.09
2023	1,058,641.60	1,057,022.14
2024	1,093,194.65	1,091,575.18
2025	1,127,747.69	1,126,128.22
2026	1,162,300.73	1,160,681.26
2027	1,196,853.77	1,195,234.30
2028	1,231,406.82	1,229,787.35

Year	$WoPR_{i,t}$	$NewR_{i,t}$
2029	1,265,959.86	1,264,340.39
2030	1,300,512.90	1,298,893.43
2031	1,335,065.94	1,333,446.47
2032	1,369,618.99	1,367,999.52
2033	1,404,172.03	1,402,552.56
2034	1,438,725.07	1,437,105.60
2035	1,473,278.11	1,471,658.64
2036	1,507,831.16	1,506,211.69
2037	1,542,384.20	1,540,764.73
2038	1,576,937.24	1,575,317.77
2039	1,611,490.28	1,609,870.81
2040	1,646,043.32	1,644,423.86
2041	1,680,596.37	1,678,976.90
2042	1,715,149.41	1,713,529.94
2043	1,749,702.45	1,748,082.98
2044	1,784,255.49	1,782,636.03
2045	1,818,808.54	1,817,189.07
2046	1,853,361.58	1,851,742.11
2047	1,887,914.62	1,886,295.15
2048	1,922,467.66	1,920,848.20
2049	1,957,020.71	1,955,401.24
2050	1,991,573.75	1,989,954.28
2051	2,026,126.79	2,024,507.32
2052	2,060,679.83	2,059,060.37
2053	2,095,232.88	2,093,613.41
2054	2,129,785.92	2,128,166.45
2055	2,164,338.96	2,162,719.49
2056	2,198,892.00	2,197,272.54
2057	2,233,445.05	2,231,825.58
2058	2,267,998.09	2,266,378.62
2059	2,302,551.13	2,300,931.66
2060	2,337,104.17	2,335,484.71
2061	2,371,657.22	2,370,037.75
2062	2,406,210.26	2,404,590.79

STEP 3: Monitoring of all areas deforested by baseline class of agents of deforestation through the years in which planned deforestation was forecasted to occur

For each monitoring event, we will estimate all areas deforested by the class of agents in the country by monitoring the total area licensed for conversion to HTI concessions and the actual deforestation (when applicable data become available). We will document areas of deforestation and leakage in our monitoring report by using the equation (34):

$$LKA_{planned,i,t} = A_{defLK,i,t} - NewR_{i,t} \quad (34)$$

Where:

$LKA_{planned,i,t}$	The area of activity shifting leakage in stratum i in year t (ha)
$NewR_{i,t}$	New calculated forest clearance by the baseline agent of the planned deforestation in stratum i in year t where no leakage is occurring (ha)
$A_{defLK,i,t}$	The total area of monitored deforestation by the baseline agent of the planned deforestation in stratum i in year t (ha)
i	1, 2, 3, ... M strata (unitless)
t	1, 2, 3, ... t^* time elapsed since the start of the project activity (years)

As a result of project activities described in Section 2.1.11, we assumed that no leakage will occur. We will monitor and report the actual leakage throughout the duration of the project.

STEP 4: Monitoring of GHG emissions outside the project boundary by baseline agent of deforestation

This can only be monitored and quantified when a specific deforestation agent is identified and therefore, is not considered by the project.

STEP 5: Estimation of peat carbon in all of the class of agents' concessions

We determined the emission factors for activity shifting leakage to peatlands based on carbon lost at PDT ($C_{peatloss,tPDT}$) in the undrained peatland of alternative areas. We estimated the PDTs using the principles in the equations (1) to (12) set out in Module X-STR by applying drainability limit restrictions similar to principles applied to the project area.

Using the land-use designation of Production Forest (*Hutan Produksi* or HP) in Indonesia right before the project start date, we considered areas that could potentially generate peat emissions as a result of shifting leakage.⁵⁶ Some HP areas are unlicensed, while others have become licensed HTI concessions (Table 50). We examined these unlicensed HP and licensed HTI areas as a conservative measure because other types of industrial forestry-based plantations could potentially occupy unlicensed HP areas in the future.

We assumed that on peatlands, anytime there is deforestation there is simultaneous drainage. We conservatively assumed that drained peatland is equal to deforested peatland area because industrial-level conversion and deforestation on large areas of peatlands results in canal development that drains the peat. Furthermore, the 2015 nation-wide catastrophic fires resulted in deforestation in areas that might not have been drained when the fires occurred. By assuming these deforested areas were drained, we conservatively included a possible scenario that licensed HTI or unlicensed HP areas would eventually be drained. In order to determine the proportion of undrained peatland in unlicensed HP areas, we conservatively compared the total, forested HTI plantations in HP and unlicensed HP areas, from actual spatial data.⁵⁶ From the analysis, approximately 7,309,070.22 ha (61.3%) of the licensed HTI in HP area was estimated to have been deforested at the project start date. We assumed conservatively that all

peatlands in the unlicensed area are forested and undrained. This assumption considered a higher AGB carbon stock in peatlands despite the actual vegetation composition, hence a more conservative approach for accounting growth rate and emission factors.

Table 50. Deforested and forested area in HTI and unlicensed HP areas right before the project start.

Land Cover Types	Peatland		Non-Peatland		Peatland + Non-Peatland	
	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)
HTI plantations in HP areas						
Deforested in 2015	1,607,241	54.7%	5,701,829	63.5%	7,309,070	61.3%
Forested in 2015	1,332,395	45.3%	3,282,103	36.5%	4,614,498	38.7%
Total HTI plantation area	2,939,636	100.0%	8,983,932	100.0%	11,923,569	100.0%
Unlicensed HP areas						
Deforested in 2015	0	0.0%	0	0.0%	0	0.0%
Forested in 2015	12,676,418	100.0%	55,541,598	100.0%	68,218,016	100.0%
Total Unlicensed HP area	12,676,418		55,541,598		68,218,016	
HTI plantations in HP areas + Unlicensed HP areas						
Deforested in 2015	8,083,356	51.8%	24,317,315	37.7%	32,400,671	40.4%
Forested in 2015	7,532,698	48.2%	40,208,215	62.3%	47,740,913	59.6%
Total HTI + Unlicensed HP area	15,616,054		64,525,530		80,141,584	

We referred to the same data source for project's peatland cover to determine the country's peatland distribution, using a 2008 national dataset.⁵⁷ We summarized total peatland area and carbon stock loss at t_{PDT} ($C_{peatloss,t_{PDT}}$) in licensed HTI Acacia plantations and unlicensed HP areas in

Table 51. The amount of carbon loss at t_{PDT} was based on peat thickness loss at t_{PDT} , bulk density similar to that of the project area (149 kg m^{-3}) and carbon content (0.53 kg kg^{-1} peat DM) (35):

$$C_{peatloss,t_{PDT},k} + P_{t_{PDT},k} \times BD \times C_c \times 10 \quad (35)$$

Where:

$C_{peatloss,t_{PDT},k}$	Carbon loss at $t = PDT$ in peat stratum k (t C ha^{-1})
$P_{t_{PDT}}$	Available peat thickness for microbial decomposition and burning as restricted by drainability limit in peat stratum k (m)
BD	Bulk density of peat (kg m^{-3})
C_c	Carbon content of peat (kg kg^{-1} peat dry mass)
k	Peat thickness strata

Table 51. Summary of peat thickness and average carbon stock loss at t_{PDT} in all HTI and unlicensed HP areas in Indonesia.

PLPD T	HTI plantations in HP Area			Unlicensed HP Area		
Range (m)	Area (ha)	Avg $C_{peatloss,tPDT}$ (t C ha ⁻¹)	$C_{peatloss,tPDT}$ (t C)	Area (ha)	Avg $C_{peatloss,tPDT}$ (t C ha ⁻¹)	$C_{peatloss,tPDT}$ (t C)
< 1	16,110	616	9,931,072	69,469	616	42,825,166
1-2	109,939	1,292	142,061,549	474,085	1,292	612,603,475
2-3	289,125	2,046	591,520,931	1,246,776	2,046	2,550,780,142
3-4	492,518	2,781	1,369,804,594	2,123,857	2,781	5,906,925,988
4-5	386,185	3,576	1,381,058,434	1,665,324	3,576	5,955,455,246
5-6	827,464	4,353	3,602,355,428	3,568,221	4,353	15,534,220,713
6-7	744,692	5,104	3,800,675,086	3,211,290	5,104	16,389,422,650
>7	73,603	5,501	404,865,597	317,396	5,501	1,745,877,570
Total	2,939,636		11,302,272,691	12,676,418		48,738,110,950

STEP 6: Estimation of CO₂ emission factor for leakage to peatland per ha

We used the proportion of deforested area (54.7%) in the HP area licensed for HTI concessions, to estimate the proportion of deforested or drained peatland before the project start date. We assumed the projected undrained peatland that would be drained in the baseline in HP areas licensed for HTI to be equal to the forested peatland without the area designated for conservation (10% of the peatland). We estimated the projected undrained peatland that would be drained in the unlicensed HP areas as equal to 90% of peatland area.

Table 52. Projection of undrained peatland in HP areas as alternative areas for leakage to peatland.

Category	Acacia		Unlicensed	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Peatland	2,939,636	100.00	12,676,418	100.00
Deforested/drained peatland	1,607,241	54.70	-	0.00
Forested Peatland	1,332,395	45.30	12,676,418	100.00
Conservation area	293,964	10.00	1,267,642	10.00
Projected undrained peatland (in the baseline scenario)	1,038,432	35.30	11,408,776	90.00

The emission factor for leakage to peatlands is the average loss of carbon from peat soils per ha in all of the class of agents' concessions at PDT, expressed as t CO₂ in the equation (36):

$$LK_{EF} = \left(C_{peatloss,tPDT} \times \left(\frac{44}{12} \right) \right) / A_{conc-ag} \quad (36)$$

Where:

LK_{EF}	CO ₂ emission factor from leakage to undrained peatlands (t CO ₂ -e ha ⁻¹)
$C_{peatloss,tPDT}$	Cumulative peat carbon loss due to activity shifting leakage at t_{PDT} (t C) (derived from VCS Module X-STR)
$A_{conc-ag}$	Total number of hectares with undrained peatlands under concession to the agent of deforestation or total number of ha with peatlands in the alternative areas (ha)

Total $C_{peatloss,tPDT}$ was factored by the percentage of drained peatland. Estimated LK_{EF} for licensed and unlicensed HP areas is summarized below.

Table 53. Estimated emission factors of leakage to peatland.

Parameters	HTI plantations in HP area	Unlicensed HP area
$C_{peatloss,tPDT}$ (t C)	3,989,702,260	43,864,299,855
Total undrained area of peatlands in alternative areas	1,038,432	11,408,776
LK_{EF} (t CO ₂ -e ha ⁻¹)	14,088	14,098

STEP 7: Estimation of net GHG emissions due to leakage to undrained peatlands as a result of project implementation

We created proportions of undrained peatlands in alternative areas based on licensed HTI, unlicensed HP area, and undrained peatland areas, described below.

Table 54. Proportion of undrained peatland areas in the alternative area.

Category	HTI plantations in HP area (ha)	Unlicensed HP area (ha)
Alternative area (HP area)	11,923,568.70	68,218,015.60
Undrained peatlands	1,038,431.54	11,408,775.87
PROPPEAT-AGENT	0.087	0.167

We will calculate emissions due to leakage to undrained peatlands during project monitoring using the equation (37):

$$LK_{peat,i} = LKA_{plannted,i,t} \times PROP_{PEAT-AGENT} \times LK_{EF} \quad (37)$$

Where:

$LK_{peat,t}$	Net greenhouse gas emissions due to activity shifting to undrained peatlands as a result of implementation of a planned deforestation project in year t (t CO ₂ -e)
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$LKA_{planned,i,t}$	The area of activity shifting leakage in stratum i in year t (ha)
$PROP_{PEAT-AGENT}$	Proportion of undrained peatland areas in the agent's concessions with respect to the total area of such concessions (unitless)
LK_{EF}	CO ₂ emission factor from leakage to undrained peatlands (t CO ₂ -e ha ⁻¹)
i	1, 2, 3, ... M strata (unitless)
t	1, 2, 3, ... t^* time elapsed since the start of the project activity (years)

3.2.3.1.2 Total emissions from activity shifting for avoiding planned deforestation

We will calculate total emissions from activity shifting for avoiding planned deforestation (APD) at each monitoring event. This calculation will be based on the parameters described in Steps 1 to 7 above (38):

$$\Delta C_{LK-AS,planned} = \sum_{t=1}^{t^*} \sum_{i=1}^M \left((LKA_{planned,i,t} \times \Delta C_{BSL,i}) + GHG_{LK,E,i,t} + LK_{peat,t} \right) \quad (38)$$

Where:

$\Delta C_{LK-AS,planned}$	Net CO ₂ emissions due to activity shifting leakage for projects preventing planned deforestation (t CO ₂ -e)
$LK_{peat,t}$	Net greenhouse gas emissions due to activity shifting to undrained peatlands as a result of implementation of a planned deforestation project in year t (t CO ₂ -e)
$\Delta C_{BSL,planned}$	Net CO ₂ emissions in the baseline from planned deforestation in the project area (t CO ₂ -e)
$GHG_{LK,E,i,t}$	Greenhouse gas emissions as a result of leakage of avoiding deforestation activities in stratum i in year t (t CO ₂ -e)
$LKA_{planned,i,t}$	The area of activity shifting leakage in stratum i in year t (ha)
i	1, 2, 3, ... M strata (unitless)
t	1, 2, 3, ... t^* time elapsed since the start of the project activity (years)

We assume that no leakage will occur. There are extensive leakage mitigation activities in place for the SMPP, and we will continue to monitor and report any leakage that occurs during the project crediting period.

3.2.3.1.3 Estimation of emissions from displacement of pre-project agricultural activities (LK-ARR)

The VM0007 Module LK-ARR requires the use of the CDM tool “Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity” area. Step 1 of the CDM tool requires that the area subject to pre-project agricultural activities that is expected to be afforested/reforested (therefore the activities having to be displaced) be identified. In the areas identified for ARR activities, the SMPP project area did not have any pre-project agricultural activities taking place within the project area. As a result, no pre-project agricultural activities will be displaced by ARR project activities, and hence $Change_C_LK-ARR = 0$.

3.2.3.2 Estimation of emissions from ecological leakage (LK-ECO)

Applicability conditions of the VM0007 Module LK-ECO require that ecological leakage affecting the soil (peat) carbon pool does not occur. With a robust design and implementation plan of constructing compacted

peat dams to block existing canals, we expect that no ecological leakage will occur in the project scenario. We will monitor the effectiveness of rewetting activities to confirm that no ecological leakage is occurring at each monitoring event. Monitoring of ecological leakage will take place by installing monitoring dip wells within the vicinity of canal block positions inside and bordering the project area (see details in Annex 8).

3.2.4 Net GHG Emission Reductions and Removals

This section provides an overview of total net emission reductions and details activity specific calculations in the subsections. We calculated Net GHG emission reductions as the sum of total net GHG emission reductions of the WRC project activity and total net GHG removals of the ARR project activity (39):

$$NER_{REDD+} = NR_{ARR} + NER_{WRC} \quad (39)$$

Where:

NER_{REDD+}	Total net GHG emission reductions of the REDD+ project activity up to year t^* (t CO ₂ -e)
NR_{ARR}	Total net GHG removals of the ARR project activity up to year t^* (t CO ₂ -e)
NER_{WRC}	Total net GHG emission reductions of the WRC project activity up to year t^* (t CO ₂ -e)

3.2.4.1 Uncertainty analysis

Using Module X-UNC as a guideline, we calculated WRC uncertainty of the SMPP in both the baseline and project scenarios. Our project does not have a REDD component, so REDD uncertainty calculations were not necessary. We modified the X-UNC equation (21) to the following equation (40):

$$NER_{REDD+ERROR} = \frac{\sqrt{(Uncertainty_{WRC_{BSL},t^*} \times GHG_{BSL-WRC,t^*})^2 + (Uncertainty_{WRC_{WPS},t^*} \times GHG_{WPS-WRC,t^*})^2}}{(GHG_{BSL-WRC,t^*} + GHG_{WPS-WRC,t^*})} \quad (40)$$

We calculated CO₂ and CH₄ emission uncertainties from microbial decomposition of peat and dissolved organic carbon (DOC) from water bodies in the baseline and project scenarios, using the standard error data from the peat emission factors in the IPCC Wetlands Supplement 2013 (see Annex 11).⁵³ We established that CH₄ emission uncertainty was zero, as it was conservatively excluded from our emission calculations. We also established that uncertainty from GHG emissions from peat burning was also zero in the project scenario, as we assumed full fire prevention in the project area. However, we calculated uncertainty from GHG emissions from peat burning in the baseline using the dry mass burnt per stratum per year and their standard deviations converted to 95% confidence intervals. We combined emissions data from CO₂ and CH₄ burning to produce an overall uncertainty in CO₂ equivalent, because Module X-UNC does not distinguish between these emissions.

We calculated the uncertainty for WRC as 34.79% and 22.29% for the years 2016 and 2017, respectively in the baseline scenario. In the project scenario the uncertainty was calculated as 1.99% and 1.41%, for 2016 and 2017, respectively. This resulted in a total error in this project activity at 26.12% and 17.03, for 2016 and 2017, respectively. Assuming a threshold of 15% uncertainty, we deducted the VCUs for 2016 and 2017 by 11.12% and 2.03%, respectively. Further details on all calculations are provided in Annex 14.

3.2.4.2 Total net GHG emission reductions of WRC project activity

We calculated net GHG emission reductions related to WRC project activities by subtracting project emissions and emissions due to leakage from baseline emissions (see Table 55).

Table 55. Total net GHG emission reductions of the WRC project activity.

Year	Estimated Baseline Emissions (t CO ₂ -e)	Estimated Project Emissions (t CO ₂ -e)	Estimated Leakage Emissions (t CO ₂ -e)	Estimated NET GHG Emissions Reduction (t CO ₂ -e)
2016	718,957	239,018	-	479,939
2017	822,692	239,018	-	583,674
2018	899,653	239,018	-	660,635
2019	924,163	239,018	-	685,145
2020	1,085,933	264,660	-	821,273
2021	1,150,380	262,988	-	887,392
2022	1,279,358	238,456	-	1,040,901
2023	1,384,264	239,694	-	1,144,570
2024	1,388,023	234,512	-	1,153,511
2025	1,546,190	145	-	1,546,045
2026	1,701,545	145	-	1,701,400
2027	1,759,834	145	-	1,759,689
2028	1,811,863	145	-	1,811,719
2029	1,778,340	145	-	1,778,195
2030	1,790,964	145	-	1,790,819
2031	1,748,830	145	-	1,748,686
2032	1,767,378	145	-	1,767,234
2033	1,703,875	145	-	1,703,730
2034	1,748,057	145	-	1,747,912
2035	1,703,173	145	-	1,703,028
2036	1,733,796	145	-	1,733,651
2037	1,708,282	145	-	1,708,137
2038	1,679,122	145	-	1,678,977
2039	1,706,243	145	-	1,706,098
2040	1,663,616	145	-	1,663,471
2041	1,675,493	145	-	1,675,348
2042	1,630,998	145	-	1,630,853
2043	1,591,492	145	-	1,591,347
2044	1,583,425	145	-	1,583,280
2045	1,576,829	145	-	1,576,685
2046	1,590,362	145	-	1,590,217
2047	1,523,857	145	-	1,523,712

Year	Estimated Baseline Emissions (t CO ₂ -e)	Estimated Project Emissions (t CO ₂ -e)	Estimated Leakage Emissions (t CO ₂ -e)	Estimated NET GHG Emissions Reduction (t CO ₂ -e)
2048	1,561,449	145	-	1,561,304
2049	1,508,080	145	-	1,507,935
2050	1,503,031	145	-	1,502,886
2051	1,454,395	145	-	1,454,250
2052	1,467,410	145	-	1,467,265
2053	1,471,782	145	-	1,471,637
2054	1,455,984	145	-	1,455,839
2055	1,395,526	145	-	1,395,382
2056	1,386,087	145	-	1,385,942
2057	1,359,032	145	-	1,358,887
2058	1,378,997	145	-	1,378,852
2059	1,359,351	145	-	1,359,206
2060	1,283,117	145	-	1,282,972
2061	1,289,006	145	-	1,288,861
2062	1,260,605	145	-	1,260,460
Total	69,510,836	2,201,886	-	67,308,950

3.2.4.3 Total net GHG removals from ARR project activity

We calculated net GHG removals related to ARR project activities by subtracting baseline removals and emissions due to leakage from the project removals (see Table 56).

Table 56. Total net GHG removals of the ARR project activity.

