Joint Crediting Mechanism Proposed Methodology Form

Cover sheet of the Proposed Methodology Form	
Form for submitting the proposed methodology	
Host Country	Indonesia
Name of the methodology proponents submitting this form	Mitsubishi Research Institute, Inc.
Sectoral scope(s) to which the Proposed Methodology applies	REDD (Reducing emissions from deforestation and forest degradation)
Title of the proposed methodology, and version number	Methodology for reducing emissions from deforestation and forest degradation by promoting forest conservation activities, Version 1.0
List of documents to be attached to this form (please check):	☐The attached draft JCM-PDD: ☒Additional information Provincial Government of East Kalimantan (2012) "Local Action Plan for Greenhouse Gas Emission Reduction East Kalimantan Province"
Date of completion	2015/2/26

History of the proposed methodology

Version	Date	Contents revised
V 1.0	2015/1/13	First draft released
V 2.0	2015/2/26	Final released

A. Title of the methodology

Methodology for reducing emissions from deforestation and forest degradation by promoting forest conservation activities, Version 2.0

B. Terms and definitions

Terms	Definitions
Forest	Under the Kyoto Protocol, each country defines "forest" within its boundaries using three parameters: crown cover (%), minimum area (ha), and tree height (m). Indonesia's definition of forest: ・ Minimum crown cover: 30% ・ Minimum area: 0.25 ha ・ Minimum tree height: 5 m
Project area	Discrete parcel(s) of land that are under threat of deforestation on which the project developers will undertake the project activities
Reference area	Area with similar characteristics to the project area, used to estimate the future rate of forest carbon reduction in the project area.
Reference period	Time period used to estimate the historical rate of forest carbon reduction in the reference area.
Carbon Stock	The quantity of carbon stored within a carbon pool, measured in tones of CO2

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	Activities in the forests for avoiding forest fires and illegal logging etc. which result in deforestation and forest degradation (e.g. Forest patrols etc.)
Calculation of reference emissions	Reference emissions are calculated on the basis of the reference scenario, which assumes that current deforestation and other trends continue.
Calculation of project	Project emissions are calculated on the basis of the actually

emissions	monitored land cover change and emission factors over the project period.
Monitoring parameters	Land cover area changes and emission factors (carbon stocks per ha) by land cover category

D. Eligibility criteria

This methodology is applicable to projects that satisfy all of the following criteria.

Criterion 1	Ensure that the forest in which the activities will be carried out meets the definition of "forest" adopted by the host country, and that the forest conservation activities, etc. to be carried out are in conformity with the scope of REDD+ adopted by the relevant host country. < Definition of "forest" in Indonesia > Crown ratio：30%, Minimum tree height： 5m, Minimum land area：0.25ha < Scope of REDD+ > （1）Reducing emissions from deforestation （2）Reducing emissions from forest degradation （3）Conservation of forest carbon stocks （4）Sustainable management of forests （5）Enhancement of forest carbon stocks
Criterion 2	< Authority to manage the project area > Obtain concession for the land which will serve as the project area.
Criterion 3	< Specification of the satellite image and analysis method > The following specifications must be met as for the resolution of satellite image and analysis method: ● High resolution remote sensing data (spatial resolution is **5m/pixel or better**, such as "ALOS/PRISM" etc.) from the most recent year in the project period.
Criterion 4	< Inclusion of safeguards > Through REDD+ activities, apply appropriate safeguards, including methods such as demonstrating concern for protection of biodiversity. Comply with the rules and regulations of the host country, if the country has rules and regulations on safeguard activities.
Criterion 5	< No Peat Swamp Forest > No peat swamp forest is included in the Project Area. Or the impact of deforestation and forest degradation are negligible small in terms of emissions from soil organic carbon.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Net greenhouse gas emissions under the reference scenario (Current trends on emissions from deforestation and forest degradation and carbon removals from afforestation/reforestation and forest enhancement)	CO2
Project emissions	
Emission sources	GHG types
Net greenhouse gas emissions under the project scenario (Reduced emissions from deforestation and forest degradation and enhanced carbon removals from afforestation/reforestation and forest enhancement)	CO2
Net greenhouse gas emissions due to leakage	CO2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Reference emissions are calculated in the following procedures:

Step 1: Definition of the project boundaries
Step 2: Definition of the reference region
Step 3: Stratification of the total area subject to deforestation
Step 4: Estimation of the net carbon stock changes in the reference region
(Calculation with **moderate resolution** remote sensing data)
Step 5: Identification of the deforestation rate and the reference emissions in the project area

The BaU emissions assume the emissions when the project activities (e.g. regeneration, afforestation/reforestation, other livelihood supports etc.) are not implemented.