Year	Estimated baseline removals (t CO ₂ -e)	Estimated project removals (t CO ₂ -e)	Estimated leakage emissions (t CO ₂ -e)	Estimated NET GHG emissions reductions (t CO ₂ -e)
2016	30,475	-	-	(30,475)
2017	59,712	-	-	(59,712)
2018	88,163	-	-	(88,163)
2019	117,743	-	-	(117,743)
2020	25,430	461,539	-	436,109
2021	60,867	461,539	-	400,672
2022	95,190	461,539	-	366,349
2023	121,347	461,539	-	340,192
2024	30,764	461,539	-	430,776

Year	Estimated baseline removals (t CO ₂ -e)	Estimated project removals (t CO ₂ -e)	Estimated leakage emissions (t CO ₂ -e)	Estimated NET GHG emissions reductions (t CO ₂ -e)
2025	63,464	120,710	-	57,246
2026	94,565	120,710	-	26,145
2027	121,988	120,710	-	(1,277)
2028	21,149	120,710	-	99,561
2029	22,537	120,710	-	98,174
2030	25,451	120,710	-	95,260
2031	26,064	120,710	-	94,646
2032	(74,052)	120,710	-	194,762
2033	22,537	120,710	-	98,174
2034	25,451	120,710	-	95,260
2035	26,064	120,710	-	94,646
2036	(74,052)	120,710	-	194,762
2037	22,537	120,710	-	98,174
2038	25,451	120,710	-	95,260
2039	26,064	120,710	-	94,646
2040	(74,052)	120,710	-	194,762
2041	22,537	120,710	-	98,174
2042	25,451	120,710	-	95,260
2043	26,064	120,710	-	94,646
2044	(74,052)	120,710	-	194,762
2045	22,537	120,710	-	98,174
2046	25,451	120,710	-	95,260
2047	26,064	120,710	-	94,646
2048	(74,052)	120,710	-	194,762
2049	22,537	120,710	-	98,174
2050	25,451	120,710	-	95,260
2051	26,064	120,710	-	94,646
2052	(74,052)	120,710	-	194,762
2053	22,537	120,710	-	98,174
2054	25,451	120,710	-	95,260
2055	26,064	120,710	-	94,646
2056	(74,052)	120,710	-	194,762
2057	22,537	120,710	-	98,174
2058	25,451	120,710	-	95,260

Year	Estimated baseline removals (t CO ₂ -e)	Estimated project removals (t CO ₂ -e)	Estimated leakage emissions (t CO ₂ -e)	Estimated NET GHG emissions reductions (t CO ₂ -e)
2059	26,064	120,710	-	94,646
2060	(74,052)	120,710	-	194,762
2061	22,537	120,710	-	98,174
2062	25,451	120,710	-	95,260
Total	978,846	6,894,688	-	5,915,842

3.2.4.4 Calculation of the VCS non-permanence risk buffer withholding

The combined non-permanence risk buffer for the project was determined as 14%. Per VCS methodology VM0007, the annual buffer withholding for all activities was determined as a percentage of the total carbon stock benefits which excludes emissions due to leakage (see Table 57). As the project does not account for emissions from fossil fuel combustion, direct N₂O emissions and emissions from biomass burning were also omitted from calculations.

Table 57. Annual non-permanence risk buffer withholding.

Year	WRC NET GHG emission reductions (t CO ₂ -e)	ARR NET GHG emission reductions (t CO ₂ -e)	Non-Permanence risk buffer (14%)
2016	479,939	(30,475)	62,924
2017	583,674	(59,712)	73,354
2018	660,635	(88,163)	80,146
2019	685,145	(117,743)	79,436
2020	821,273	436,109	176,033
2021	887,392	400,672	180,328
2022	1,040,901	366,349	197,015
2023	1,144,570	340,192	207,866
2024	1,153,511	430,776	221,800
2025	1,546,045	57,246	224,460
2026	1,701,400	26,145	241,856
2027	1,759,689	(1,277)	246,177
2028	1,811,719	99,561	267,579
2029	1,778,195	98,174	262,691
2030	1,790,819	95,260	264,051
2031	1,748,686	94,646	258,066
2032	1,767,234	194,762	274,679
2033	1,703,730	98,174	252,266
2034	1,747,912	95,260	258,043
2035	1,703,028	94,646	251,674

Year	WRC NET GHG emission reductions (t CO ₂ -e)	ARR NET GHG emission reductions (t CO ₂ -e)	Non-Permanence risk buffer (14%)
2036	1,733,651	194,762	269,977
2037	1,708,137	98,174	252,883
2038	1,678,977	95,260	248,393
2039	1,706,098	94,646	252,104
2040	1,663,471	194,762	260,152
2041	1,675,348	98,174	248,293
2042	1,630,853	95,260	241,655
2043	1,591,347	94,646	236,039
2044	1,583,280	194,762	248,925
2045	1,576,685	98,174	234,480
2046	1,590,217	95,260	235,966
2047	1,523,712	94,646	226,570
2048	1,561,304	194,762	245,849
2049	1,507,935	98,174	224,855
2050	1,502,886	95,260	223,740
2051	1,454,250	94,646	216,845
2052	1,467,265	194,762	232,683
2053	1,471,637	98,174	219,773
2054	1,455,839	95,260	217,153
2055	1,395,382	94,646	208,603
2056	1,385,942	194,762	221,298
2057	1,358,887	98,174	203,988
2058	1,378,852	95,260	206,375
2059	1,359,206	94,646	203,539
2060	1,282,972	194,762	206,882
2061	1,288,861	98,174	194,184
2062	1,260,460	95,260	189,800
Total	67,308,950	5,915,842	10,251,448

3.2.4.5 Calculation of Verified Carbon Units (VCUs)

We calculated VCUs by subtracting the VCS non-permanence risk buffer, adjusted for the net emission reductions uncertainty for each project activity (see Table 58).

Table 58. Calculation of estimated verified carbon units.

Year	NER_{WRC}	NGR_{ARR}	$Adjusted_NER_{WRC} + NGR_{ARR}$	Non-Permanence Risk Buffer (14%)	Estimated VCUs
2016	479,939	(30,475)	399,505	62,924	336,581
2017	583,674	(59,712)	513,353	73,354	439,999
2018	660,635	(88,163)	572,472	80,146	492,325
2019	685,145	(117,743)	567,402	79,436	487,966
2020	821,273	436,109	1,257,382	176,033	1,081,349
2021	887,392	400,672	1,288,064	180,328	1,107,735
2022	1,040,901	366,349	1,407,250	197,015	1,210,235
2023	1,144,570	340,192	1,484,762	207,866	1,276,896
2024	1,153,511	430,776	1,584,287	221,800	1,362,486
2025	1,546,045	57,246	1,603,291	224,460	1,378,830
2026	1,701,400	26,145	1,727,545	241,856	1,485,689
2027	1,759,689	(1,277)	1,758,412	246,177	1,512,235
2028	1,811,719	99,561	1,911,280	267,579	1,643,700
2029	1,778,195	98,174	1,876,369	262,691	1,613,677
2030	1,790,819	95,260	1,886,079	264,051	1,622,027
2031	1,748,686	94,646	1,843,331	258,066	1,585,265
2032	1,767,234	194,762	1,961,996	274,679	1,687,316
2033	1,703,730	98,174	1,801,904	252,266	1,549,637
2034	1,747,912	95,260	1,843,171	258,043	1,585,128
2035	1,703,028	94,646	1,797,674	251,674	1,545,999
2036	1,733,651	194,762	1,928,413	269,977	1,658,436
2037	1,708,137	98,174	1,806,310	252,883	1,553,427
2038	1,678,977	95,260	1,774,236	248,393	1,525,843
2039	1,706,098	94,646	1,800,744	252,104	1,548,639
2040	1,663,471	194,762	1,858,233	260,152	1,598,080
2041	1,675,348	98,174	1,773,522	248,293	1,525,229
2042	1,630,853	95,260	1,726,113	241,655	1,484,457
2043	1,591,347	94,646	1,685,993	236,039	1,449,954
2044	1,583,280	194,762	1,778,043	248,925	1,529,117
2045	1,576,685	98,174	1,674,858	234,480	1,440,378
2046	1,590,217	95,260	1,685,476	235,966	1,449,510
2047	1,523,712	94,646	1,618,358	226,570	1,391,788
2048	1,561,304	194,762	1,756,066	245,849	1,510,217
2049	1,507,935	98,174	1,606,108	224,855	1,381,253
2050	1,502,886	95,260	1,598,146	223,740	1,374,405

Year	NER_{WRC}	NGR_{ARR}	$Adjusted_NER_{WRC} + NGR_{ARR}$	Non-Permanence Risk Buffer (14%)	Estimated VCUs
2051	1,454,250	94,646	1,548,895	216,845	1,332,050
2052	1,467,265	194,762	1,662,027	232,683	1,429,344
2053	1,471,637	98,174	1,569,811	219,773	1,350,037
2054	1,455,839	95,260	1,551,099	217,153	1,333,945
2055	1,395,382	94,646	1,490,027	208,603	1,281,424
2056	1,385,942	194,762	1,580,704	221,298	1,359,406
2057	1,358,887	98,174	1,457,061	203,988	1,253,072
2058	1,378,852	95,260	1,474,111	206,375	1,267,736
2059	1,359,206	94,646	1,453,852	203,539	1,250,312
2060	1,282,972	194,762	1,477,735	206,882	1,270,852
2061	1,288,861	98,174	1,387,035	194,184	1,192,850
2062	1,260,460	95,260	1,355,719	189,800	1,165,919
Total	67,308,950	5,915,842	73,164,225	10,251,448	62,912,755

3.3 Monitoring

3.3.1 Data and Parameters Available at Validation

The data and parameters for the SMPP that will be available at validation according to the VCS methodology VM0007 MF are provided in the tables below. A detailed list of all relevant data and parameters are further elaborated in our Climate MRV System.

Data / Parameter	$\Delta C_{BSL-ARR}$
Data unit	t CO ₂ -e
Description	Net GHG removals in the ARR baseline scenario up to year t^*
Equations	PD Section 3.1.3.1.6 Equation 5
Source of data	Module BL-ARR
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Module BL-ARR
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$GHG_{BSL-WRC}$
Data unit	t CO ₂ -e
Description	Net GHG removals in the WRC baseline scenario up to year t^*

Equations	PD Section 3.1.3.1.6 Equation 6
Source of data	Module BL-PEAT
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Module BL-PEAT
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$D_{peatburn,i,t}$
Data unit	m yr ⁻¹
Description	Fire scar depth per year
Equations	PD Section 3.2.1.5.3 Equation 14, PD Section 3.2.1.5.5 Equation 20, PD Section 3.2.2.6 Equation 31
Source of data	Konecny et al. (2016)
Value applied	0.17 m, 0.1 m, 0.06 m, and 0.02 m, for 1 st , 2 nd , 3 rd , and subsequent burning, respectively.
Justification of choice of data or description of measurement methods and procedures applied	Literature
Purpose of Data	Calculation of baseline and project emissions
Comments	N/A

Data / Parameter	CC
Data unit	%
Description	Carbon concentration of the peat
Equations	N/A
Source of data	Own measurement
Value applied	0.53
Justification of choice of data or description of measurement methods and procedures applied	Sampling using standard field and laboratory techniques
Purpose of Data	Calculation of baseline and project emissions
Comments	N/A

Data / Parameter	<i>Project Forest Cover Benchmark Map</i>
Data unit	

Description	Map showing the location of forest land within the project area at the beginning of each monitoring period. If within the Project Area some forest land is cleared, the benchmark map must show the deforested areas at each monitoring event
Equations	Equation 3,7 (Module M-MON)
Source of data	Remote sensing in combination with GPS data collected during ground truthing
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Module M-MON
Purpose of Data	Calculation of baseline emissions
Comments	N/A

3.3.2 Data and Parameters Monitored

The data and parameters for the SMPP that will be monitored according to the VCS methodology VM0007 MF are provided in the tables below. A detailed list of all relevant data and parameters are further elaborated in our Climate MRV System.

Data / Parameter	$\Delta C_{WPS-ARR}$
Data unit	t CO ₂ -e
Description	Net GHG removals in the ARR project scenario up to year t^*
Equations	PD Section 3.1.3.1.6 Equation 5
Source of data	Module M-ARR
Description of measurements methods and procedures to be applied	See Module M-ARR
Frequency of monitoring/recording	See Module M-ARR
QA/QC procedures to be applied	See Module M-ARR
Purpose of data	Calculation of project emissions
Calculation Method	See Module M-ARR
Comments	

Data / Parameter	ΔC_{LK-ARR}
Data unit	t CO ₂ -e
Description	Net GHG emissions due to leakage from the ARR project activity up to year t^*
Equations	PD Section 3.1.3.1.6 Equation 5

Source of data	Module LK-ARR
Description of measurements methods and procedures to be applied	See Module LK-ARR
Frequency of monitoring/recording	See Module LK-ARR
QA/QC procedures to be applied	See Module LK-ARR
Purpose of data	Calculation of leakage
Calculation Method	See Module LK-ARR
Comments	

Data / Parameter	$GHG_{WPS-WRC}$
Data unit	t CO ₂ -e
Description	Net GHG emissions in the WRC project scenario up to year t^*
Equations	PD Section 3.1.3.1.6 Equation 6
Source of data	Module M-PEAT
Description of measurements methods and procedures to be applied	See Module M-PEAT
Frequency of monitoring/recording	See Module M-PEAT
QA/QC procedures to be applied	See Module M-PEAT
Purpose of data	Calculation of project emissions
Calculation Method	See Module M-PEAT
Comments	See Module M-PEAT

Data / Parameter	GHG_{LK-ECO}
Data unit	t CO ₂ -e
Description	Net GHG emissions due to ecological leakage from the WRC project activity up to year t
Equations	PD Section 3.1.3.1.6 Equation 6
Source of data	Module LK-ECO
Description of measurements methods and procedures to be applied	See Module LK-ECO
Frequency of monitoring/recording	See Module LK-ECO

QA/QC procedures to be applied	See Module LK-ECO
Purpose of data	Calculation of leakage emissions
Calculation Method	See Module LK-ECO
Comments	See Module LK-ECO

Data / Parameter	$E_{peatburn-WPS,i,t}$
Data unit	t CO ₂ -e yr ⁻¹
Description	GHG emissions from burning of peat within the project boundary in the project scenario in stratum <i>i</i> in year <i>t</i>
Equations	PD Section 3.2.2.6 Equation 30
Source of data	Literature values
Description of measurements methods and procedures to be applied	See Module E-BPB
Frequency of monitoring/recording	At each monitoring period
QA/QC procedures to be applied	See Module E-BPB
Purpose of data	Calculation of project emissions
Calculation Method	N/A
Comments	N/A

Data / Parameter	$E_{proxy-CO2,i,t}$
Data unit	t CO ₂ -e yr ⁻¹
Description	Soil emission of CO ₂ as land-use proxy in stratum <i>i</i> at year <i>t</i>
Equations	PD Section 3.2.2.4 Equation 27
Source of data	IPCC default factors
Description of measurements methods and procedures to be applied	See Module M-PEAT
Frequency of monitoring/recording	At each monitoring period
QA/QC procedures to be applied	See Module M-PEAT
Purpose of data	Calculation of project emissions
Calculation Method	N/A
Comments	N/A

Data / Parameter	$E_{proxy-CH_4,i,t}$
Data unit	t CO ₂ -e yr ⁻¹
Description	Soil emission of CH ₄ as land-use proxy in stratum <i>i</i> at year <i>t</i>
Equations	PD Section 3.2.2.4 Equation 28
Source of data	IPCC default factors
Description of measurements methods and procedures to be applied	See Module M-PEAT
Frequency of monitoring/recording	At each monitoring period
QA/QC procedures to be applied	See Module M-PEAT
Purpose of data	Calculation of project emissions
Calculation Method	N/A
Comments	N/A

Data / Parameter	A_i
Data unit	ha
Description	Total area of stratum <i>i</i>
Equations	PD Section 3.2.2.4 Equation 27 & 28
Source of data	Module X-STR
Description of measurements methods and procedures to be applied	See module X-STR
Frequency of monitoring/recording	See module X-STR
QA/QC procedures to be applied	See module X-STR
Purpose of data	Calculation of project emissions
Calculation Method	N/A
Comments	N/A

Data / Parameter	$E_{peatditch-CO_2,i,t}$
Data unit	t CO ₂ -e yr ⁻¹
Description	Emission of CO ₂ from ditches and open water stratum <i>i</i> at year <i>t</i> in the project scenario
Equations	PD Section 3.2.2.5.1 Equation 29
Source of data	Literature values

Description of measurements methods and procedures to be applied	IPCC default factor for naturally drained organic soils
Frequency of monitoring/recording	At each monitoring period
QA/QC procedures to be applied	See Module M-PEAT
Purpose of data	Calculation of project emissions
Calculation Method	N/A
Comments	N/A

Data / Parameter	$A_{ditch-WPS,i,t}$
Data unit	ha
Description	Total area of ditch and other open water stratum i in year t in the project scenario
Equations	PD Section 3.2.2..5.1 Equation 29
Source of data	Module X-STR
Description of measurements methods and procedures to be applied	See Module X-STR
Frequency of monitoring/recording	See Module X-STR
QA/QC procedures to be applied	See Module X-STR
Purpose of data	Calculation of project emissions
Calculation Method	N/A
Comments	N/A

Data / Parameter	<i>Project Forest Cover Monitoring Map</i>
Data unit	
Description	Map showing the location of forest land within the project area at the beginning of each monitoring period. If within the Project Area some forest land is cleared, the benchmark map must show the deforested areas at each monitoring event
Equations	Equation 3,7 (Module M-MON)
Source of data	Remote sensing in combination with GPS data collected during ground truthing
Description of measurements methods and procedures to be applied	See Module M-MON

Frequency of monitoring/recording	See Module M-MON
QA/QC procedures to be applied	See Module M-MON
Purpose of data	Calculation of project emissions
Calculation Method	See Module M-MON
Comments	See Module M-MON

Data / Parameter	$A_{DefPA,i,u,t}$
Data unit	Ha
Description	Area of recorded deforestation in the project area in stratum i converted to land use u at time t
Equations	Equation 3 (Module M-MON)
Source of data	Remote sensing imagery
Description of measurements methods and procedures to be applied	See Module M-MON
Frequency of monitoring/recording	See Module M-MON
QA/QC procedures to be applied	See Module M-MON
Purpose of data	Calculation of project emissions
Calculation Method	See Module M-MON
Comments	See Module M-MON

Data / Parameter	$C_{BSL,i}$
Data unit	t CO ₂ -e ha ⁻¹
Description	Carbon stock in all pools in the baseline in stratum i
Equations	Equations 5, 17, 18, 19, 24, 27 (Module M-MON)
Source of data	Module M-MON
Description of measurements methods and procedures to be applied	See Module M-MON
Frequency of monitoring/recording	See Module M-MON
QA/QC procedures to be applied	See Module M-MON
Purpose of data	Calculation of project emissions
Calculation Method	See Module M-MON

Comments	See Module M-MON
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Data / Parameter	$A_{RRL,forest,t}$
Data unit	Ha
Description	Remaining area of forest in <i>RRL</i> at time <i>t</i>
Equations	
Source of data	Module M-MON
Description of measurements methods and procedures to be applied	See Module M-MON
Frequency of monitoring/recording	See Module M-MON
QA/QC procedures to be applied	See Module M-MON
Purpose of data	Calculation of project emissions
Calculation Method	See Module M-MON
Comments	See Module M-MON

3.3.3 Monitoring Plan

3.3.3.1 Approaches for climate impact monitoring

The adaptive management plan for climate impact monitoring incorporates lessons learned from past monitoring to revise goals and objectives, includes the most recent scientific findings and new technologies as they become available in order to systematically increase effectiveness of existing practices. The adaptive management plan creates a tool to unify past and present experience into strategic planning for project management as part of a shared learning process. The following tasks will be performed on an annual basis by the project team as part of the monitoring report compilation:

- Disseminate and evaluate field data collection, and improve workflows were needed.
- Review recent literature on the scientific advancements of the specific sections of the climate impact monitoring system (i.e. remote sensing, forest inventories, in-situ GHG emission monitoring from peat decomposition, water bodies, peat and biomass burning, and peat characteristics and peat subsidence).
- Review the latest technological advancements in the different fields and incorporate these were feasible and needed.

Climate impact monitoring includes monitoring changes in land cover, peat thickness and water table level, as per the VCS VM0007 methodological requirements. A summary of the main monitoring methods is given below.

3.3.3.1.1 Remote sensing

We will obtain and analyze satellite imagery to detect land cover change, such as natural regeneration of vegetation, or (if any) vegetation loss caused by fire or encroachment. In cases where forest changes take place, we will follow the procedures outlined in VCS methodology VM0007 Module M-MON to quantify the relevant parameters.

M-MON outlined three main steps for monitoring of greenhouse gas emissions and removals by implemented by applying the following:

STEP 1. Selection and analyses of sources of land-use and land-cover (LU/LC) change data

STEP 2. Interpretation and analyses

STEP 3. Documentation

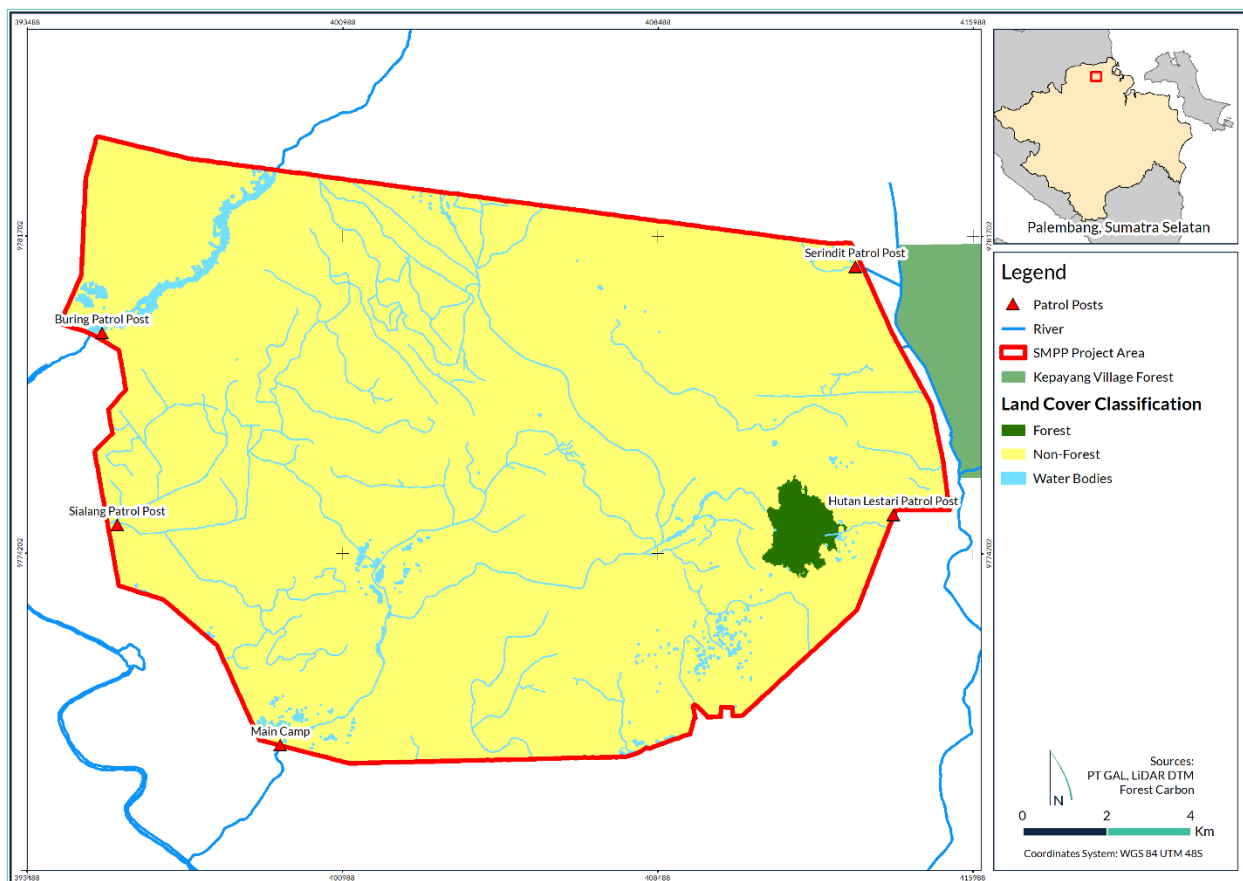
We will update the land cover map at each monitoring period and carry out the update annually. In Step 1 (with more details of the process documented in the Remote Sensing Standard Operating Procedure document in **Annex X**), our base image will be medium-resolution satellite image covering the Project Area (e.g. 30 x 30 m resolution of Landsat 8 or finer resolution). We plan to use the same source of remotely sensed data and data analysis techniques within the period for which the baseline is fixed.

We plan to use Landsat 8 Level-2 image containing surface reflectance and spectral index bands, as the Level-2 image is the same source data used for producing the forest benchmark map and has gone through geometric, topographic and atmospheric corrections. If for any reason we need to replace the source data with different types of image, we will perform minimum pre-processing that involves geometric correction and georeferencing and cloud and shadow detection and removal.

In **Annex X** we document detailed post-processing to locate area change detected in the imagery and calculate the area of each land cover type of change within the Project Area at the end of each monitoring period, in order to update the remaining area of forest in RRL (ARRL,forest,t) At the time of baseline revision, we will calculate the area of each land cover type in the Project Area and then update the forest cover benchmark map.

We will quantify the area of recorded deforestation by subtracting change areas of forest cover for Step 2 to produce an estimate of the emissions resulting from any deforestation that occurs within the Project Area ($\Delta CP, Def, i, t$). The quantification of newly deforested area is based on common practices of change detection techniques detailed in **Annex X**. We will then calculate the emissions from deforestation by multiplying areas of deforestation by the average forest carbon stock per hectare. The area of remaining forest will be based on subtracting non-forest area and we will record it in a forest benchmark map, which will be updated for each monitoring period. Map 31 below shows the initial benchmark map of forest/non-forest area distribution. The net carbon stock change as a result of deforestation is equal to the area deforested multiplied by the emission per hectare. The emission per hectare is equal to the difference between the stocks before and after deforestation minus any wood products created from timber extraction in the process of deforestation.

Map 31. Forest cover benchmark map



In addition to the above, we will use MODIS and VIIRS hotspot data to provide nearly real-time updates on potential fire activity in the project area and alert ground fire controlling/prevention team to examine the field conditions.

In Step 3 to document the methodological procedures used in Steps 1-2 above, in **Annex X** we list details of data and documentation preparation. In particular, we will document data sources and pre-processing steps undertaken for the remote sensing data, definition of the land cover classes, classification approach and classification algorithms, description of the ground truth or ground reference data collected for training purposes, ancillary data used in the classification, software used to perform the classification, and additional spatial data and analysis used for post-classification analysis. For the classification accuracy assessment, we document accuracy assessment technique used, description of the ground truth or reference data collected for classification accuracy assessment, and final classification accuracy assessment result.

3.3.3.1.2 Field measurement

Monitoring C stock

In 2020 we will begin monitoring change in carbon stocks of tree biomass through field measurements using a point sampling method with an allometric equation on tree diameter (diameter at breast height or DBH).⁵⁸ Per CDM A/R Methodological Tool “Calculation of the number of sample plots for measurements within A/R CDM project activities,”⁵⁹ the project will establish monitoring plots for areas representing the ARR activities in 2020 and continue to monitor thereafter every five years. Allometric equations based on DBH will be the main parameter.

Monitoring GHG emissions from microbial decomposition of peat

In 2020 we will begin monitoring GHG emissions from microbial decomposition of peat by directly monitoring proxy variables for GHG flux that are used when calculating GHG emissions. For strata with less dynamic water table levels (e.g. undrained forested peatland) as well as strata where water table levels are more dynamic or without forest cover (e.g. initially drained deforested peatland), we will monitor forest and non-forest cover as well as water table levels to update annual strata cover conditions and drainage status. Remote sensing methods in Section 3.3.3.1.1 will inform changes in vegetation cover. To monitor drainage status, we will implement point-based monitoring using dip wells installed and distributed along transects comprising each water table level stratum. We will then develop a hydrological model to extrapolate dip well measurements into a continuous water table level map. We will examine changes in vegetation cover and water table levels to determine status change strata (if any), and efficacy of compacted peat dams for canal blocking. Annual GHG emissions from microbial decomposition of peat will be summarized by using IPCC default emission factor and following procedures in the VSC methodology VM0007 Module M-PEAT. A detailed canal blocking plan, as well as water table level monitoring sampling design and SOP are available in Annex 8.

Monitoring GHG emissions from water bodies

We will determine the amount of time necessary to develop and monitor site-specific dissolved organic carbon (DOC) value(s). The value(s) will be used to calculate emissions from water bodies by considering changes in area (i.e. channel widths and lengths derived from visual assessment with medium-high resolution remote sensing images).

Monitoring GHG emissions from peat and biomass burning

In addition to the hotspot remote sensing data listed in Section 3.3.3.1.1, we will also monitor GHG emissions from peat and biomass burning with regular patrol. At every burning incident (if any), we will delineate burning area by a combination of ground checking and visual assessment from remote sensing imagery. We will summarize GHG emissions from burning annually following Module E-BPB.

Peat characteristics and subsidence

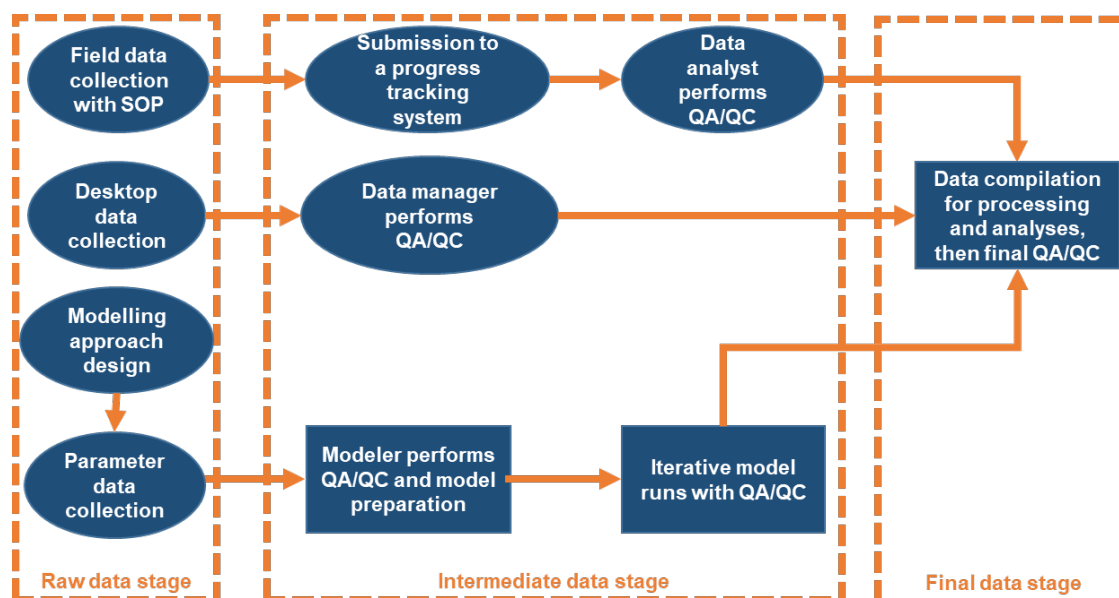
The baseline scenario requires updating every ten years. Upon the year to update, we will conduct peat inventory at sampling locations stratified by a DTM. The inventory data collection will include peat depth, peat type, bulk density and carbon content. The field data will inform the most suitable topographic and hydrological variables for deriving an interpolated peat thickness map. We will then use this model output to characterize subsidence and other baseline emission characteristics. The details of monitoring design can be found in Annex 8.

3.3.4 Dissemination of Monitoring Plan and Results (CL4.2)

All data generated by the project area flows through a multi-stage data collection, QA/QC, compilation and analysis management process (

Figure 5). Both soft (scanned or digital) and hard copies of data are stored in the project's central office in Jakarta, synchronized in a network attached storage and backed up in a cloud system. This allows simultaneous multi-user inputs and data versioning history, as well as lost data recovery.

Figure 5. Data collection, QA/QC, and processing workflow. Steps in oval = conducted internally by the project staff; Steps in rectangle = conducted by either internal project staff or external project consultant.



We standardize data through standard operation procedures (SOPs) and perform multiple quality assurance and quality control (QA/QC) assessments. All data collected, recorded, stored, and reported are subject to review and approval by data analysts, data managers, the technical project lead, and the project team leader with reference to each level of data management. In order to ensure the security and traceability of data entry and QA/QC, all data in raw, intermediate, and final stages have access levels pre-defined for different types of users.

Brief, regular monitoring reports will be generated to assess the quality of data being received from the field and investigations into any potential outliers. Any possible monitoring equipment failures will be carried out to ensure the data passes QA/QC.

We will have the climate monitoring plan available for public review at the project office. The full results of the initial climate monitoring included in this project document are being made publicly available in the project zone. Additionally, a project document summary is written and provided to communities throughout the project zone in English and Bahasa Indonesia.

3.4 Optional Criterion: Climate Change Adaptation Benefits

3.4.1 Regional Climate Change Scenarios (GL1.1)

Precipitation in Indonesia is strongly influenced by El Niño/ Southern Oscillation (ENSO) events, which might become more frequent and intense as a result of climate change. Because Indonesia typically experiences drought during El Niño events (the warm phase of ENSO) and excessive rain during La Niña events (cool phase of ENSO), the shifting global pattern of ENSO will have substantial regional impacts.⁶⁰

Various reports show that the geographic region of the project zone is likely to exhibit various effects of climate change with greater weather anomalies by 2050, 2080, and 2100. Temperatures will increase consistently with increased duration of heat waves and dry spells.^{61,62} There will be a considerable shift in precipitation patterns, with increase in rainfall especially during the wettest months of rainy season (December to February).^{60,63} Pattern of seasonality is likely to change, with the wet season begins several weeks later than the average compared to historical periods.⁶⁴ This delay would result in increase in rainfall

later in the crop year and decrease in rainfall later in the dry season.⁶² There will be increased frequency and intensity of heavy rainfall events.⁶¹

The region is vulnerable to other weather-related disasters and climate hazards such as forest and land fires, storms, and drought that damage infrastructure and degrade ecosystems, leading to loss of life, property, ecosystem services, and livelihoods.⁶¹ Accordingly, longer dry season and a more intense rainy season will result in prolonged drought and more intense flooding.⁶⁴

3.4.2 Climate Change Impacts (GL1.2)

Changes in land-use, temperature, and precipitation have already caused widespread wildfires in the project zone, as evidenced by the catastrophic fires in 2015. Altered biophysical features, as well as vegetation composition and structure impact biodiversity and ecosystem services functioning. Climate change would exacerbate this problem.

Climate change has food security and economic growth implications. Changing precipitation patterns, evaporation, run-off, and soil moisture would all impact agricultural production levels. In addition, reduced availability of freshwater will have implications for health and economic production processes.⁶²

Specific to agriculture, heat stress will reduce production, heat and humidity increase will increase pests and diseases, heavy rainfall will increase flood damage to cultivated land, and increased inundation and drought will cause production loss or failure. For water resources, elongated dry seasons will reduce water supplies for domestic consumption and agriculture and floods will decrease water quality. For natural resources, increased frequency and extent of wildfires will cause decline in biodiversity (or extinction of endangered species) and ecosystem services and affect viability of forest-dependent livelihoods. For human health, increased floods and humidity will introduce incidence of waterborne and vector-borne diseases, whereas increased heat will bring risk of food security.⁶¹

In the province of South Sumatra where the project zone is, climate change will impose declines in the value of agricultural output, increased exposures and costs due to impacts of dengue fever and malaria, and increased value of agricultural losses.⁶³

3.4.3 Measures Needed and Designed for Adaptation (GL1.3)

The project area and project zone are vulnerable to the potential impacts of climate change, which imposes impact on ecosystem services functioning, livelihoods and health. In the project zone, we aim to strengthen community (human) and environmental (non-human) resilience by implementing adaptation options through a variety of project activities (see details in Section 2.1.11). We summarize activities relevant to climate change adaptation and their respective benefits in Table 59 below.

Table 59. Climate change adaptation benefits from project activities.

Project activity	Components	Climate change risks and concerns addressed	Adaptation benefits
Forest Patrolling	Project boundary demarcation Guard posts Radio communication system for reporting Foot, bicycle, boat and vehicle patrolling Data collection and analysis on threats Drone monitoring Local law enforcement	Poor disaster risk management (DRM) in reduction, response and recovery Lack of seamless early detection and risk prevention systems	The activity provides mechanisms for prevention, monitoring, reporting and response to minimize risks and damage caused by climate change. The risk minimization enhances resilience to potential climate change impacts.
Fire Prevention and Monitoring	Patrol activities Early Warning System of potential fires Fire Response and Suppression teams	Increased fire risk Intensified fire damage to peatland Loss of biodiversity Decreased or lost ecosystem services functions and quality	The activity provides mechanisms for prevention, monitoring, and rapid response to minimize fire risks and damage exacerbated by climate change. The risk minimization enables healthy conditions to maintain biodiversity and ecosystem functioning, hence enhances resilience to potential climate change impacts.
Canal Blocking and Hydrology Management	Technical assessment Canal blocking plan Peat dam installation Hydrology monitoring Collaboration with adjacent concessions	More intense and longer duration of drought Increased risk of flooding Loss of biodiversity Decreased or lost ecosystem services functions and quality	The activity provides robust, replicable mechanisms for improving soil and water quality, hence strengthens biodiversity and ecosystem services features. The biophysical improvement prepares the site facing climate change, hence generates resilience to potential impacts.
Reforestation and Assisted Natural Regeneration (ANR)	Tree nurseries ANR approach trials Annual ANR and replanting Technical support to nearby <i>Hutan Desa</i>	Decline or loss of native gene pools Lack of local knowledge for climate-smart reforestation	The activity conserves gene pools that could be threatened by climate change, supports assisted gene flow especially for more resilient species, and raises awareness in the communities. The knowledge transfer also supports community forests.

Project activity	Components	Climate change risks and concerns addressed	Adaptation benefits
Community Development	Education opportunities Improved livelihoods and quality of life Youth and local employment Waste clean up Co-financing rainwater catchment system	Lack of alternative livelihood sources Worsened sanitation Increased chance and spread of diseases Undeveloped resilience to altered productivity	The activity diversifies communities' opportunities for livelihoods and employment, and thereby generating resilience to challenges brought by climate change. The improved sanitation and water usage also enhance the well-being and community health.
Biodiversity Management and Monitoring	Detecting, identifying and understanding the characteristics, distribution, sensitivity and vulnerability of HCVs Biodiversity feature monitoring design Biodiversity monitoring implementation	Population decline Loss of biodiversity and habitats Heightened status of threatened species Lack of evidence-based conservation plan development	The activity establishes a data-driven, traceable system to monitor changes in biodiversity features in response to climate change. The system provides basis for predicting climate change impact on biodiversity and for developing conservation planning adjusted to address the impacts.
Cross-cutting	Adaptive management Effective administration and human resources Financial management Legal compliance	Insufficient resources for disaster risk management in reduction, response and recovery Lack of sustainable natural resources management plan	The activity ensures that the decision-making process to address climate change impacts is backed by sustainable business management and operations. Therefore, a mechanism to generate business resilience to climate change is in place.

4 COMMUNITY

4.1 Without-Project Community Scenario

4.1.1.1 Descriptions of Communities at Project Start (CM1.1)

The SMPP is in an isolated area with comparatively little interaction with local people. The closest surrounding villages are removed from the project site at a significant distance by boat, car, or motorbike (Map 8). For example, the Kepayang village is located about 15 km from the SMPP's main camp but given road conditions it is about a 45-minute to 1.5-hour motorbike or car ride. On a small motorized canoe (often used by local fishermen), it can take roughly two hours.

There are still some important groups that interact with the project landscape and activities. In the Climate, Community & Biodiversity Standards, Third Edition, a “community” refers to any group of people that derive any income, livelihood, cultural values, or other contributions to well-being from within the project area. There are no individuals living within the SMPP area and few that rely on it for their livelihood or ascribe cultural value to the zone. The SMPP interacts with a total of two community groups, according to the CCB: a group of 21 fishermen, distributed across the Kepayang river, the Buring river, and the Tembesu Daro canal, and two small-scale palm oil farmers and their families.

Following the CCB methodology, we have defined the residents of nearby settlements, including from the formally recognized Muara Muang and Kepayang villages, as well as other unofficial settlements along the rivers, as “other stakeholders” as they do not derive their livelihoods from the project area. However, these communities are an important aspect of the social development component of the project and thus the community profiles and our program objectives for them are covered in detail in section 4.3, which covers other stakeholder groups.

Fishing activities are spread across three main areas, including those used by four fishermen along the Kepayang river, four fishermen along the Buring river, and the remaining along the Tembesu Daru canal. Proximity of large industrial activities among other factors, has resulted in the Lalan river becoming too polluted to fish safely. Fishing communities therefore rely on the cleaner waters in and around the SMPP for safe and productive fishing, despite the considerable distance away from their homes. The smallholder farmers cultivate palm oil on the eastern border of the project boundary and the project team has an on-going and open dialogue with them about the impact and potential benefits of the project.

4.1.1.1.1 Local ethnicities

All of the people living in this region, the fishermen and farmer communities, as well as the other stakeholders, have diverse ethnic backgrounds. There are currently no longer any self-described indigenous people living in the area. The current inhabitants of the area have mostly migrated from other parts of Indonesia and have lived in this region for a long time, dating back to the founding of these settlements and villages. Many people have come from other areas in Sumatra, further north from the SMPP area, including from Jambi province and further away from Medan in North Sumatra, and ethnic groups also include people of Javanese and Melayu origin.

4.1.1.1.2 Land-uses and economic well-being

The community of fishermen interacting with the SMPP are comprised primarily of retired older men, many of whom may not be able to complete other jobs or do not have other stable income sources. Of these fishermen, nine individuals rely solely on this fishing activity as their livelihood and harvest fish full time. The other twelve individuals conduct their fishing activities on a seasonal basis and rely on other jobs, using fishing to supplement their income and diversify their food sources. Both categories of fishermen consider fishing within the SMPP and neighboring areas a crucial aspect of their livelihoods to support their families. The farmers that cultivate land along the southeastern border of the SMPP are of a lower economic bracket compared to others within the nearby villages, and as there are many opportunities for other more formal

jobs in the wider area, farming is much less common. Specifically, these farming activities focus primarily on small-scale palm oil production.

Our 21 community fishermen range in age from 39 to 69, and live in village and settlement areas of Kepayang, Tebing Harapan, Buring, Bakung, and Pal 8. We have demographic information about each of the community fishermen and farmers, however this information will be kept confidential. Through dialogue with these with local fishermen, we have estimated the average economic value of fishing livelihoods in the SMPP results in a monthly net income of \$47 USD per fisherman. The average monthly salary in the Muara Merang and Kepayang villages ranges from \$139-\$209 USD per household, which is also well above the international poverty line of \$1.90 USD per day according to the World Bank.⁶⁵

Adjacent to the project area, there are two farmers that occupy 8 and 7 ha of farmland, respectively, with 5.9 ha and 5.6 ha located within the SMPP license area. These two farmed patches of land are identified in Map 33. All of these community members live among the other stakeholders in the closest villages and settlements (however it is important to note, as described in Table 3 and in Section 2.1.6, that these villages and settlements are still a significant distance away from the SMPP).

4.1.1.1.3 Public health

The quality of the main river tributaries that connect with that project site river water are poor and often unsafe for use, however the water becomes cleaner closer into the project site. Smaller canals are used for washing, bathing, and toilet use if proper toilets are not available. For drinking and cooking, transient fisherman or farmers working during the day use collected rainwater or bring in wholesale bottled water, sourced from treated rainwater or containers brought from Palembang. The transient community groups that interact with the project area have no other infrastructure to rely on other than makeshift latrines in the farming areas.

4.1.1.1.4 Education

Community fishermen that frequent the SMPP are comprised primarily of retired older men and the two farmers are also older males with education levels ranging from elementary to high school. The areas near the SMPP have a variety of opportunities for formal education and the project has a strategy to invest in these opportunities for project community members and their families and those defined as other stakeholders.