In the methodology, when setting the reference region, area(s) with almost the same or lower risks of deforestation and forest degradation shall be selected, compared to the project area. Therefore, the estimated deforestation rate of the reference region will be more conservative

than that of the project area.

F.2. Calculation of reference emissions

Specific procedures for calculating reference emissions in the project area are shown in the followings:

Step 1: Definition of the project boundaries

a) Geographical boundaries

The spatial boundaries of a project shall be defined so as to facilitate accurate measuring, monitoring, accounting, and verifying of the project's emissions reductions and removals. The following information shall be provided:

- Name of the project area;
- Map of the area;
- Total land area; and
- Details of forestland rights holder and user rights.

b) Temporal boundaries

Start date and end date of the "historical reference period" shall be defined. "Historical reference period" is necessary for setting temporal boundaries to calculate "Reference emissions."

c) Carbon pools

In the project, any significant decreases in carbon stock in the project scenario and any significant increases in carbon stock in the reference scenario shall be calculated. Appropriate carbon pools should be selected for accounting emission reductions. Aboveground biomass and Belowground biomass should be included.

Carbon pool	Included/Excluded
Aboveground biomass	Included
Belowground biomass	Included
Dead-wood	Optional
Harvested wood products	Optional
Litter	Optional
Soil organic carbon	Optional

Step 2: Definition of the reference region

The reference region shall be defined in order to project deforestation rate in the project area. The area of the reference region shall be calculated in the following manner:

MREF = RAF * PA

RAF = 7500 * PA $^{-0.7}$

If RAF as calculated is <1, RAF shall be made equal to 1

Where,

In addition, similarities between the reference region and the project area shall be ensured, and the reference region shall be defined using some of the following criteria:

- The main agent(s) of deforestation
- Landscape factors
- Transportation networks and human infrastructure
- Social factors
- Policies and regulations

Step 3: Stratification of the total area subject to deforestation

Stratification of the total area subject to deforestation in the project area shall be identified. The stratification may refer to the official data defined by the local authorities such as RAD-GRK (Local Action Plan for Greenhouse Gas Emission Reduction) in Indonesia.

Land cover categories defined by the Provincial Government of East Kalimantan

No.	Land Cover Category	Proposed carbon stock [ton/ha]
1	Primary dry land forest	195.4
2	Secondary/former logged dryland forest	169.7
3	Primary mangrove forest	170
4	Primary swamp forest	196
5	Plantation forest	64
6	Bush	15
7	Plantation/garden	63
8	Settlement	1
9	Open land	0
10	Grass	4.5
11	Water area	0
12	Secondary/former logged mangrove forest	120
13	Secondary/former logged swamp forest	155
14	Swamp bush	15
15	Dryland agriculture	8

16	Mixed dryland agriculture shrubs/garden	10
17	Field	5
18	Embankment	0
19	Airport/port	5
20	Transmigration	10
21	Mining	0
22	Swamp	0

Source: Provincial Government of East Kalimantan "Local Action Plan for Greenhouse Gas Emission Reduction East Kalimantan Province"

Step 4: Estimation of the historical net carbon stock changes in the reference region

(Calculation with <u>moderate resolution</u> remote sensing data)

The historical net carbon stock changes in the reference region can be calculated as follows:

a) Collection of appropriate data sources

Collect medium resolution remote sensing data (spatial resolution is **<u>30m/pixel or better</u>**, such as "Landsat" or "Spot" sensor data) for at least three points in time of no less than 3 years apart each other and covering the historical reference period.

b) Estimation of land cover area change by creating "land cover change matrix (Area-basis)"

Based on the difference of the remote sensing data taken at two different points of time, the "land cover change matrix (Area-basis)" in the reference region shall be created.

c) Provision of emission factors by land cover category

Emission factors by land cover category shall be provided in either of the following manners:

<Option 1: On-site sampling survey>

Emission factors by land cover category can be identified based on the results of the on-site sampling survey of the total area.

<Option 2: Application of existing official data>

When official data prepared by the local authorities are available, emission factor can be obtained from the existing data such as RAD-GRK (Local Action Plan for Greenhouse Gas Emission Reduction).

d) Estimation of carbon stock change by creating "land cover change matrix (Carbon-basis)"

By multiplying "land cover change matrix (Area-basis)" with emission factor data, "land cover change matrix (Carbon-basis)" shall be created. The historical net carbon stock changes in the reference region are calculated in the following formula:

$\Delta CS_{ref,T} = \sum (A_{i,j,T} * \Delta EF_{i,j,T})$

Where,

$\Delta CS_{ref,T}$ [tCO2]: Net carbon stock change in the time period of T

$A_{i,j,T}$: Total area changed from strata i to strata j in the time period of T [ha]