4.1.2 Interactions between Communities and Community Groups (CM1.1)

The communities identified by SMPP are outlined in Section 4.1.1.1 above. According to the standard CCB definition, specific groups within communities that can be distinguished are referred to as “community groups”, but due to the size of our defined communities we do not have any community groups in our project zone. As we do not have community groups in the SMPP, we do not have any interactions between communities and community groups.

4.1.3 High Conservation Values (CM1.2)

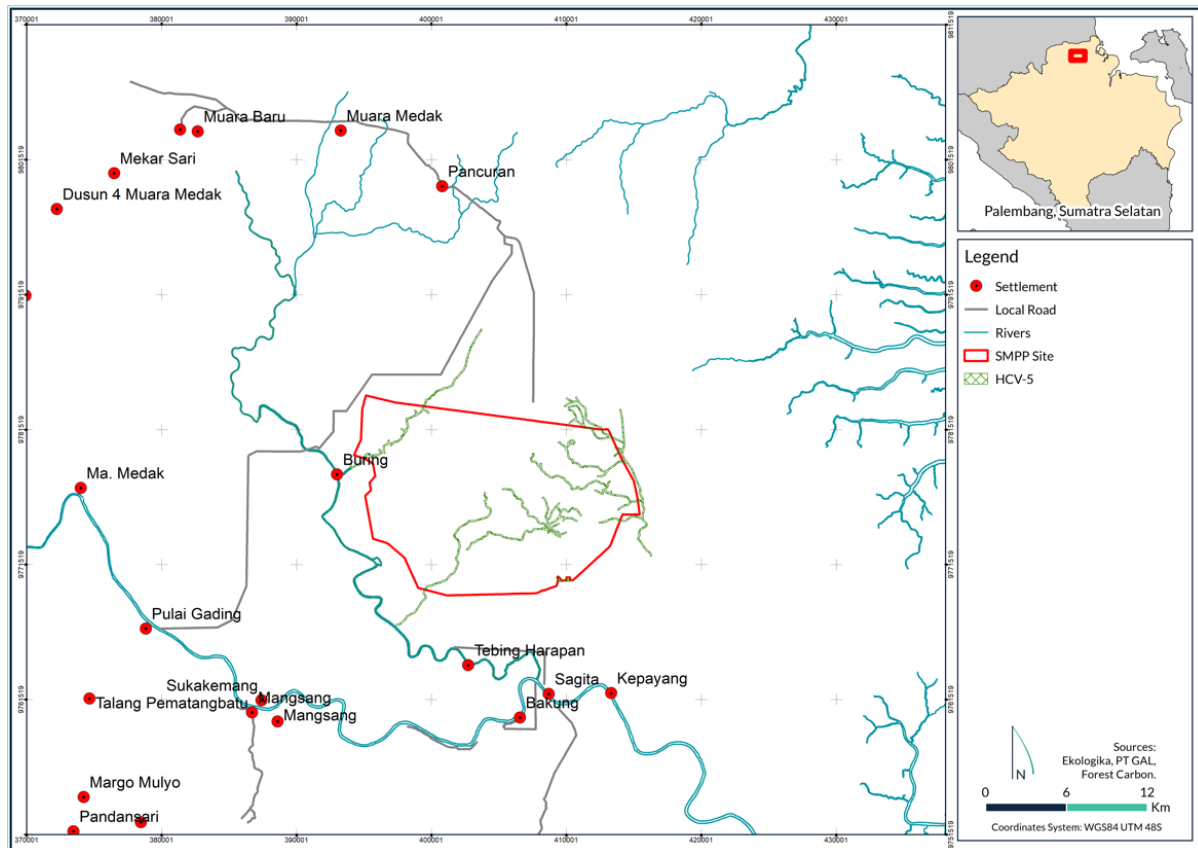
The SMPP project aims to protect and improve the quality of high conservation values (HCVs) that support community well-being within our project area. There are two HCVs identified within the SMPP area related to community well-being (outlined below in Table 60). The HCV areas are further described for HCV 4 in Section 5.1.3.5 in Map 41 and for HCV 5 regarding fishing in, Map 34, Map 35, Map 36, and farming in Map 33.

Table 60. Summary of high conservation values related to community well-being in the SMPP area.

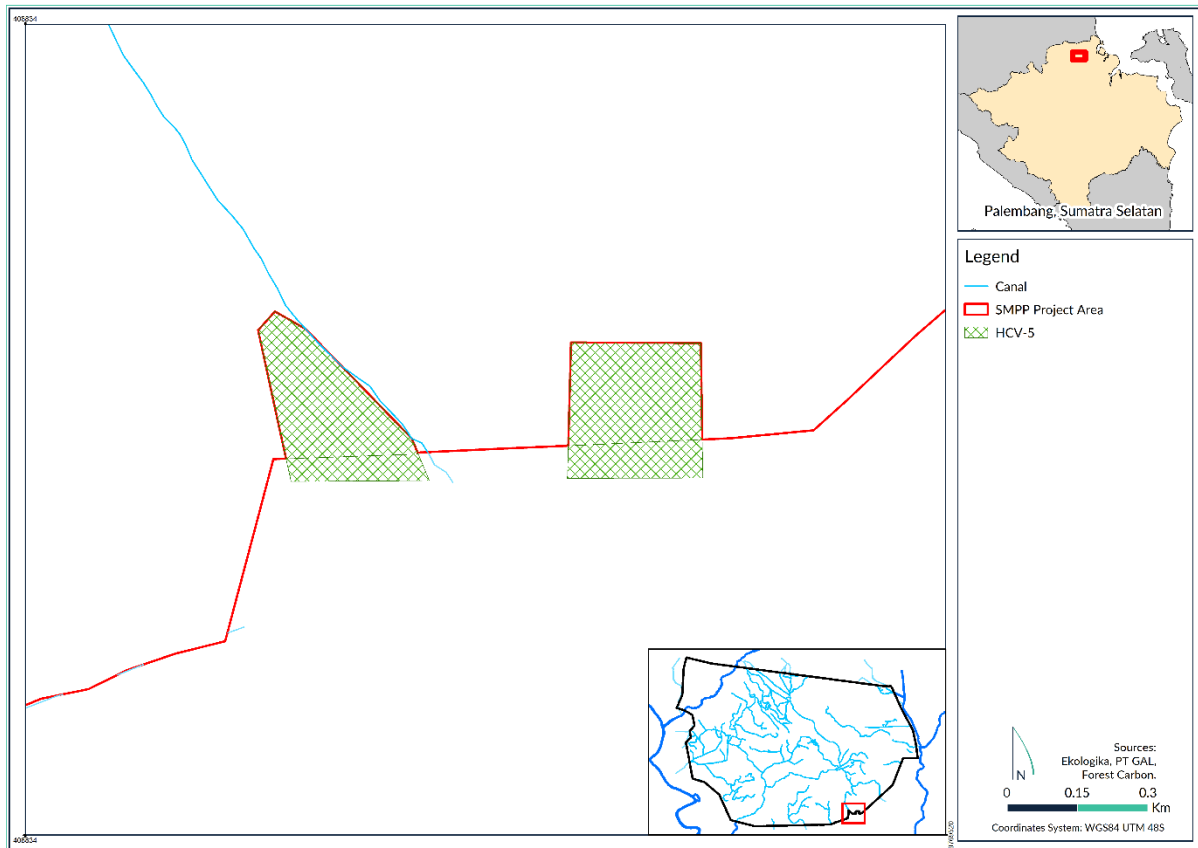
High Conservation Value	HCV 4 – Ecosystem Services: Quality of Life
Qualifying Attribute	Areas important for watersheds, erosion control, and areas that provide restrictions on destructive fires, pollination services. The SMPP's peat forest areas provide the following ecosystem services related to community well-being: • Flood and fire prevention and protection; • Land and fisheries protection; • Wind protection and microclimate regulation; • Clean water supply; and • Pollination service.
Focal Area	HCV 4 has been identified within the SMPP landscape: • Flood prevention areas include peat forest in KM 14, floodplains in the Buring river, the Serindit patrol post, and the Kepayang river. • Fire prevention, wind protection, microclimate regulation, and water catchment areas include peat forest on the eastern side of the SMPP (the remaining forest block in KM 14). • Land protection, aquifer and fisheries are buffer areas, although shrub land cover can still function to prevent morpho-erosion of the rivers. • Pollination services are indicated by the presence of a honey tree, although not many but there are still trees that contain honeycomb (primarily Kempas trees) in the remaining forest block in KM 14 on the eastern side of the SMPP.

High Conservation Value	HCV 5 – Community Needs: Fishing and Small-Scale Farming
Qualifying Attribute	Area and resources that are essential to meet the basic needs of community (e.g., livelihood, health, nutrition, water), identified through engagement with local people. Fisheries: • Provide fresh water and habitat for fish including spawning grounds and fishing grounds. • Important as sources of protein for the other stakeholders living in nearby settlements and villages, and as direct revenue sources for SMPP community fishermen that travel long distances to use the resources of the SMPP fishing grounds. Small-scale farming: • Provide land to farm.
Focal Area	Fishing: Along the Buring river, Tembusu Daro canal, and Kepayang river inside the SMPP boundary. Farming: In the southern region of the SMPP (boundary markers 420-427).

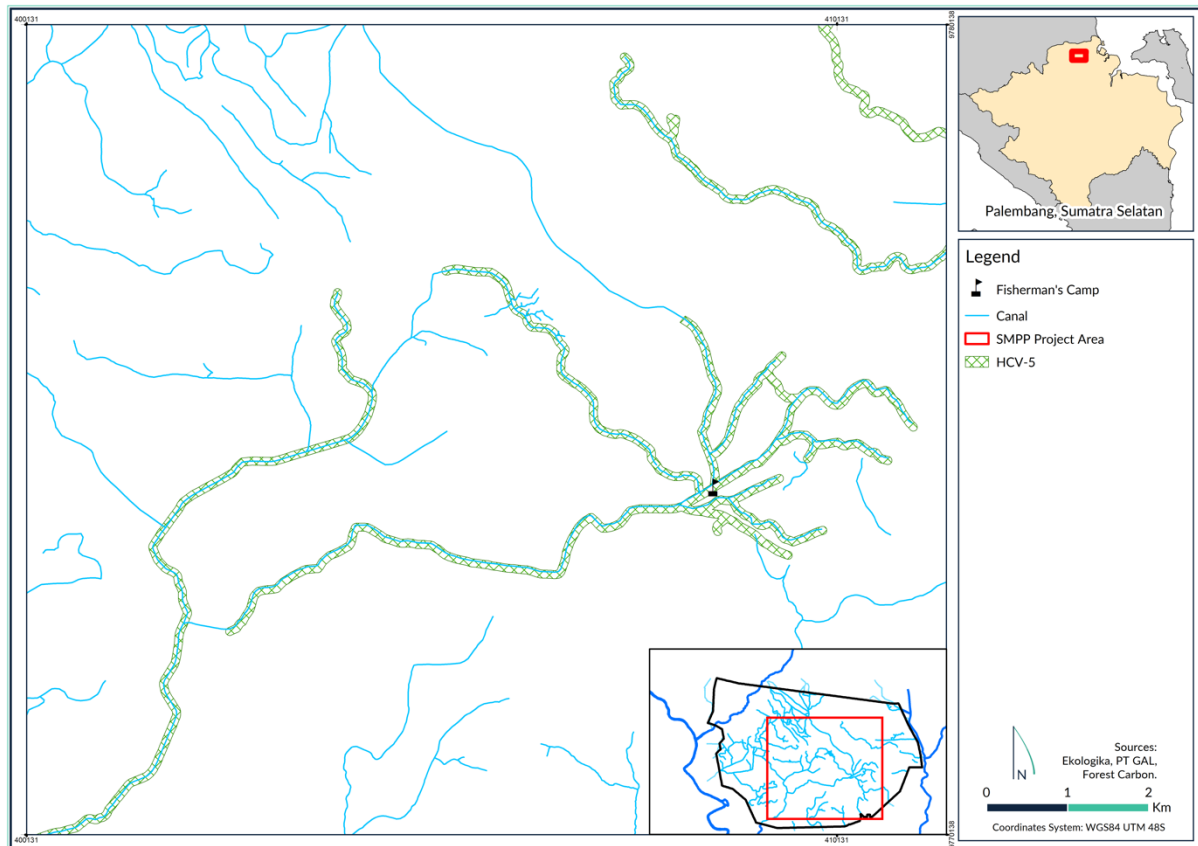
Map 32. HCV 5 areas throughout the SMPP.



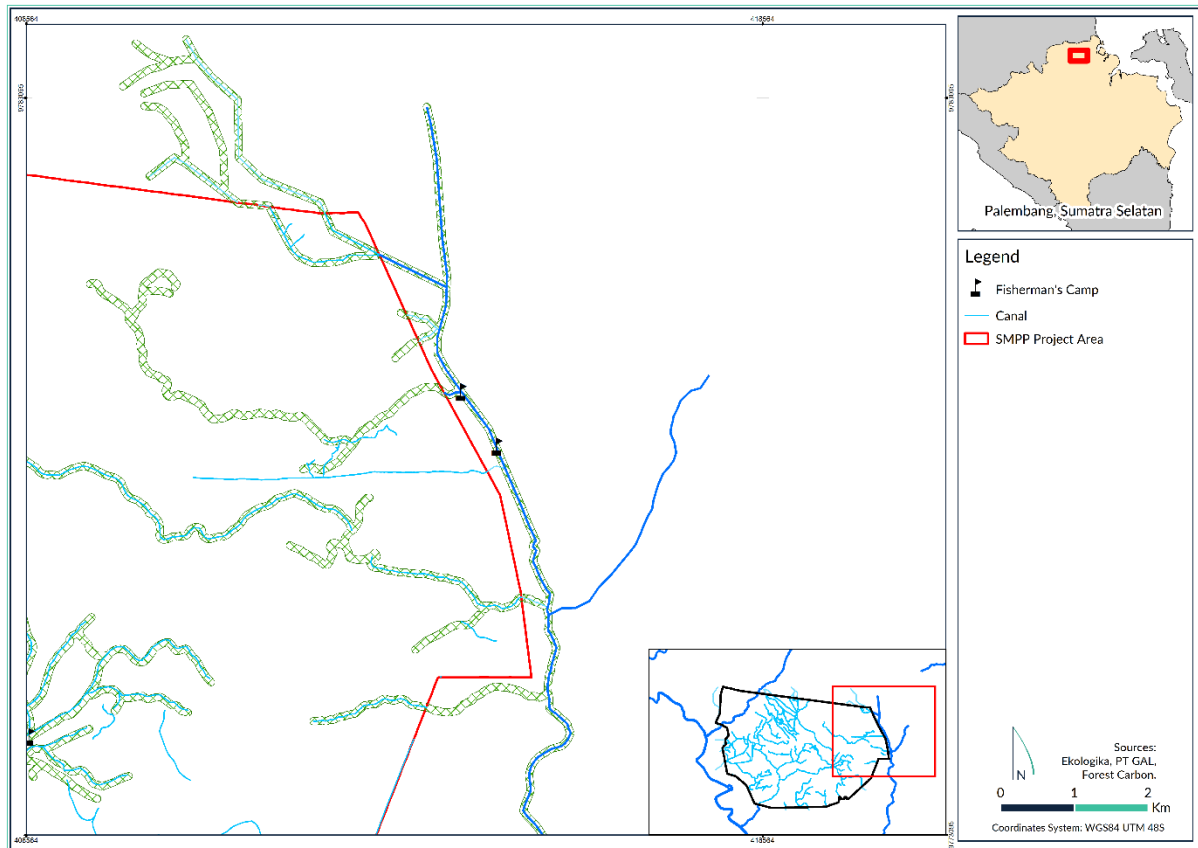
Map 33. Farming areas along the southern boundary of the SMPP (HCV 5).



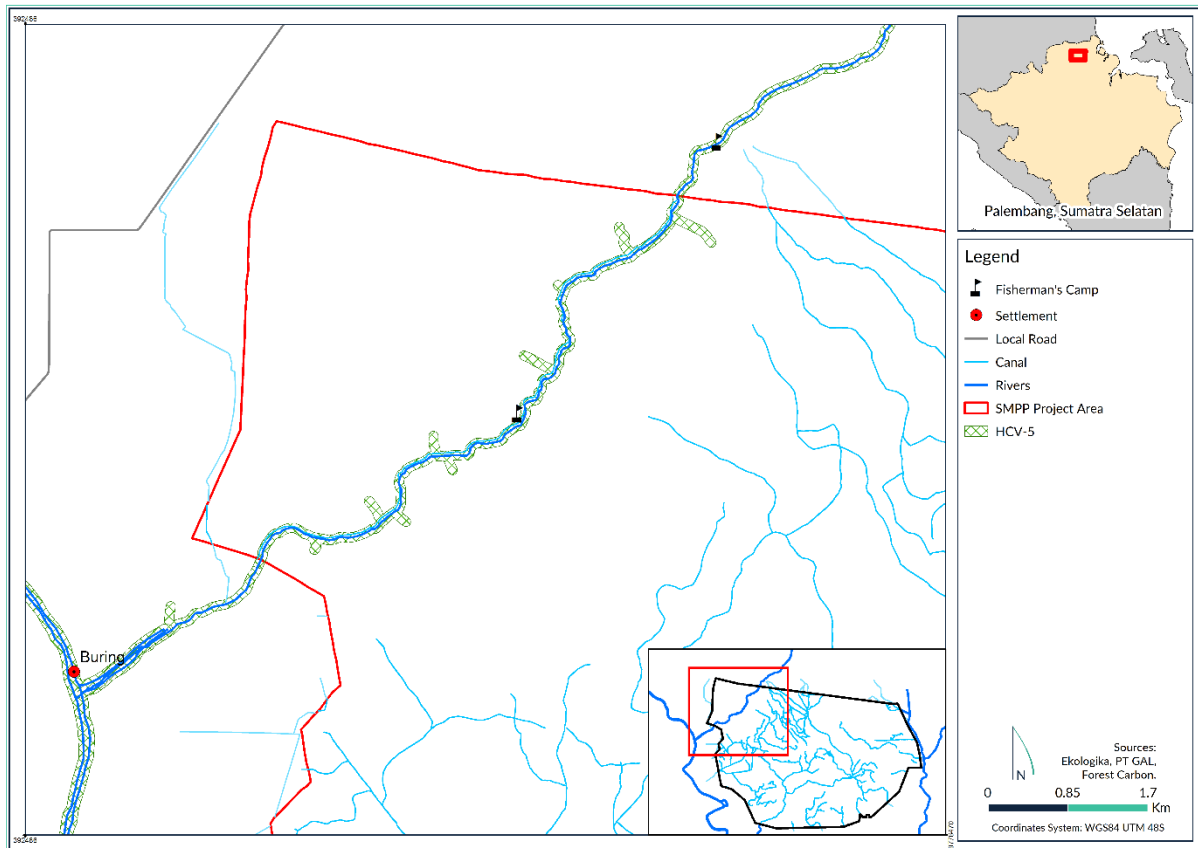
Map 34. Fishing areas along the Tembesu Daro canal (HCV 5).



Map 35. Fishing areas along the Kepayang river (HCV 5).



Map 36. Fishing areas along the Buring river (HCV 5).



4.1.4 Without-Project Scenario: Community (CM1.3)

The SMPP area is largely surrounded by industrial plantation forest and therefore—in the absence of this project—this endangered peatland ecosystem would be at extremely high risk for conversion to an industrial forest plantation, namely fast-growing *Acacia* plantations grown for pulp and paper. This activity would have significant impacts on the physical conditions of the SMPP area, and in turn would impact the farming and fishing communities that operate within the SMPP, in addition to the other stakeholders that would be hit by downstream effects from fire and water quality degradation. First, an *Acacia* plantation would require further draining of the already degraded peat leading to a further homogenization of important aquatic habitats. This drainage would further reduce the water quality in the SMPP and negatively affect fishing grounds, and massive canalization would disrupt soils. Secondly, the short average rotation of *Acacia* tree crops would mean that plantation forests cannot provide in situ, permanent long-term biodiversity benefits that affect overall ecosystem services for stakeholders near and far. As such, this land-use conversion would directly impact the fishermen and farmers that rely on the SMPP area for their livelihoods. Additionally, there is no guarantee that in the absence of the project the fishermen, and farmers in particular would maintain access to the land they need to support their livelihoods. Therefore, the without-project scenario would lead to net negative impacts on communities, negating any limited positive impacts derived from the establishment of *Acacia* plantations such as opportunities for employment and limited corporate social responsibility programs.

4.2 Net Positive Community Impacts

4.2.1 Expected Community Impacts (CM2.1)

As described in Section 4.1.1.1 above, the SMPP has a limited number of communities within the project area. The small group of fishermen and farmers that derive their livelihoods from within the SMPP area all reside in the neighboring areas outside of the project boundary (see Section 2.1.6 for a definition of communities and other stakeholders). However, the project will still provide a variety of positive impacts to these stakeholders, as outlined in Table 61 below. Due to the lack of individuals living near or within the SMPP, we will focus much of our community development programming on those defined by the CCB as other stakeholders, which live primarily in the Muara Merang and Kepayang villages. These activities are outlined in detail throughout Section 4.3. Given that the direct community members also live in these same surrounding areas, our work to provide benefits to other stakeholders in neighboring settlements and villages will also benefit community members beyond what has been immediately identified below.

Table 61. Expected impacts for specific community groups in the SMPP.

Community Group	Fishermen and their Families
Impact(s)	• Reduced fires in the region; • Protection of and access to fishing grounds; • Improved water quality within the project area will benefit fish stocks; • Improved access to clean water; • Improved access to education; • Improved waste management; and • Employment opportunities within SMPP.
Type of Benefit/Cost/Risk	Predicted Direct Benefits
Change in Well-being	Potential improvement to livelihoods and overall quality of life

Community Group	Small-Scale Farmers and their Families
Impact(s)	• Reduced fires in the region reduces risk of farm destruction. • Long-term livelihood security as the SMPP and farmers have an agreement to ensure the farmers can maintain access to their existing plots of land that overlap with the project area. • Improved access to education; • Improved waste management; and in general, enhanced ecosystem services in the project area.
Type of Benefit/Cost/Risk	Predicted direct benefits
Change in Well-being	Potential improvement to livelihoods and overall quality of life

4.2.2 Negative Community Impact Mitigation (CM2.2)

The SMPP communities of fishermen and farmers do not reside within the SMPP but only enter and exit for activities related to their livelihoods. It is possible that as biodiversity returns to the SMPP area, fishermen or farmer communities may be impacted by large wildlife such as sun bears or tigers. To deal with this potential negative impact, we have a wildlife human conflict reduction strategy and will train

community members on how to reduce this risk. We will also continue to maintain direct lines of communication with the project communities to address issues through our adaptive management plan to mitigate issues as they arise.

Increased water levels from canal blocking and other peat rewetting strategies could potentially impact farmer productivity, but through in person interviews our farmer community members have expressed a sentiment that the decreased risk from fire from mitigation activities by the project outweighs any inconvenience caused by higher water levels. The biggest risk to smallholder farming assets is from wildfires, which could completely wipe out their investment, as evidenced by the 2015 fire which degraded a large portion of the area.

4.2.3 Net Positive Community Well-Being (CM2.3, GL1.4)

With the SMPP, we aim to generate significant net positive impacts for the fishing and farming communities within the SMPP. The project will ensure that fishermen will be able to maintain access to their fishing grounds and in addition the project will buy fish to support these individual's livelihoods, which will also provide sustenance for project staff. The project will also offer employment opportunities for this community if they are interested.

Better hydrology management is expected to improve the water quality in the project area which will create more abundant and protected fishing grounds. The project will also help reduce fires throughout the wider project landscape, by deploying a fully equipped fire-fighting team and early warning system (EWS) for fires. These efforts to protect the concession also protects vital community assets, reducing the risk of fishing grounds or farms being destroyed. The identified farmer community will have long-term livelihoods security through an agreement with the project that guarantees land tenure for their existing plots of land that overlap into the project boundaries. These stakeholders are also engaged and have been trained in fire monitoring and other forest patrol activities.

Additionally, the well-being of nearby stakeholders will improve as we enact our community development plan and bring community-focused activities into the SMPP and the surrounding villages and settlements. Positive impacts from the SMPP community development program targeting other stakeholders will also affect the fishermen and farmers that rely on the project area, as these communities live in the villages and settlements surrounding the SMPP area. Benefits from this community development include improved access to clean water, effective waste management, health care and education (see Section 4.3.1). In general, ecosystem services in the project area will be significantly enhanced. When compared to the without-project scenario, the communities and other stakeholders in the region will benefit from an overall increased quality of life and improved livelihoods as a result of project activities.

4.2.4 High Conservation Values Protected (CM2.4)

Our project will ensure that no HCVs related to community well-being will be negatively affected by the SMPP. The identified communities that interact with SMPP rely heavily on the protection of the HCV 5 areas for fishing and small-scale farming. The other stakeholders in nearby villages benefit from the protection of the peat swamp forest and other areas within the SMPP for overall improved water quality. Our project's main objective is to protect and enhance these areas, and therefore there are no predicted negative impacts on these HCVs. The SMPP will utilize our community development team on the ground to continuously monitor for any potential negative impacts on these HCVs in the project area.

4.3 Other Stakeholder Impacts

The project defines "Other stakeholders" as any groups other than communities that will be affected by project activities, namely proactive social development efforts and livelihoods programming. The SMPP aims to work with residents of nearby settlements and villages, including those primarily from the formally

recognized Muara Muang and Kepayang villages, as well as other unofficial settlements along the rivers, all of which are defined as other stakeholders (see Table 3 in Section 2.1.9 for further detail).

Approximately 3,316 people comprising 851 households reside in Muara Muang, and 2,436 people in 789 households reside in Kepayang.¹² It is important to emphasize that these stakeholders are still fairly removed from the project site, at a significant distance from the SMPP. However, SMPP is committed to robust development activities in the villages and settlements that surround the project site, despite their distance. Not only are these efforts a key part of the benefit sharing strategy for the project, but the creation of strong and supportive relationships with local stakeholders will also prevent risks associated with future encroachment, in the case where the project's restored ecological functions become an attractive target for illegal activities such as logging or poaching.

Other stakeholders – Economic Profile

Other stakeholders find livelihoods through more formal employment in areas throughout the Musi Banyuasin regency. There are a wide variety of economic opportunities available the villages immediately surrounding the SMPP, and these options ensure that the majority of people can find consistent, stable incomes. Potential occupations include working for nearby companies with mining, oil and gas, industrial agriculture, paper pulp, and palm oil production operations, as well as other farming including cultivation of rubber, cassava, palm oil and pineapple crops.

These diverse opportunities have resulted in above-average income and employment levels and levels of community infrastructure that are also above the national average. The relatively stable and varied access to livelihood opportunities results in communities that have above-average access to resources, a steadily declining poverty line and adequate community infrastructure. Most people live in well-built sturdy homes with sanitation facilities, and many residents with higher income levels own cars and other forms of motorized transportation.

In 2018, 9.8% of the population of Indonesia lived below the national poverty line.¹⁰ In Musi Banyuasin regency, the percentage of the population that is impoverished has been declining over the years with a drop from 18.99% in 2011 to 16.75% in 2017.¹¹ In the province of South Sumatra, the poverty level is defined from a monthly household expenditures metric that is set at less than or equal to IDR 400,000. Additionally, in 2017 the Human Development Index (HDI) of the Musi Banyuasin regency was 66.96. Based on a social appraisal of the nearby villages, the average monthly income per household in the Muara Merang and Kepayang villages is 2-3 million IDR, or 24-36 million IDR per year (estimated through discussions in these villages). This value equates to around \$4.61- \$6.91 USD per day, which is also well above the international poverty line of \$1.90 USD per day according to the World Bank.

Other stakeholders – Public Health

The public health conditions of other stakeholders are described in Section 2.1.6.4. As part of SMPP community development program, we will work with SMPP stakeholders to increase the level of public health services available.

Other stakeholders – Education

The educational facilities and educations levels of other stakeholders residing in Muara Merang and Kepayang are described in detail in Section 2.1.6.5. As part of SMPP community development program, we will work with SMPP stakeholders to implement a variety of education initiatives and support.

4.3.1 Impacts on Other Stakeholders (CM3.1)

The majority of SMPP community development activities will be directly focused on the project's other stakeholders, who we have defined as residents of nearby settlements and villages surrounding the SMPP. We do not anticipate any negative impacts to this group of other stakeholders as a result of project activities, especially as these stakeholders do not derive their livelihoods from project area and reside a considerable distance away from the SMPP (see Section 2.1.6). The SMPP's community development activities will

generate positive impacts for other stakeholders as the activities are designed to strengthen family livelihoods by creating local employment opportunities, making new investments into small businesses and increasing the quality of education in nearby villages. The following expected impacts on these other stakeholders include:

- Education support through continued education opportunities for local teachers through Open University (*Universitas Terbuka*), after school programs for elementary school children, adult education for employees who do not hold a high school diploma, improvement of elementary and middle school sanitation facilities, and enrichment and maintenance of school libraries.
- Improved livelihoods and quality of life through local food sourcing for project employees and training for craftsmen/women, as well as investments in women's groups in both Muara Merang and Kepayang villages and support to community health programs.
- Youth and local employment to increase the number of SMPP field staff recruited locally in addition to the creation of educational development and capacity building opportunities for employees.
- Community garbage and plastic waste cleanup initiatives including plastic recycling and trash collection, which creates value from plastic waste, supported by community cleanup events on a monthly basis.
- Co-financing for the construction of household rainwater catchment systems to address the need of clean and pollution-free water.

Community investments are designed to be an integral part of the SMPP's operating expenses. The project aims to deliver tangible benefits to surrounding communities through community-based business development programs and education initiatives. To support these efforts, the project will continue to allocate a significant portion of its operating budget for community development throughout its long-term operations.

4.3.2 Mitigation of Negative Impacts on Other Stakeholders (CM3.2)

Identified other stakeholders, principally the residents of the settlements and villages closest to the SMPP rarely engage in activities in the project area and reside a great distance away from the SMPP, which reduces the risk of negative impacts from project activities (see Section 2.1.6).

However, it is possible that as biodiversity returns to the SMPP area, local stakeholders may be impacted by large wildlife such as sun bears or tigers, but we have assessed this risk as low. To deal with this potential negative impact, SMPP will be developing a wildlife human conflict reduction strategy and will train stakeholders on how to reduce this potential negative risk in due course. We will also continue to maintain direct lines of communication with local stakeholders and should any other negative impacts emerge, we will be prepared as part of our adaptive management plan to adjust operations so that potential negative impacts can be mitigated effectively.

4.3.3 Net Impacts on Other Stakeholders (CM3.3)

As described in Section 4.3.2 above, the SMPP has no net negative impacts to other stakeholders. All positive impacts to other stakeholders are discussed in Section 4.3.1.

4.4 Community Impact Monitoring

4.4.1 Community Monitoring Plan (CM4.1, CM4.2, GL1.4, GL2.2, GL2.3, GL2.5)

The SMPP has created a monitoring plan to track community and other stakeholder impacts delivered by the project. This monitoring plan addresses the following core issues: improved livelihoods, education support, and health (Table 62). This plan considers the components necessary to conduct successful monitoring of all stakeholders and the impacts of the SMPP throughout the duration of the project. Our community monitoring plan considers the overall requirements of the project combined with the financial, logistical, and staff capacity constraints, starting with the specific fishing and farming communities and widening to the equally-important group of other stakeholders who live in nearby settlements and villages. Further information about how SMPP will address social impacts related to the HCVs 4 and 5, please refer to Section 4.1.3. All further details and descriptions of the activities that will take place as part of our community monitoring are outlined in the SMPP Monitoring Report.

Table 62. Details of the SMPP's community monitoring plan.

Focal Issue	Key results	Indicator/Variable	Data collection method	Targeted community	Monitoring frequency
Improved livelihoods	Access to primary resource for community livelihood is maintained	# of fishermen utilizing the area	Community survey	Community fishermen	Every 3 months
		# of farmers utilizing the area	Community survey	Community small-scale farmers	Every 6 months
	Community income improved	Gains achieved from the sale of fish	Community survey	Community fishermen	Every 3 months
		% of SMPP food budget sourced from SMPP community and other stakeholders	Internal report	Community fishermen, community small-scale farmers, and other stakeholders- residents of settlements and villages near SMPP	Every 12 months
	Project employment increased	# of people directly employed by the SMPP	Internal data records (employment contracts)	Other stakeholders- residents of settlements and villages near SMPP	Every 12 months
	Local employment or livelihoods increased	# of local people employed by the SMPP	Internal data records (employment contracts)	Other stakeholders- residents of settlements and villages near SMPP	Every 12 months
		# of investments and agreements with other stakeholders signed by the SMPP	Internal report & contracts	Other stakeholders- residents of settlements and villages near SMPP	Every 12 months
	Gender equity and economic success increased	# of investments and agreements with local women's groups signed by the SMPP	Internal report & contracts	Women's groups in Muara Merang and Kepayang villages	Every 12 months
		% of women directly employed by SMPP	Internal data records (employment contracts)	Other stakeholders- female residents of settlements and villages near SMPP	Every 12 months

Focal Issue	Key results	Indicator/Variable	Data collection method	Targeted community	Monitoring frequency
Education Support	Quality of, or access to, education increased	# schools repaired or equipped	Internal report	Kepayang and Muara Merang schools	Every 12 months
		# of university students supported	Data record, proof of enrollment to university	Voluntary teachers in Kepayang and Muara Merang schools with insufficient education background	Every 12 months
		# of students attending afterschool programs supported by the SMPP	Enrollment Records	Kepayang and Muara Merang schools	Every 12 months
		# of students continuing their education in adult programs supported by the SMPP	Enrollment Records	Hidayah and Intan Learning Centers (<i>Pusat Kegiatan Belajar Masyarakat</i> or PKBM)	Every 12 months
		# of books in each school library in surrounding villages	Survey	Kepayang and Muara Merang elementary schools	Every 12 months
	Access to clean water improved	# of individuals attending trainings in household rainwater catchment systems construction	Internal report	Other stakeholders- residents of settlements and villages near SMPP	Every 12 months
Health		# of households with improved rainwater catchment systems	Survey	Other stakeholders- residents of settlements and villages near SMPP	Every 12 months
		# of health facilities improved	Internal report	Other stakeholders- residents of settlements and villages near SMPP	Every 12 months
	Medical and sanitation facilities and services improved	# of constructed and operational sanitation facilities	Internal report	Kepayang and Muara Merang schools	Every 12 months

Focal Issue	Key results	Indicator/Variable	Data collection method	Targeted community	Monitoring frequency
		# of people registered into Indonesia's national healthcare system with SMPP support	Internal report	Other stakeholders- residents of settlements and villages near SMPP	Every 12 months
		# of children vaccinated with SMPP support	Internal report	Other stakeholders- residents of settlements and villages near SMPP	Every 12 months
		# of community clean-up events held	Internal report	Other stakeholders- residents of settlements and villages near SMPP	Every 12 months
	Waste management improved	# of plastic recycling and trash collection programs implemented	Internal report	Other stakeholders- residents of settlements and villages near SMPP	Every 12 months
		Kg of plastic waste processed as recycling	Internal report	Other stakeholders- residents of settlements and villages near SMPP; and SMPP field sites.	Every 12 months
	Fire safety improved	Frequency of fire safety or prevention trainings	Internal report	SMPP staff and other stakeholders- residents of settlements and villages near SMPP	Every 3 months

4.4.2 Monitoring Plan Dissemination (CM4.3)

Our community monitoring plan will be disseminated to project communities, other stakeholders and the public. Translated summaries of this work will be available along with other key other project documents, and this dissemination is discussed in Section 2.3.2.

4.5 Optional Criterion: Exceptional Community Benefits

The project is not seeking to be validated to the Gold Level for the Community component as the majority of the residents in local villages near the project area are not below the national poverty line.¹¹ Additionally, the project is not owned or co-managed by local communities, and as a result the project does not meet the CCBA criteria to obtain this distinction. Despite this, we will seek to deliver high levels of net positive impacts for the identified project communities and other stakeholders who live in nearby villages and settlements through the implementation of the project's community development plan.

5 BIODIVERSITY

5.1 Without-Project Biodiversity Scenario

5.1.1 Existing Conditions (B1.1)

Tropical biodiversity is in rapid decline globally, driven largely by habitat destruction and over exploitation as well as a range of interacting drivers including climate change, invasive species, and habitat degradation.⁶⁶ The terrestrial biomes of Southeast Asia have been identified as some of the most at risk biomes on the planet,⁶⁶ and Indonesia has suffered significant forest and biodiversity loss over the last 40 years.⁶⁷

Sumatra is the sixth largest island in the world and the second largest island in Indonesia after Borneo. The remaining forests of Sumatra still maintain a rich biodiversity with high levels of endemism. However, Sumatra globally has one of the highest deforestation rates in the world, driven largely by transmigration and expansion of commercial agricultural production in the form of pulp/paper and palm oil production. Between 1985 and 2001, Sumatra lost 12 million hectares of natural forest, or 48% in 22 years. In 2007, Sumatra only had 30% forest cover remaining or about 13 million hectares of forest. The forests in the eastern plains of Sumatra, where the project site is located, are especially vulnerable to species extinction risk, and natural forest cover in the area has already declined by 70%.⁶⁸ The SMPP aims to reverse this trend by protecting a site of acknowledged international importance in an area with significant peatland ecosystems and high conservation value species. The project aims to increase the variety, integrity, and extent of the peat swamp forest and to increase the abundance, diversity and habitat features of critically endangered and endemic wildlife.

5.1.1.1 Biodiversity Baseline

Ongoing ecological surveys of the SMPP site, including recent field visits in both May and June of 2018 and in January 2019, have confirmed these areas still contain many globally significant species, despite the degraded nature of the forest throughout most of the concession. Species of particular interest include:

- Sun bears (*Helarctos malayanus*), which are surprisingly abundant judging by the number of tracks, scrapes, and other signs observed.
- Agile gibbons (*Hylobates agilis*), which are present in sufficient numbers to suggest the potential for the site to ultimately hold a significant population, provided habitat regeneration occurs as planned.
- Hornbill species (Bucerotidae) and pheasants such as the Crestless Fireback (*Lophura erythrophthalma*).
- The Sumatran tiger (*Panthera tigris* ssp. *Sumatrae*) has also been documented by project staff through visual sightings, vegetation markings, and observed footprints.

There are several tiger prey species—such as pigs and deer—of enough population density in the project area which indicates tigers may be using the site regularly as a hunting ground. Similarly, they may be using the project area to move between adjacent habitat blocks with the project site acting as a significant biological corridor. With adequate long-term protection of the prey base, particularly the native deer and wild pig populations, it is very likely that the project site will support resident tigers. SMPP biodiversity staff continue to investigate how to strengthen the project site as a habitat for this critically endangered species, including boosting prey species.

Several external threats have been identified within the project site, including Illegal logging, forest and land fires, hunting, lack of understanding and awareness of rare and threatened ecosystems by communities and peat drainage. In a January 2019 field visit, no sign of illegal logging, hunting or poaching was found. However, forest patrol teams and project management staff consider it essential to ensure threat levels

maintain at their current low level, especially as wildlife populations recover over time in response to successful project implementation.

Despite the degradation in the forest landscape, the SMPP site has maintained a significant level of biodiversity with a number of RTE and endemic species present (Table 63), with monitoring conducted throughout the project area since 2017 (Map 37).

Table 63. List of fauna and flora species identified during independent rapid biodiversity assessment.

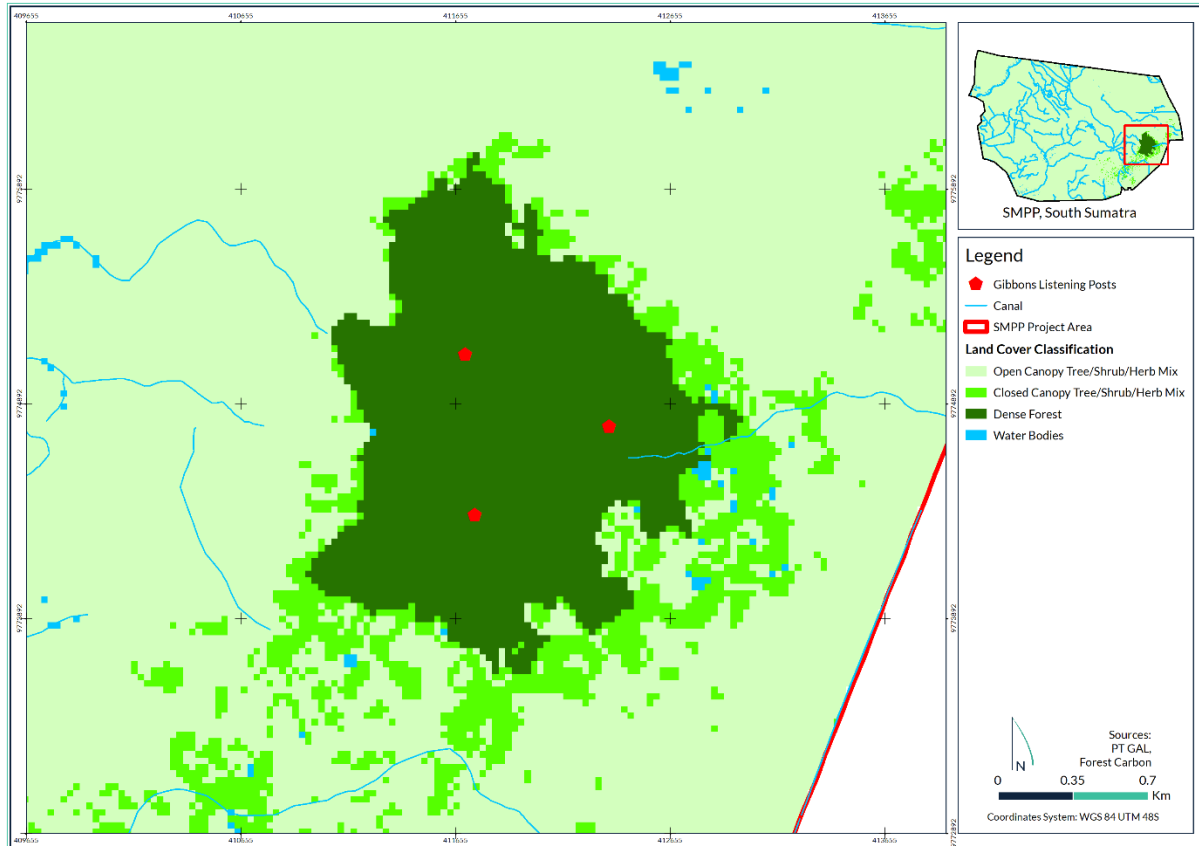
Scientific Name	Common Name	Local Name	Family	IUCN	CITES	Endemic
Mammals						
<i>Callosciurus notatus</i>	Plantain squirrel	Bajing kelapa	Sciuridae	LC	Not listed	No
<i>Helarctos malayanus</i>	Sun bear	Beruang madu	Ursidae	VU	I	No
<i>Hylobates agilis</i>	Agile gibbon	Owa	Hylobatidae	EN	II	No
<i>Hystrix brachyura</i>	Malayan porcupine	Landak	Hystriidae	LC	Not listed	No
<i>Lutrogale perspicillata</i>	Smooth-coated otter	Berang-berang	Mustelidae	VU	II	No
<i>Macaca fascicularis</i>	Nicobar crab-eating Macaque	Monyet kera/ekor panjang	Cercopithecidae	LC	II	No
<i>Macaca nemestrina</i>	Southern pig-tailed Macaque	Beruk	Cercopithecidae	VU	II	No
<i>Muntiacus muntjak</i>	Southern red Muntjac	Kijang	Cervidae	LC	Not listed	No
<i>Panthera tigris ssp. Sumatrae</i>	Sumatran tiger	Harimau Sumatera	Felidae	CR	I	Yes
<i>Paradoxurus hermaphroditus</i>	Common Palm Civet	Musang luwak	Viverridae	LC	III	No
<i>Presbytis melalophos</i>	Sumatran Surili	Simpai merah	Cercopithecidae	EN	I	Yes
<i>Prionailurus bengalensis</i>	Leopard cat	Kucing hutan/kuwuk	Felidae	LC	II	No
<i>Rhinosciurus laticaudatus</i>	Shrew-faced squirrel	Bajing tanah moncong runcing	Sciuridae	NT	Not listed	No
<i>Rusa unicolor</i>	Sambar deer	Rusa sambar	Cervidae	VU	Not listed	Yes
<i>Sus barbatus</i>	Bearded pig	Babi jenggot	Suidae	VU	Not listed	No
<i>Sus scrofa</i>	Wild boar	Babi hutan	Suidae	LC	Not listed	No
<i>Tragulus kanchil</i>	Lesser Oriental Chevrotain	Pelanduk kancil	Tragulidae	LC	Not listed	