$\Delta EF_{i,j,T}$: The difference between emission factors of strata i and strata j [tCO2/ha]

i : 1, 2, 3, … , M strata

j : 1, 2, 3, … , M strata

T : 1, 2, 3, … , T time periods in the historical reference period

Step 5: Identification of the deforestation rate in the reference region

The average deforestation rate (Average forest carbon reduction per year) in the reference region, R_{AVE} [%], shall be calculated as the historical average basis in the following formula :

$R_T = \Delta CS_{ref,T} / y_T / CS_T$

Where,

R_T : Deforestation rate in the reference region in the time period of T [%/year]

$\Delta CS_{ref,T}$: Net carbon stock change in the reference region at the time period of T [tCO2]

y_T : Number of years in the time period of T [year]

$CS_{ref,T}$: Carbon stock in the reference region at the beginning of the time period of T [tCO2]

T : 1, 2, 3, … , T time periods in the historical reference period

$R_{AVE} = R_T$ / T

Where,

R_{AVE} : Average deforestation rate in the reference region [%/year] (Average forest carbon reduction per year)

Step 6: Calculation of the reference emissions in the project area

Finally, the reference emissions in the project area can be calculated by taking the average

of net carbon stock change in the reference region in the following formula:

REL_y = Average ($\Delta CS_{ref,T}$ / y_T) * A_{PJ} / A_{RE}

Where,

REL_y : Reference emission level in the project area in the year of y [tCO2/year]

$\Delta CS_{ref,T}$: Net carbon stock change in the reference region at the time period of T [tCO2]

y_T : Number of years in the time period of T [year]

y : 1, 2, 3, … , y years in the project period

A_{PJ}: Area of project area

A_{RE}: Area of reference area

G. Calculation of project emissions

Project emissions are calculated in the following procedures:

Step 1: Estimation of the net carbon stock changes in the project area
(Calculation with **high resolution** remote sensing data)
Step 2: Identification of project emissions in the project area

Specific procedures for calculating project emissions in the project area are shown in the following manner:

Step 1: Estimation of the net carbon stock changes in the project area
(Calculation with high resolution remote sensing data)

In this step, two kinds of tier, such as Tier1 and Tier2 depending on the potential of accuracy, are set up. Specifications of these two Tier are shown as below:

Tier 1: use of high resolution data
Tier 2: use of not only high resolution data but also very high resolution data

The net carbon stock changes in the project area can be calculated in the following manner:

a) Tier1: use of high resolution data

i) Collection of appropriate data sources

Collect moderate resolution multispectral remote sensing data (spatial resolution is 30m/pixel or better, such as "ASTER, ALOS/PRISM DEM" etc.)

Collect DEM data such as ASTER DEM etc.

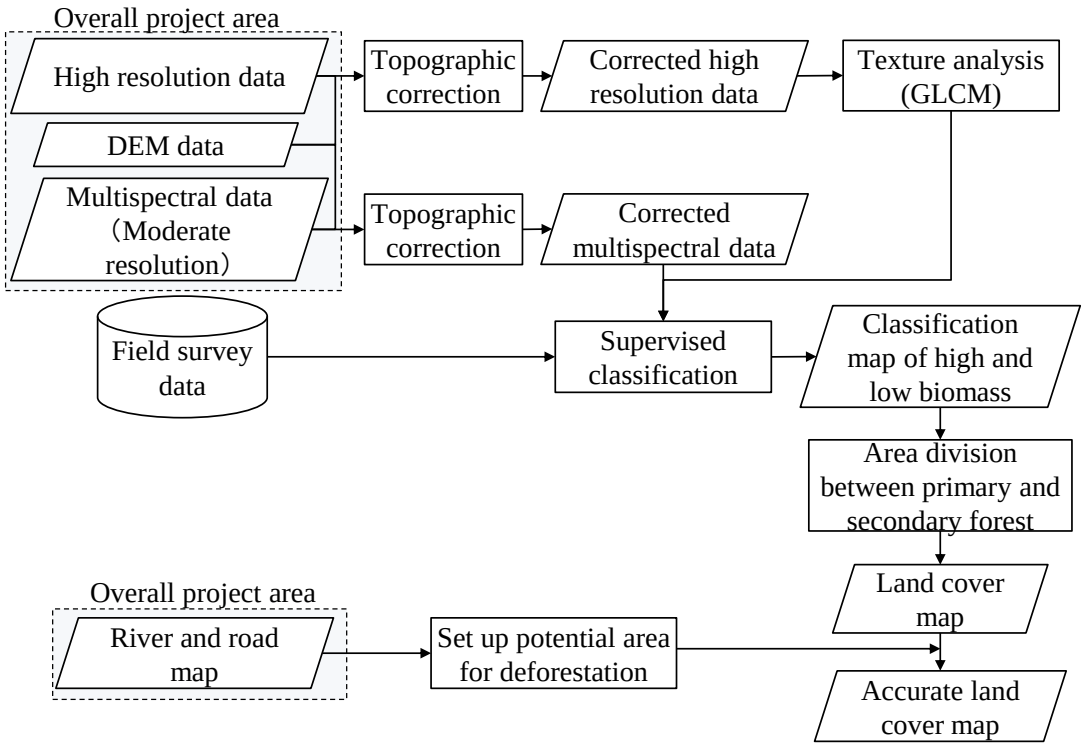
Collect field survey data which contains land cover data in enough number of quadrats