Scientific Name	Common Name	Local Name	Family	IUCN	CITES	Endemic
Birds						
<i>Accipiter gularis</i>	Japanese Sparrowhawk	Elangalap nipon	Accipitridae	LC	II	No
<i>Amaurornis phoenicurus</i>	White-breasted waterhen	Kareo padi	Rallidae	LC	Not listed	No
<i>Buceros rhinoceros</i>	Rhinoceros hornbill	Enggang cula	Bucerotidae	VU	II	No
<i>Centropus sinensis</i>	Greater Coucal	Bubut besar	Cuculidae	LC	Not listed	No
<i>Chalcophaps indica</i>	Grey-capped emerald dove	Delimukan zamrud	Columbidae	LC	Not listed	No
<i>Elanus caeruleus</i>	Black-winged kite	Elang tikus	Accipitridae	LC	II	No
<i>Gallus gallus</i>	Red junglefowl	Ayam hutan merah	Phasianidae	LC	Not listed	No
<i>Gracula religiosa</i>	Common hill myna	Tiong emas	Sturnidae	LC	II	No
<i>Haliastur indus</i>	Brahminy kite	Elang bondol	Accipitridae	LC	II	No
<i>Ictinaetus malayensis</i>	Black eagle	Elang hitam	Accipitridae	LC	II	No
<i>Lophura erythrophthalma</i>	Malay Crestless Fireback	Sempidan merah	Phasianidae	VU	Not listed	No
<i>Loriculus galgulus</i>	Blue-crowned hanging-parrot	Serindit Melayu	Psittacidae	LC	II	No
<i>Microhierax fringillarius</i>	Black-thighed falconet	Alap-alap capung	Falconidae	LC	II	No
<i>Nisaetus cirrhatus</i>	Changeable hawk-eagle	Elang brontok	Accipitridae	LC	II	No
<i>Nisaetus nanus</i>	Wallace's hawk-eagle	Elang Wallace	Accipitridae	VU	II	No
<i>Otus lempiji</i>	Sunda Scops-owl	Celepuk reban	Strigidae	LC	II	No
<i>Psittacula longicauda</i>	Long-tailed parakeet	Betet ekor-panjang	Psittacidae	VU	II	No
<i>Psittinus cyanurus</i>	Blue-rumped parrot	Nuri tanau	Psittacidae	NT	II	No
<i>Rhipidura javanica</i>	Sunda pied fantail	Kipasan belang	Rhipiduridae	LC	Not listed	No
<i>Spilornis cheela</i>	Crested serpent-eagle	Elangular bido	Accipitridae	LC	II	No
Reptiles						
<i>Amyda cartilaginea</i>	Asiatic softshell turtle	Labi-labi	Trionychidae	VU	II	No

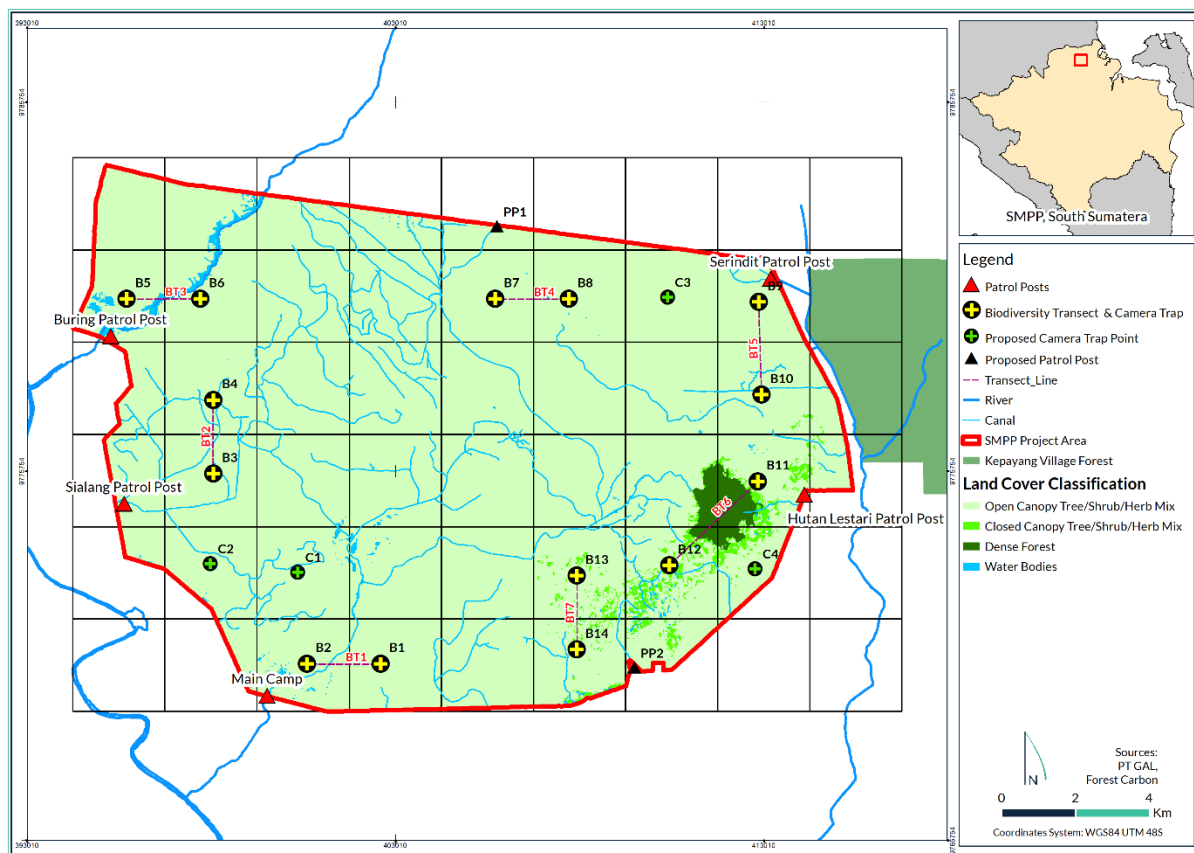
Scientific Name	Common Name	Local Name	Family	IUCN	CITES	Endemic
<i>Broghammerus reticulatus</i>	Reticulated python	Sawa, sanca batik	Pythonidae	LC	II	No
<i>Cuora amboinensis</i>	Amboina box turtle	Kuya batok	Geoemydidae	VU	II	No
<i>Heosemys spinosa</i>	Spiny turtle	Kura-kura duri	Geoemydidae	EN	II	No
<i>Ophiophagus hannah</i>	King cobra	Tedung, ular anang	Elapidae	VU	II	No
<i>Tomistoma schlegelii</i>	False gharial	Sinyulong	Gavialidae	EN	II	No
<i>Varanus salvator</i>	Common water monitor	Biawak, biancak	Varanidae	LC	II	No
Fish						
<i>Notopterus notopterus</i>	Bronze featherback	Putak	Notopteridae	LC	Not listed	No
<i>Scleropages formosus</i>	Asian arowana	Arwana perak	Ostoglossidae	EN	II	No
Plants						
<i>Anisoptera marginata</i>		Tenam	Dipterocarpaceae	EN	Not listed	No
<i>Aquilaria microcarpa</i>		Gaharu	Thymelaeaceae	VU	II	No
<i>Cantleya corniculata</i>		Bedaru	Stemonuraceae	VU	Not listed	No
<i>Combretocarpus rotundatus</i>		Perepat	Anisophylleaceae	VU	Not listed	No
<i>Cyrtostachys lakka</i>	Lipstick palm	Palem merah	Arecaceae	VU	II	No
<i>Dyera costulata</i>		Jelutung bukit	Apocynaceae	VU	Not listed	No
<i>Dyera polyphylla</i>		Jelutung rawa	Apocynaceae	VU	II	No
<i>Nepenthes</i> sp.	Pitcher plants	Kantong semar	Nepenthaceae	N/A	II	No
<i>Shorea dasyphylla</i>		Meranti payau	Dipterocarpaceae	EN	II	No
<i>Shorea platycarpa</i>	Light red Meranti	Meranti paya	Dipterocarpaceae	CR	Not listed	No
<i>Shorea teysmanniana</i>		Meranti merawan	Dipterocarpaceae	EN	Not listed	No
<i>Shorea uliginosa</i>		Meranti kelungkum	Dipterocarpaceae	VU	Not listed	No

Most of the species were identified around the edges of the project area and in the surrounding concessions, representing strong potential for wildlife return as an outcome from assisted regeneration efforts. More effective biodiversity tracking will be conducted in a systematic manner to include broader coverage of the project site though the establishment of gibbon/hornbill listening posts (Map 37), additional camera-trap locations and annual bird survey transects.

Map 37. Approximate location for gibbon listening posts.



Map 38. Sites for camera-trap establishment and bird monitoring transects.



5.1.2 Threats to Biodiversity

Potential threats to biodiversity, including fire, conversion to industrial timber plantations, small-scale illegal timber extraction, and smallholder agricultural expansion, are described in Table 6, in Section 2.1.18. In Table 64 below, the internal threats to biodiversity and the associated mitigation measures are detailed. This data is a result of HCV biodiversity assessments at the project site that was undertaken to support the implementation of project activities (further details about these HCV assessments are described later in Section 5.1.3.5).

Table 64. Identification of internal threats and mitigation to protect HCVs in the SMPP area.

HCV	Presence/ Attributes of HCV	Internal Threats	Recommended mitigation actions for potential internal threats
HCV 1 Biodiversity concentrations include endemic species, and rare, threatened, or endangered species (RTE) that are	Habitat for RTE species, in the form of remaining peat swamp forests ecosystem in the southeast, Buring river (including young shrubs), Kepayang	The design of canal blocking does not consider aspects of biodiversity.	Creation of canal blocking design that takes into account the documented biodiversity by involving the team (Division of Biodiversity and Landscape GAL) comprehensively (Zoning: LIN & PR1). Closing and shifting infrastructure (roads, canals) that cause habitat

HCV	Presence/ Attributes of HCV	Internal Threats	Recommended mitigation actions for potential internal threats
significant at the global, regional, and national levels.	river, Tembesu Daro canal.		fragmentation of HCV 1 species (Zoning: LIN).
		Distribution and planting of inappropriate vegetation species e.g.: gelam (<i>Melaleuca cajuputi</i>) (Zoning: PR4).	Selection of local species for priority planting and revegetation to outcompete the gelam (Zoning: PR 1-4).
			Setting up an area specifically for HCV 1 protected area (Zoning: LIN).
		Inadequate or lack of knowledge of RTE species by all SMPP Field staff (Zoning: N).	Labeling and maintenance of HCV 1 boundary by creating HCV information boards (Zoning: LIN & PR1).
			Ensure that wood-based infrastructure (camps, bridges, and canal block) does not use HCV 1 species (Zoning: N).
			SOP on the prohibition of utilization of HCV 1 species (Zoning: N).
			Create a briefing packet for all employees / staff / contractors about the RTE species (Zoning: N).
HCV 3. Rare, threatened, or endangered (RTE) ecosystems, habitats or refugia.	The remaining closed canopy peat swamp forest is ± 400 ha.	The design of the canal blocking plan does not take into account the project's biodiversity and hydrology (Zoning: LIN & PR1).	Creation of canal blocking design that takes into account the biodiversity and hydrology of the SMPP (Zoning: LIN & PR1).
		Distribution and planting of inappropriate vegetation species e.g. gelam (<i>Melaleuca cajuputi</i>) (Zoning: PR4).	Training to increase staff awareness related to the importance of the peat swamp forest ecosystem as an endangered ecosystem (Zoning: N).
		Inadequate or lack of knowledge of ecosystems by GAL staff (Zoning: N).	Closing and shifting infrastructure (roads, canals) that cause habitat fragmentation of PSF ecosystem HCV 3 species (Zoning: LIN).
HCV 4. Areas important to water		Dispersion of gelam (Zoning: PR4).	Regular monitoring of gelam forest area (Zoning: PR4, PJ4, PJ5, PJ2).

HCV	Presence/ Attributes of HCV	Internal Threats	Recommended mitigation actions for potential internal threats
catchments, for erosion control, and areas that can act as fire breaks, pollination services.	The remaining peat swamp forest is ± 400 ha and river buffers.		Routinely pluck the sapling (Zoning: PR4, PJ4, PJ5, PJ2).
		The design of the canal blocking plan does not take into account the hydrology of the SMPP (Zoning: PJ1, PJ2, PJ3, PJ5, PR1, LIN).	Develop a canal blocking design that takes into account the hydrology of the SMPP with support from an expert team (Zoning: N).

5.1.3 High Conservation Values (B1.2)

The SMPP project aims to protect and improve the quality of high conservation values (HCVs) within the project area. Through planned biodiversity monitoring and other project activities, the project is identifying and understanding the characteristics, distribution, sensitivity and vulnerability of these HCVs. Project efforts to restore and rehabilitate degraded peat swamp forest are a relatively low intensity activity, as these efforts do not include activities relating to forest conversion to monoculture plantation, grazing or browsing by domestic animals, or abstraction of water.

However, there are some activities that could be considered higher risk, including:

- The potential for areas to emerge with more homogenous vegetation due to reforestation programs.
- The modification of hydrologic connectivity from canal blocking, and potential hunting or trapping in the management area by local communities or outside groups.

Based on the scale and intensity of activities of the project and the vulnerability level of the HCVs, the overall risks to HCVs have been are low. Specific information about the presence of HCVs related to biodiversity are described further in Section 5.1.3.5. Despite the low risk level, protective measures have been developed to avoid negative impacts, and these mitigation efforts are further elaborated in Section 5.2.2.

5.1.3.1 Protected areas

Although there are no officially allocated protected areas within the SMPP, this area is a key biological corridor for species that transit the Berbak-Sembilang National Park to the northeast, and other adjacent forest blocs surrounding the project site. Many endangered and endemic species have been cataloged in areas allocated for conservation in nearby concessions in the north and south of the SMPP, which present additional biodiversity opportunities if these areas can also be put under long-term restoration and protection programs.

5.1.3.2 Threatened species

Overall, of all the species identified ~4% are critically endangered, ~20% are endangered and ~30% are vulnerable. This indicates that the SMPP site will have a significant positive impact on biodiversity under the project scenario.

The biodiversity assessments carried out in 2018 identified 46 species of mammal, bird, reptile and fish, many of which are classified as RTE species in the IUCN Red List or are Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) species of concern (Table 65). Of the 15 present bird species, 14 are listed as CITES Appendix II species, and one was listed as vulnerable under on the IUCN Red List (Wallace's hawk-eagle). As expected, a significantly larger proportion of the mammals present in the areas are classified as threatened species. Of the ten identified mammal

species, one is classified as critical (Sumatran tiger). Three species are currently listed as endangered (Sumatran Surili, agile gibbon, Malay tapir) and three are listed as vulnerable (Smooth-coated otter, sun bear, Sambar deer). Similarly of the mammals identified, three are CITES Appendix I species, and four species are under Appendix II.

Given the recent rapid loss of peat swamp forest and the ongoing threats, it is no surprise that the majority of the plants and trees identified in the area have been afforded some form of protection by international classification bodies. Three of the eleven species are classified as endangered and seven as vulnerable, with five species also being listed in CITES Appendix II. Of the seven identified reptile species, both the False Gharial and the Spiny turtle are listed as endangered with two more species of turtle and one species of snake listed as vulnerable. Six of the seven reptile species are also listed in CITES Appendix II. Only two species of fish were identified in the rapid assessment. However, one of them, the Asian arowana, is listed as endangered and is a CITES Appendix II species.

5.1.3.3 Endemic species

Biodiversity assessments to date have identified three important endemic species in the project area namely: the Sumatran tiger, the Sumatran Surili and the Sambar deer, all of which have various levels of threat associated with them (Table 65).

5.1.3.4 Threatened or rare ecosystems

The SMPP aims to protect and restore 22,922 hectares of a threatened peatland ecosystem. The SMPP sits within the Merang-Kepayang peat dome, the largest peat swamp dome in South Sumatra, which covers more than 150,000 ha.^{36,69} A number of critical climate and biodiversity assets are linked to the wider peat swamp forest zone that surrounds the SMPP: the Sembilang-Berbak National Park to the northeast and the Muaro Jambi peat swamp to the north. These areas are especially important for sheltering high levels of biodiversity and a multitude of critically endangered and vulnerable species, for example the sun bear (*Helarctos malayanus*), the Malay tapir (*Tapirus indicus*), and the Sumatran tiger (*Panthera tigris* ssp. *Sumatrae*). The remaining ~400 ha of intact closed canopy peat swap forest in the SMPP project area is identified as an HCV 3 area and its protection and eventual expansion and enhancement as a corridor to surrounding concessions is a key aspect of the project scenario.

5.1.3.5 HCV areas in SMPP

Based on the preliminary data collection and knowledge of current conditions, the project has designed an appropriate biodiversity management and monitoring approach for the long-term management of biodiversity risks and benefits, including those related to HCV values.

The project assessed HCV areas for biodiversity based on the High Conservation Value Resource Network or HCVRN's 2014 Global Guideline for Management and Coordination of the Global Secretariat as well as the 3rd edition of CCB Standards (Climate, Community, and Biodiversity). The assessment of HCV areas for community was based on the HCVRN's Common Guidance for the Identification of HCVs (2013). This was in combination with the identification of HCV's sub-categories according to the HCV Identification Guidelines for Indonesia (2009) which provide context specifically for Indonesia.

The assessment team also used the same resources listed above as a reference to develop the HCV management and monitoring recommendations and the CCB Standards (The Climate, Community and Biodiversity Alliance) June 21st, 2017 edition was also used.

Comprehensive biodiversity assessments were conducted in the SMPP area by multiple teams throughout 2018. In April 2018, preliminary surveys were conducted which were followed by a comprehensive review in January 2019. Additional monitoring with the use of camera-trapping techniques began with the installation of a 10-point camera-trap system, which was installed in May and June of 2018. The data from this study was compiled in September 2018 when the cameras were collected. A month-long camera-trapping study in the HCV 3 area was conducted in January 2019 to better understand the animal populations in the SMPP. There are three HCVs identified within the SMPP area related to biodiversity (outlined below in Table 65). These HCV areas are further described in Map 39, Map 40, and Map 41.

Table 65. Summary of high conservation values related to biodiversity in the SMPP area.

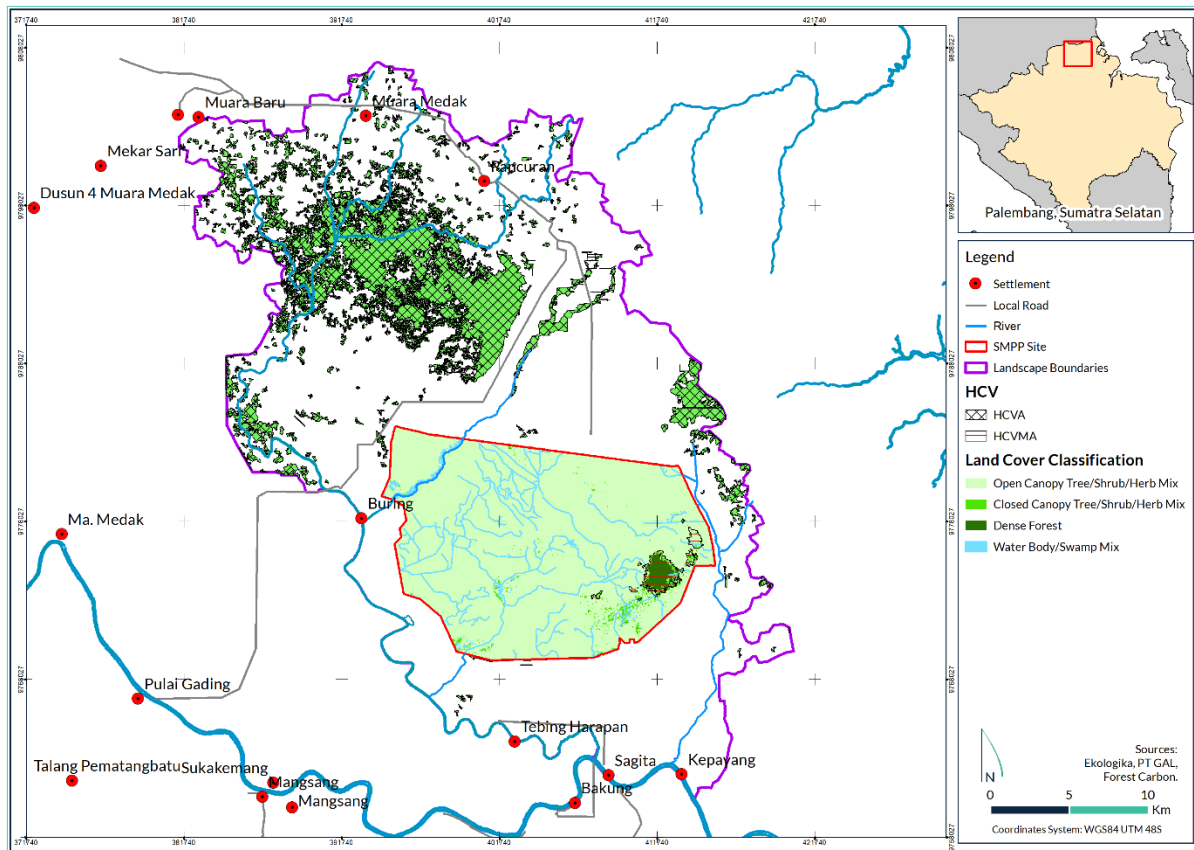
High Conservation Value	HCV 1 – Species Diversity
Qualifying Attribute	Areas that have biodiversity support functions for Protected Areas (Kawasan Lindung) or Conservation, particularly: • Conservation areas near or inside the management unit (with significant biodiversity); • Areas expected to provide biodiversity support for protected or conservation areas near management unit; • Areas where the management unit's activities might potentially have negative impacts on the biodiversity conservation functionality of a protected or conservation area; • All Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) listed in the IUCN Red List; • Species with Limited Coverage (Endemic species) located in one island or part of the island; • Endemic species; • Species protected by the Indonesian Law: UU No. 5/1990 and the species listed in PP no. 7/1999; • Species listed in CITES Appendix I and II; • Species that require a location with certain characteristics during their life cycle to congregate, breed, migrate or otherwise, are referred to as keystone habitat In the SMPP, there are: • 26 species of plants, • 18 species of mammals, • 42 species of birds, • 12 species of reptiles and amphibians, and • 2 species of fish All IUCN Red List species, categorized as critically endangered, endangered, and vulnerable are listed in Table 67 in Section 5.5.1.
Focal Area	Habitat for RTE species, in the form of remaining peat swamp forest ecosystem in the southeast, Buring river, Kepayang river, Tembesu Daro canal is KBKT 1 (<i>Kawasan Bernilai Konservasi Tinggi</i> or High Conservation Value Area).

High Conservation Value	HCV 3 – Ecosystems and Habitats
Qualifying Attribute	RTE = Rare, Threatened, or Endangered ecosystems, habitats, or refugia. Threatened: • Loss of 50% or more of the original area of a biogeographic unit ecosystem. • Will experience a loss of 75% or more of the original area based on the assumption that all Conversion Production Forest (<i>Hutan Produksi Konversi</i> or HPK) / Other Usage Areas (<i>Area Penggunaan Lain</i> or APL) areas in the spatial plan will be converted.

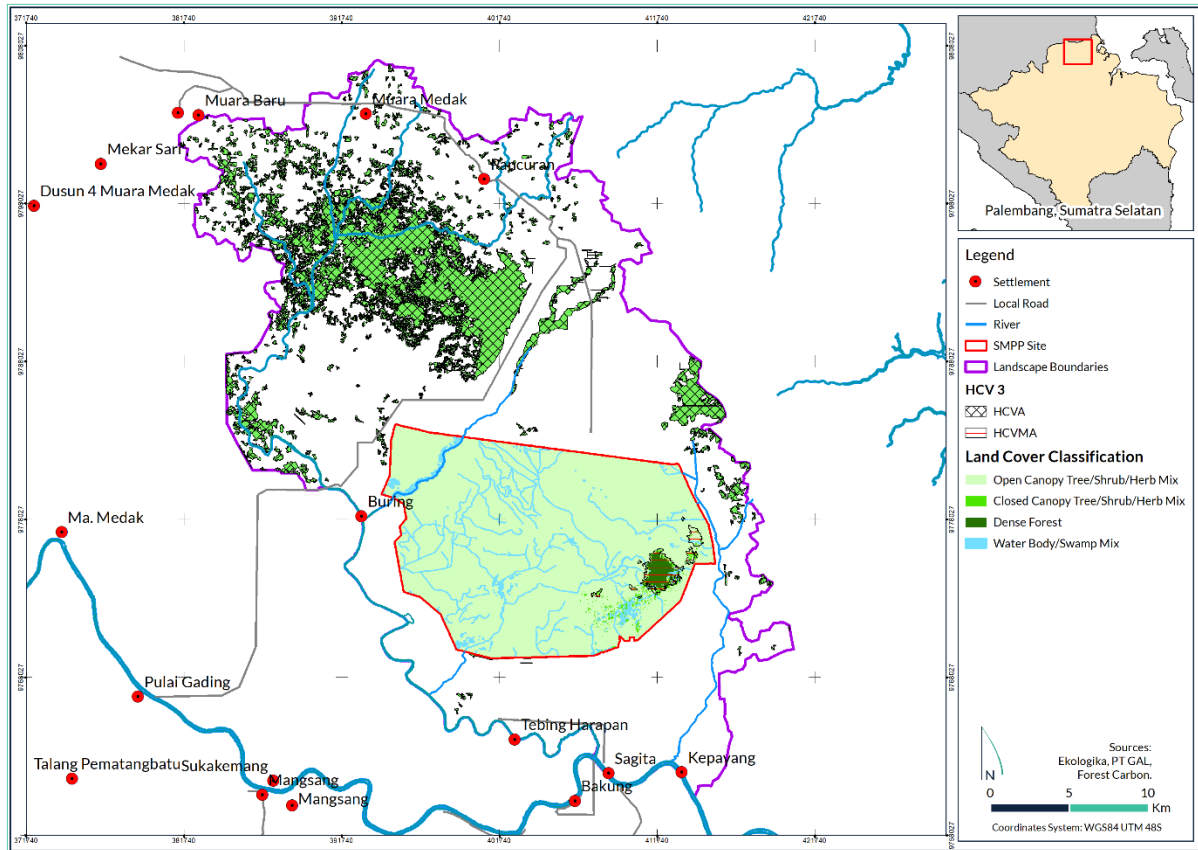
	The remaining secondary peat swamp forest ecosystem and habitat within the SMPP is considered threatened.
Focal Area	The remaining peat swamp forest is ± 400 ha.

High Conservation Value	HCV 4 – Ecosystem Services
Qualifying Attribute	Areas important for watersheds, erosion control, and areas that provide restrictions on destructive fires, pollination services. Ecosystem or forest that serves to and/or for: • Manage extreme water flow events, including buffer zones (riparians) or intact floodplains; • Maintain the downstream river flow regimes; • Maintain the water quality characteristics; • Fire prevention and protection; • Protection of vulnerable soils, aquifer and fisheries; • Clean water supply; • Wind protection, and moisture, rainfall, and other climatic elements; and • Pollination service. The SMPP creates these ecosystem services through its peat swamp forest, river, and buffer areas.
Focal Area	From a field visit, HCV 4 area within the SMPP landscape has been identified, specifically with respect to: • The identified flood prevention areas are peat forest in the east near the <i>Hutan Lestari</i> patrol post, as well as the floodplains in the Buring river, Serindit Patrol post and Kepayang river. • Areas that can serve as fire prevention are the peat forest area located on the eastern side (the remaining forest block near the <i>Hutan Lestari</i> patrol post). • Areas identified as land protection, aquifer and fisheries are buffer areas, although the shrub land cover can still function to prevent morpho erosion of the river. • Areas identified for wind protection and microclimate regulator are the peat forest area located on the eastern side (the remaining forest block in KM 14). • Areas that serve as water catchments identified during field visits are the peat forest area located on the eastern side (the remaining forest block in KM 14). • Pollination services found in this area are indicated by the presence of a honey trees, found in in the remaining forest block in KM 14. Kempas is one of the trees that contains honeycomb.

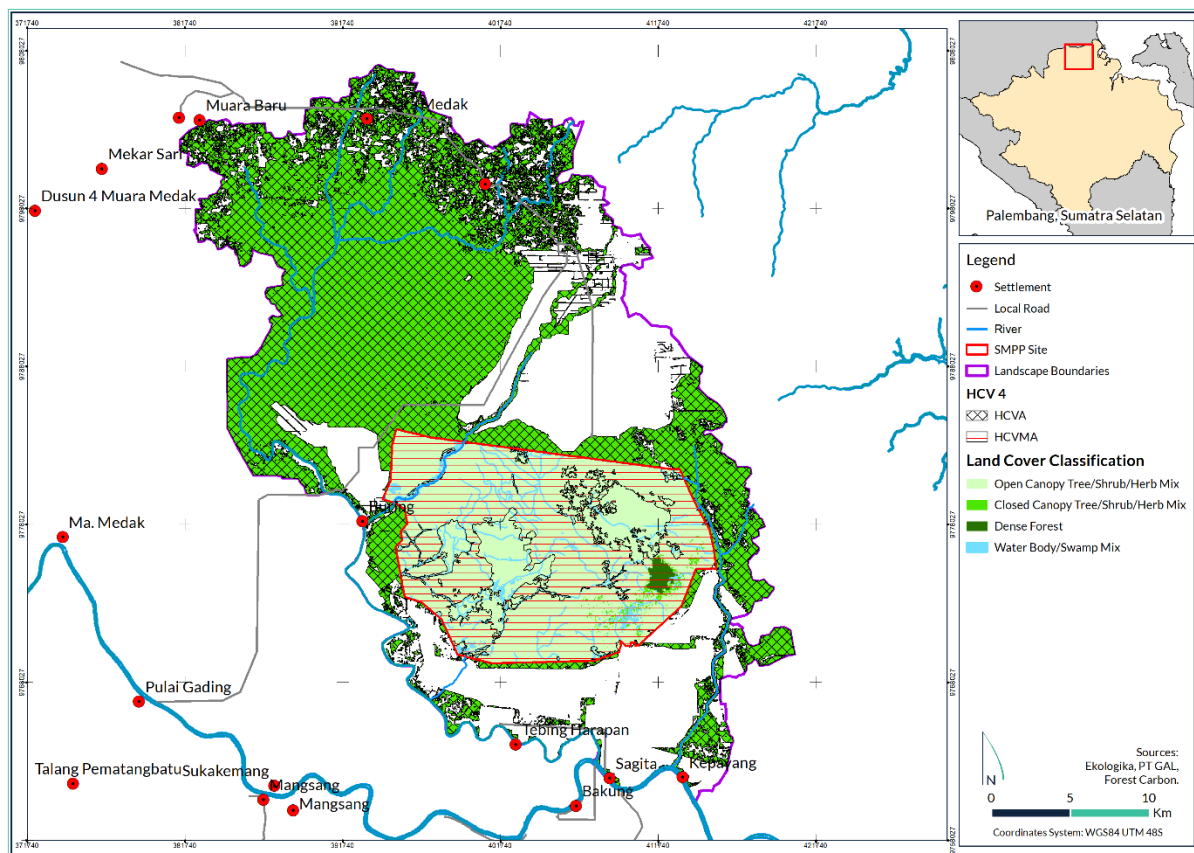
Map 39. Locations related to HCV 1, species diversity, in the SMPP area.



Map 40. Locations related to HCV 3, ecosystems and habitat, in the SMPP area.



Map 41. Locations related to HCV 4, ecosystem services, in the SMPP area.



5.1.3.6 Identifying areas for management to maintain or enhance identified HCVs

The remaining intact peat swamp forest will require little management to maintain its HCVs. However, in order to enhance the existing HCVs across the entire concession and the surrounding degraded land, the project will ensure active management of fires and rehabilitation of the surrounding peatland hydrology. Active planting for restoration is also planned around this particular area, to extend a wildlife corridor into neighboring forest and throughout the parts of the SMPP.

5.1.4 Without-project Scenario: Biodiversity (B1.3)

The SMPP area is largely surrounded by production and industrial plantation forest. In the absence of an active restoration project, the area would be at particularly high risk for clearance, drainage and conversion to an industrial forest plantation to produce pulp and paper. The full conversion of the area to industrial Acacia pulp and paper plantation under the business as usual scenario would endanger biodiversity outcomes significantly when compared to the project scenario.

It should be noted that in some cases Acacia plantations have been shown to improve biodiversity on degraded lands,⁷⁰ assisting conservation by providing a complementary but short-term forest habitat, creating buffer effects, and increasing connectivity where the natural land cover has previously been forest.⁷¹ However, any potential positive impacts to biodiversity would be limited and short term.

Net negative impacts would be more likely when compared to the project scenario for several key reasons. An Acacia plantation would require further draining of the already degraded peat leading to accelerated GHG emissions, further homogenization of important aquatic habitats and increased risk of fire. Secondly, the short average rotation of Acacia tree crops would mean that plantation forests cannot provide in-situ,

long-term biodiversity benefits. Thirdly, conversion to Acacia would also lead to indirect loss of the remnant intact peat swamp forest, which support populations of globally important species. Further degradation of the hydrological system would isolate animal populations and ensure that the viability of many rare and threatened species is put at higher risk.

Without the project, an increase in Acacia plantations would result in total habitat destruction over time, especially through diminishing connectivity of habitats, massive canalization disrupting soils and hydrology and eventual clearance and replanting of the Acacia forest area. Loss of the remaining intact peat swamp forest, which is protected under the project scenario, would lead to net negative impacts on biodiversity, negating any limited positive impacts derived from the establishment of Acacia plantations. More detailed information on critically endangered, endangered, and vulnerable species and their without-project scenarios is provided below in Table 68 in Section 5.5.2.

5.2 Net Positive Biodiversity Impacts

5.2.1 Expected Biodiversity Changes (B2.1)

Under the project scenario, the maintenance and improvement in both the quality and extent of threatened habitats will have significant positive impacts on the range of biodiversity in the area. Reduced degradation, fragmentation and reduction in the fire disturbance frequency will ensure the ongoing survival of the documented species at the site and the expansion of important species into newly restored areas. Restoration efforts are also expected to lead to an eventual long-term increase in the carrying capacity for a range of species across the project area. As the landscape recovers and is returned to a regenerated state, colonization of species from outside the project area into newly established habitats will drive increased diversity, including species that are currently using the area only as a corridor but that may eventually become residents. Peatland rehabilitation will lead to improved ecosystem services for biodiversity, affecting an increase in important pollinating and seed dispersing species which will accelerate natural regeneration within the project area. Through implementation of the project scenario, the survival and eventual recovery of populations of many species of conservation concern is expected. These species would otherwise become severely depleted or would be eliminated entirely from the landscape under the baseline scenario.

These benefits will be achieved by reducing the threats outlined in Section 2.1.8. No negative effect on biodiversity in the project area is anticipated from any project activities (see Table 66 for further outline of changes to biodiversity).

The expected net benefits for biodiversity will be:

- The persistence of the full range of intact, ecologically functional habitats which are minimally degraded or undisturbed by humans.
- The restoration and regeneration of drained, burned over and degraded peatland into functional forest.
- The protection of drained, burned over and degraded peatland from fire risks.
- The persistence and recovery of populations of species of conservation concern. These populations should fulfil their full range of ecological functions and eventually grow to carrying capacity.
- The augmentation of the current extant biodiversity through provisioning of habitat through restoration activities.
- Improvement of both terrestrial and aquatic habitat quality and quantity that currently acts as a biological corridor.

There are two fundamental assumptions dictating why the above prescribed biodiversity benefits will be achieved by avoiding the baseline scenario of conversion to an industrial Acacia plantation. The

assumptions relate to each of the two key current habitat types occurring in the project area. Firstly, a majority of the land cover is already degraded, drained or previously burned peatland. The current vegetation structure across much of the project area consists of open patches with scrub and early successional species (Figure 2). The last incidence of significant fire in the area was 2015 and the process of natural regeneration is clearly visible. The project will significantly reduce the risk of fires to ensure that the degraded areas can regenerate further. This natural regeneration will be augmented through active restoration and replanting with species of both genetic and ecological significance.

The second assumption is that these biodiversity benefits will also be achieved by reducing the threats outlined in Section 2.1.8. in the remaining area of closed canopy peat swamp forest (~400 ha). Because this area will remain undrained in the project scenario it will continue to provide important habitat for both flora and fauna as it will benefit from active threat reduction, improved hydrology, and gradual expansion in size. It will also provide additional benefits as a seed and seedling source for reforestation efforts in other parts of the project area. Seeds and seedlings that disseminate naturally from the remaining peat forest are an appropriate ecotype for local restoration efforts and will help to expedite the restoration process.

The key threats that will be addressed are habitat loss, increased fire resilience and resistance, hunting in all forms, and over-harvest of non-timber forest products (NTFPs). Although hunting, fishing and over-harvesting of NTFPs are not currently issues in the project area, as the forest recovers, and the biodiversity improves the area may become targeted for such activities. These, and other threats listed in Section 2.1.8, will be addressed by the activities set out in Section 2.1.11. The conceptual model described in Section 2.1.11 (Figure 3) further illustrates each of the assumptions underlying the implementation of each of these activities.

Table 66. Changes to biodiversity.

Biodiversity Element	Increased aquatic species abundance and diversity
Estimated Change	Consistent or increasing presence of fish, as well as higher diversity of species reptiles and amphibians.
Justification of Change	One of the key project activities is the rewetting of drained peat across the project area through the installation of canal blocks. This will significantly increase the volume and extent of ground water across the project zone. These activities, in combination with riparian replanting activities and natural regeneration will lead to increased heterogeneity of aquatic habitats. More diverse habitats will, over time, lead to increased diversity and abundance of aquatic species in the SMPP. There are already some extant threatened aquatic species in the project area (see Table 65). Blocking of canals will naturally increase the extent and quality of different spawning grounds (fish and amphibians) and nesting sites (gharials and turtles) this natural diversification of the canal substrate will be further augmented by selecting species for replanting around the canal blocks that encourage the formation of root systems to bind the compacted peat material used for canal block construction. These root and vegetation mats will also provide spawning and nesting grounds for the aquatic community.

Biodiversity Element	Increased mammal diversity and abundance
Estimated Change	Consistent or increasing presence and diversity of mammal species.
Justification of Change	Without the presence of our project, it is likely that species diversity would be negatively affected by increasing development and land-use change within the wider SMPP area. However, with the project in place, the ability for these areas to support biodiversity will be strengthened and these areas will be protected. Increased forest cover and the planting of tree species that are important to mammal species for some aspect of their ecology such as

	for food sources or nesting will likely encourage population growth of key mammal species such as gibbons, sun bears, pigs, and Sambar deer.
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Biodiversity Element	Increased predator Apex predator populations
Estimated Change	Consistent or increasing presence and diversity of Apex predator species, such as Sumatran tigers.
Justification of Change	Without the presence of our project, it is likely that species diversity would be negatively affected by increasing development and land-use change within the SMPP area. Currently the majority of the land is significantly degraded, although the land is used by mammals of significance for global biodiversity conservation such as the Sumatran tiger, it is unlikely that the project area holds resident individuals. Rather, it is more likely that the project area is being utilized as a corridor between other hunting grounds or adjacent habitats. Under the project scenario, tiger prey species such as pigs and Sambar deer are likely to increase from their current densities as the rewetting and reforestation progresses. In combination with the predicted increased forest cover, this will likely result in increased use of the SMPP project area as a corridor by tigers in the area. The project area is also capable of holding resident individuals and it is hoped that continued project activities will result in reestablishment of the SMPP as a habitat.

Biodiversity Element	Increased invertebrate diversity and abundance
Estimated Change	Consistent or increasing presence and diversity of invertebrate species.
Justification of Change	Without the presence of our project, it is likely that species diversity would be negatively affected by increasing development and land-use change within the SMPP area. However, the project in place, the ability for these areas to support biodiversity will be strengthened and these areas will be protected. Increasing heterogeneity of landscape habitats will likely be associated with a marked increase in invertebrate diversity and abundance. This in turn will likely accelerate the restoration of the project area through improved ecosystem service provisioning in the form of pollination services. Honeybees are already present in the remnant peat swamp forest in the SMPP and their population would likely grow significantly with increased protection and reforestation of the degraded areas.

5.2.1.1 Expected Negative Impacts

Even though the threats to biodiversity in the SMPP area are considered low, the project proponents will ensure that all possible threats are observed and monitored to ensure they do not negatively impact the project. The SMPP is focused on restoring the degraded natural peatland ecosystems and is designed to deliver positive impacts within the project area and the wider landscape in the process.

5.2.2 Mitigation Measures (B2.3)

The project seeks to avoid any negative offsite impacts on biodiversity and other social aspects by devoting significant efforts and resources to detecting the presence, understanding the characteristics, and identifying the sensitivity of all project activities. As discussed in Section 5.2.1.1, the SMPP is designed to bring positive impacts and does not anticipate any negative impacts to biodiversity.

Even though the project does not expect any negative impacts to biodiversity, the plan is to implement the following mitigation measures to increase species abundance and diversity within the project area: patrolling, fire suppression, canal blocking, and reforestation activities. As such, few additional biodiversity-specific activities are expected at this stage. However, an active and regular biodiversity monitoring program will be implemented to assess periodic increases for specific species and inform management activities across the SMPP area.

Key biodiversity management activities include devoting significant resources to detecting, identifying and understanding the characteristics, distribution, sensitivity and vulnerability of HCVs.

As mentioned in the Section 5.2.1 above, any predicted negative impacts are most likely to occur as the prescribed project activities successfully lead to increases in biodiversity. It is possible that new animals and plants returning to the area may provide incentive for short-term opportunities for exploitation in the project area. These activities could be illegal logging of or poaching. However, a variety of mitigation measures have been implemented to avoid any potentially negative impacts to the increased biodiversity derived from project activities and to protect the SMPP from illegal activities. The community development team also conducts regular consultations to maintain appropriate monitoring of the area.

The potential offsite impacts that were identified during the early planning process now appear to be unlikely to occur. In order to ensure the absence of the offsite stakeholder impacts, the project seeks regular consultations with the project's communities and other relevant stakeholders to ensure that their concerns or challenges are integrated into the project's further planning. Further details on offsite stakeholder impacts are discussed in Section 4.3.

5.2.3 Net Positive Biodiversity Impacts (B2.2, GL1.4)

Compared with conditions under the without-project land-use scenario, and because the project does not anticipate any negative impacts to biodiversity, the net biodiversity outcomes can only be positive (as mentioned in Section 5.2.2 above). In combination with the predicted increased forest cover, this will likely result in increased use of the SMPP project area as a corridor by tigers in the area. The project area is also potentially capable of holding resident individuals.

5.2.4 High Conservation Values Protected (B2.4)

Three forms of biodiversity-related HCVs were identified above (Section 5.1.3) for the SMPP. They are:

- Concentrations of biological diversity including endemic species and rare, endangered or threatened species that are significant at the global, regional and national levels.
- Rare, Threatened, or Endangered ecosystems, habitats or refugia.
- Basic ecosystem services in critical situations, including protection of water catchment and control of fires.

By protecting part of the Merang-Kepayang peat dome landscape, the SMPP will be directly protecting vital wildlife habitats and safeguarding critical water resources that are essential for the maintenance and functioning the peat dome landscape. Reducing fire risk and maintaining connectivity by keeping the area intact will increase the site's value as an important biological corridor and improve forest cover. To this end, all the high conservation values (at the species, ecosystem or functional levels) will be much improved under the project scenario compared to the baseline for the reasons noted above (Section 5.2.3).

5.2.5 Species Used (B2.5)

The project's restoration activities that include planting or reforestation within the SMPP area shall utilize native or naturalized tree/plant species. No non-native species will be used in the project accounting area.

5.2.6 Invasive Species (B2.5)

Our project will not introduce any invasive species to the SMPP area. All of the species used in this project are already found naturally growing in this area.

5.2.7 Impacts of Non-native Species (B2.6)

The SMPP will not use any non-native species for any project activities.

5.2.8 GMO Exclusion (B2.7)

Our project will not introduce any genetically modified organisms (GMOs) to the SMPP area.

5.2.9 Inputs Justification (B2.8)

No inputs such as any fertilizers, chemical pesticides, or biological control agents will be used for the project.

5.2.10 Waste Products (B2.9)

The project has infrastructure in place for waste management at the project site. Systems for separation of organic and non-organic waste are in place. Organic or food waste is disposed of by using it to feed the animals living at the main camp (e.g. dogs, cats, and chickens). Currently the non-organic waste generated at the SMPP site is being stored in a self-contained landfill. Toilet facilities for staff use basic latrine-based systems.

Additionally, as part of our community development initiatives, the project aims to incorporate plastic recycling and trash collection systems in the Muara Merang and Kepayang villages as the project progresses.

5.3 Offsite Biodiversity Impacts

5.3.1 Negative Offsite Biodiversity Impacts (B3.1) and Mitigation Measures (B3.2)

At this stage in the project development, no offsite biodiversity impacts are predicted. However, as the project continues, and biodiversity increasingly returns to the SMPP area, it is possible that exploitation may occur, for example with hunting or illegal logging activities. The project will continue to pay close attention to the activities occurring at the project site and will address potential threats to biodiversity through the adaptive management system to prevent negative impacts from occurring. Further details on offsite biodiversity impacts are discussed in Section 5.3.

5.3.2 Net Offsite Biodiversity Benefits (B3.3)

The project area does not have villages and settlements with significant populations of people in close proximity. The project anticipates that there will be significant spillover of species outside of the project area with biodiversity benefits extending beyond the boundaries and into the surrounding landscape. Because of the low numbers of people living in the area, it can be expected that the project will maintain a net gain in biodiversity in the surrounding areas as there are no anticipated interventions required in these areas at this time.

Project teams will systematically monitor hunting and fishing grounds in and around the project area and mitigation plans will be developed if at any time there is an indication that the biodiversity outside of the

project area is being over harvested or net positive impacts are not being achieved. See risk table in Section 2.1.18 for more justification that the risks are very low.

5.4 Biodiversity Impact Monitoring

5.4.1 Biodiversity Monitoring Plan (B4.1, B4.2, GL1.4, GL3.4)

The SMPP has created a comprehensive monitoring plan to address biodiversity within the project. The monitoring plan is built around standardized and well recognized surveying and monitoring techniques and methodologies. It contains all the required components necessary to conduct successful monitoring of biodiversity and the impacts of SMPP project activities throughout the duration of the project. The biodiversity monitoring plan considers the overall requirements of the project, combined with the financial, logistical, and staff capacity constraints, as well as the target species and habitats.

There will be two key stages required before effective monitoring can be put in place within the SMPP area. First, all permanent monitoring sites (camera-trap sites and listening posts) and transects (bird surveys and patrolling areas) must be investigated and established, including where necessary tracks need to be cut and/or flagged for regular use. To minimize any negative impacts on the landscape, multiple monitoring methods will be used at each site and transects established in between monitoring points. For example, travelling between camera-trap sites on either side of the peat swamp forest will utilize the existing trails linking gibbon listening posts within the remaining closed canopy peat swamp forest. Similarly, these same trails/tracks will have bird monitoring stations established incrementally along their course. Although trails need to be clearly marked and will often follow naturally occurring contours or game trails some maintenance and initial cutting may be required. However, this will be kept to a minimum not only to limit damage to the vegetation, but also to discourage easy access for users from outside the project area. The second key component is the training and capacity development of the project staff. All monitoring—barring the annual bird surveys—will be conducted by field staff from the SMPP. The focus for biodiversity monitoring includes:

- Gibbon and hornbill monitoring protocols using listening posts;
- Use of Spatial Monitoring and Reporting Tool (SMART) conservation software as part of patrolling protocols;
- Set up of camera-traps and recording methods;
- Vegetation surveys at camera trap-sites;
- Annual site side bird surveys; and
- Management of all data collected across all methods.

The existing gibbon population in the SMPP area is located within the remaining intact peat swamp forest. To monitor this group there will be one sampling point and three listening posts (Map 37 in Section 5.1.1.1). Based on assumptions for how far gibbon calls can travel, the sampling procedures outlined here will capture the full extent of the present gibbon population. This gibbon monitoring will be conducted annually. All trainings will be conducted by the biodiversity manager on site with full participation and support from all project staff. After the establishment of the permanent listening posts, a full survey will be conducted by a well-trained monitoring team.

The SMART system will be used to monitor project activities at multiple levels. Firstly, it will be used to monitor inputs and track the performance of forest patrol teams in the field which is vital from a management perspective. Secondly, SMART data will provide a means of monitoring threat levels (i.e. levels of hunting/fishing and logging) through the generation of catch per unit effort (CPUE) indices. Using standardized threat indicators allows for comparisons over space and time and this will help to evaluate the effectiveness of enforcement and the impact of other conservation interventions. Thirdly, and of particular importance for SMPP in the earlier years of project activities—when threats of illegal activities are expected to remain low—the SMART system will be used to collect wildlife observations, and thus contribute to the

wider program of biodiversity monitoring. The use of a system like SMART and the resulting standardized reporting of such global indicators will improve management effectiveness. The steps in the use of SMART as a tool for adaptive management are as follows:

- **Forest Patrols:** Patrol teams collect and record data on where they go and what they see while on patrol, such as threats (e.g. poaching signs), patrol results, and wildlife observations.
- **Debriefing:** Patrols report their patrol activities and patrol data and routes are checked.
- **Data Entry:** Patrol data are stored in a SMART patrol database.
- **Data Analysis and Reports:** Data are processed into visually appealing (easy to understand) tables, charts, and maps showing patrol effort, coverage, and results, thus forming the basis for patrol analysis and evaluation.
- **Feedback and Patrol Planning:** Regular meetings with rangers are held to discuss patrol effort results and set new patrol targets.

The project's biodiversity monitoring and survey design for SMPP utilizes well-recognized and scientifically sound methodologies. The methodology does not target specific species (barring gibbons/hornbills), instead, it aims to capture the full range of biodiversity changes in the SMPP area across a range of important species. To this end it is a monitoring and survey plan that is both feasible and repeatable.

Camera-trapping is particularly able to provide a balanced view of the mammal community, as camera-traps take photographs of all animals larger than 500 grams that move in front of the sensor. A standardized camera-trap set-up provides information about the distribution or abundance of certain taxa and information about wildlife communities, such as species richness. Furthermore, repeated surveys will allow the project to evaluate population trends over time, providing an important indicator on the effectiveness of conservation interventions and managements decisions (as outlined in in Section 5.1.1.1).

For bird monitoring, the project will measure relative abundance, using the point count method. In the SMPP area, seven transects will be established for monitoring birds in Section 5.1.1.1). Each transect will consist of ten permanent bird counting stations spaced at 200 m intervals. These seven transects have been designed to capture data across the various types of land cover classifications within the project. Each bird species will be tracked by recording visual and audio data, along with the environmental variables at each station, including time, sunshine, wind and ambient noise.

Further information about how the project will address biodiversity impacts related to the HCVs 1, 3, and 4, can be found in Section 5.1.3.5. All further details and descriptions of the activities that will take place as part of the biodiversity monitoring will be outlined in the Biodiversity Monitoring Report.

5.4.2 Biodiversity Monitoring Plan Dissemination (B4.3)

The biodiversity monitoring plan will be disseminated to project communities and other relevant stakeholders and the public. Summaries of this work will be available in the same manner as other project documents, and this dissemination is discussed in Section 2.3.2.

5.5 Optional Criterion: Exceptional Biodiversity Benefits

The SMPP aims to achieve exceptional biodiversity benefits and be validated to the Gold Level based on the presence of ecologically important IUCN Red Listed species in our project area.

5.5.1 High Biodiversity Conservation Priority Status (GL3.1)

Throughout the SMPP project area a variety of species have been identified, including mammals, birds, reptiles, fish, and plants that are of high biodiversity conservation priority status. These are catalogued in Table 67 below.

Table 67. Species present in the SMPP that meet IUCN Red List criteria as critically endangered, endangered, and vulnerable species.

IUCN Status	Scientific Name	Common Name	Local Name	Family	Range
Mammals					
CR	<i>Panthera tigris ssp. Sumatrae</i>	Sumatran tiger	Harimau sumatera	Felidae	Endemic to Sumatra
EN	<i>Hylobates agilis</i>	Agile gibbon	Owa	Hylobatidae	Throughout Asia
EN	<i>Presbytis melalophos</i>	Sumatran Surili	Simpai merah	Cercopithecidae	Endemic to Sumatra
VU	<i>Helarctos malayanus</i>	Sun bear	Beruag madu	Ursidae	Throughout Asia
VU	<i>Lutrogale perspicillata</i>	Smooth-coated otter	Berang-berang	Mustelidae	Throughout Asia
VU	<i>Macaca nemestrina</i>	Southern pig-tailed Macaque	Beruk	Cercopithecidae	Throughout Asia
VU	<i>Rusa unicolor</i>	Sambar deer	Rusa sambar	Cervidae	Endemic to Sumatra
VU	<i>Sus barbatus</i>	Bearded pig	Babi jenggot	Suidae	Throughout Asia
Birds					
VU	<i>Buceros rhinoceros</i>	Rhinoceros hornbill	Enggang cula	Bucerotidae	Throughout Asia
VU	<i>Lophura erythrophthalma</i>	Malay Crestless Fireback	Sempidan merah	Phasianidae	Throughout Asia
VU	<i>Nisaetus nanus</i>	Wallace's hawk-eagle	Elang Wallace	Accipitridae	Throughout Asia
VU	<i>Psittacula longicauda</i>	Long-tailed parakeet	Betet ekor-panjang	Psittacidae	Throughout Asia
Reptiles					
EN	<i>Heosemys spinosa</i>	Spiny turtle	Kura-kura duri	Geoemydidae	Throughout Asia
EN	<i>Tomistoma schlegelii</i>	False gharial	Sinyulong	Gavialidae	Throughout Asia
VU	<i>Amyda cartilaginea</i>	Asiatic softshell turtle	Labi-labi	Trionychidae	Throughout Asia
VU	<i>Cuora amboinensis</i>	Amboina box turtle	Kuya batok	Geoemydidae	Throughout Asia
VU	<i>Ophiophagus hannah</i>	King cobra	Tedung, ular anang	Elapidae	Throughout Asia
Fish					

IUCN Status	Scientific Name	Common Name	Local Name	Family	Range
EN	<i>Scleropages formosus</i>	Asian arowana	Arwana perak	Ostoglossidae	Throughout Asia
Plants					
CR	<i>Shorea platycarpa</i>	Light red Meranti	Meranti paya	Dipterocarpaceae	Throughout Asia
EN	<i>Anisoptera marginata</i>		Tenam	Dipterocarpaceae	Throughout Asia
EN	<i>Shorea dasyphylla</i>		Meranti payau	Dipterocarpaceae	Throughout Asia
EN	<i>Shorea teysmanniana</i>		Meranti Merawan	Dipterocarpaceae	Throughout Asia
VU	<i>Aquilaria microcarpa</i>		Gaharu	Thymelaeaceae	Throughout Asia
VU	<i>Cantleya corniculata</i>		Bedaru	Stemonuraceae	Throughout Asia
VU	<i>Combretocarpus rotundatus</i>		Perepat	Anisophylleaceae	Throughout Asia
VU	<i>Cyrtostachys lakka</i>	Lipstick palm	Palem merah	Arecaceae	N/A
VU	<i>Dyera costulata</i>		Jelutung bukit	Apocynaceae	Throughout Asia
VU	<i>Dyera polyphylla</i>		Jelutung rawa	Apocynaceae	Throughout Asia
VU	<i>Shorea uliginosa</i>		Meranti kelungkum	Dipterocarpaceae	Throughout Asia

5.5.2 Trigger Species Population Trends (GL3.2, GL3.3)

Trigger species in the SMPP are defined, in accordance with the CCB standards, as species that cause the site to meet Key Biodiversity Area qualifying conditions, which are determined based on IUCN vulnerability criteria.⁷¹ We have identified 29 trigger species present in the SMPP including one apex predator, seven other mammal species, four bird species, five reptile species, one aquatic species, and eleven plant species. Further information about these trigger species is outlined in Table 68 below. Overall, the trigger species in the SMPP will be positively affected by the with-project scenario in all cases. At this time, we do not have estimations of population numbers of these species within the SMPP.

Table 68. Trigger species in the SMPP.

Trigger Species	Apex Predators (1): <i>Panthera tigris</i> ssp. <i>Sumatrae</i>
Population Trend at Start of Project	The Sumatran tiger (<i>Panthera tigris</i> ssp. <i>Sumatrae</i>) is endemic to the island of Sumatra. Listed as critically endangered, IUCN indicates that this species is decreasing.
Without-project Scenario	Without the presence of the project, it is highly likely that species diversity would be negatively affected by increasing development and land-use change within the SMPP area. Although the majority of the land is significantly degraded, the land is used by mammals of significance for global biodiversity conservation such as the Sumatran tiger, even though currently it is unlikely that the project area holds resident individuals. Rather, it is more likely that the project area is being utilized as a corridor between other land-uses in the landscape.
With-project Scenario	Under the project scenario tiger prey species such as pigs and Sambar deer are expected to increase from their current densities as the rewetting and reforestation progresses. In combination with the predicted increased forest cover, this will likely result in increased use of the SMPP project area as a corridor by tigers in the area. The project area is also capable of holding resident individuals.

Trigger Species	Mammals (7): <i>Hylobates agilis</i> , <i>Presbytis melalophos</i> , <i>Helarctos malayanus</i> , <i>Lutrogale perspicillata</i> , <i>Macaca nemestrina</i> , <i>Rusa unicolor</i> , and <i>Sus barbatus</i>
Population Trend at Start of Project	The agile gibbon (<i>Hylobates agilis</i>), occupying Sumatra, Kalimantan, Peninsular Malaysia and Thailand, and the Sumatran Surili (<i>Presbytis melalophos</i>), endemic to the island of Sumatra, are both listed as endangered and IUCN indicates that the populations of these species are decreasing. The other mammals mentioned above are listed as vulnerable species. These species reside throughout Asia, and the IUCN Red List indicates that the populations of these species are in decline.
Without-project Scenario	Without the presence of the project, it is likely that species diversity would be negatively affected by increasing development and land-use change within the SMPP area.
With-project Scenario	With the SMPP in place, the ability for these areas to support biodiversity will be strengthened and these areas will be protected. Increased forest cover and the planting of tree species that are important to mammal species for some aspect of their ecology such as for food sources or nesting will likely encourage population growth of key mammal species like gibbons, sun bears, pigs, and Sambar deer.

Trigger Species	Birds (4): <i>Buceros rhinoceros</i> , <i>Lophura erythrophthalma</i> , <i>Nisaetus nanus</i> , and <i>Psittacula longicauda</i>
Population Trend at Start of Project	These species of birds occur throughout Asia, and IUCN Red List indicates that populations of all of these species are decreasing and lists them as vulnerable. Hornbills in particular are at significant and ongoing risk from illegal wildlife trade.

Without-project Scenario	Without the presence of our project, it is likely that species diversity would be negatively affected by increasing development and land-use change within the SMPP area. These species are threatened by habitat loss and disturbance.
With-project Scenario	With the project, the presence of bird habitats will be improved, and a higher abundance of these species will be able to thrive.

Trigger Species	Reptiles (5): <i>Heosemys spinosa</i> , <i>Tomistoma schlegelii</i> , <i>Amyda cartilaginea</i> , <i>Cuora amboinensis</i> , and <i>Ophiophagus hannah</i> ; Aquatic Species (1): <i>Scleropages formosus</i>
Population Trend at Start of Project	The spiny turtle (<i>Heosemys spinosa</i>), false gharial (<i>Tomistoma schlegelii</i>), and Asian arowana (<i>Scleropages formosus</i>) are all listed as endangered species. The Asiatic softshell turtle (<i>Amyda cartilaginea</i>), Amboina box turtle (<i>Cuora amboinensis</i>), and king cobra (<i>Ophiophagus hannah</i>) are listed as vulnerable. All of these reptiles and fish are distributed throughout Asia. Populations of false gharial, Asian arowana, and king cobra are decreasing, while the population trends of the other species listed here are unspecified by the IUCN.
Without-project Scenario	Without the presence of our project, it is likely that species diversity would be negatively affected by increasing development and land-use change within the SMPP area. These species are threatened by habitat loss and disturbance, exacerbated by the changes to natural aquatic or water-logged areas that Acacia plantation activities generate in the baseline scenario.
With-project Scenario	One of the key project activities is the rewetting of drained peat across the project area through the installation of canal blocks. These activities will significantly increase the volume and extent of ground water across the project. This, combination with riparian replanting activities and natural regeneration will lead to increased heterogeneity of aquatic habitats. More diverse habitats will lead to increased diversity and abundance of aquatic species over time. Blocking of canals will naturally increase the extent and quality of different spawning grounds (fish and amphibians) and nesting sites (gharials and turtles) this natural diversification of the canal substrate will be further augmented by selecting species for replanting around the canal blocks that encourage the formation of root mats to bind the compacted peat material used for canal construction. These root and vegetation mats can also provide spawning and nesting grounds for the aquatic community.

Trigger Species	Plant Species (11): <i>Shorea platycarpa</i> , <i>Anisoptera marginata</i> , <i>Shorea dasyphylla</i> , <i>Shorea teysmanniana</i> , <i>Aquilaria microcarpa</i> , <i>Cantleya corniculata</i> , <i>Combretocarpus rotundatus</i> , <i>Cyrtostachys lakka</i> , <i>Dyera costulata</i> , <i>Dyera polyphylla</i> , and <i>Shorea uliginosa</i>
Population Trend at Start of Project	<i>Shorea platycarpa</i> is listed as critically endangered, while <i>Anisoptera marginata</i> , <i>Shorea dasyphylla</i> , and <i>Shorea teysmanniana</i> are listed as endangered and the remaining species above are listed as vulnerable. There is insufficient data in the IUCN Red List concerning the population trends of these species.

Without-project Scenario	Without the presence of the project, it is likely that species diversity would be negatively affected by increasing development and land-use change within the SMPP area. These species are threatened by single species Acacia plantations and continued land conversion and degradation.
With-project Scenario	With the project, a diverse selection of plant species would have the opportunity to return to a thriving forest, without the continued pressure from Acacia plantations that threaten floral biodiversity. Disturbance in these forests would be reduced and these vulnerable species would be protected, especially in areas of intact forest that would be quickly destroyed in the project baseline scenario.

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7 LIST OF ANNEXES

Annex 1 Identification of project risks

Annex 2 VCS AFOLU Non-Permanence risk analysis

Annex 3 Land Cover Classification of the project area

Annex 4 Lidar-derived Digital Terrain Model (DTM) overview

Annex 5 Peat inventory of the project area

Annex 6 Justification of eligibility of the ARR project area

Annex 7 Hydrological modeling for the project scenario

Annex 8 Canal blocking plan and hydrological monitoring planning standard operation procedures

Annex 9 Proxy analysis of reference region for conversion/deforestation rate

Annex 10 Strata changes in the baseline scenario

Annex 11 Default factors for quantification of GHG emissions in the baseline and project scenario

Annex 12 Regional fire probability modeling for predicting fire risk

Annex 13 Estimate of annual area burnt and simulation of 100-year fire occurrence

Annex 14 Uncertainty in WRC estimates

Annex 15 Peat characteristics and subsidence monitoring SOPs

Annex 16 HCV assessment related to biodiversity in the project zone