Vector data of all the rivers and roads in the project area

ii) Estimation of land cover area change by creating "land cover change matrix (Area-basis)"

Based on the difference of the remote sensing data taken at two different points of time, the "land cover change matrix (Area-basis)" in the project area shall be created.

In this analysis, as shown in the chart below, **supervised classification method, such as support vector machine, shall be conducted using field survey data and both "spectral data" and "textural data" after preprocessing. After the classification, area division between primary forest and secondary forest shall be conducted with optimal segmentation considering characteristics of primary or secondary forest distribution**. In this project area which has too many mountain in high altitude, rough terrain condition is tend to become a major reason for decreasing classification accuracy. In order to avoid the degradation, potential areas for deforestation are set up based on distance from all the rivers and roads in the project area and the classification is conducted in this limited area. As a result, more detailed and accurate analysis of forest type classification can be performed, as compared to the conventional methodologies.



Land cover map is created in the following manner.

1) Select high resolution remote sensing data, multispectral data, and DEM data
2) Collect the map of all the rivers and roads
3) Collect field survey data
4) Conduct preprocessing (topographical correction, illumination correction etc.)
5) Texture analysis with the pre-processed reflectance data
6) Pixel-based supervised classification with the reflectance data, texture data, and field survey data
7) Area division between primary forest and secondary forest
8) Limit the potential area for deforestation
9) Acquire land cover map

b) Tier2: use of very high resolution data

i) Collection of appropriate data sources

Collect **very high resolution** remote sensing data (spatial resolution is **1m/pixel or better**, such as "**WorldView 1/2/3 or ASNARO**" etc.) covering **limited area in the project area** in the latest point of time in the project period

Collect DEM data such as ASTER DEM etc.

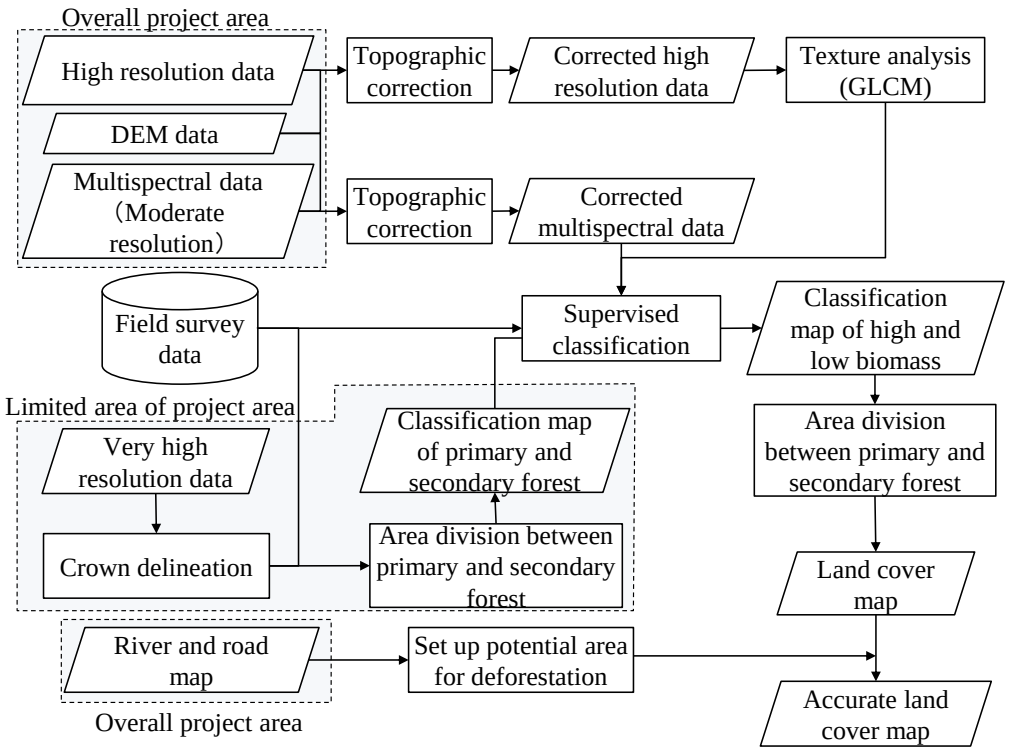
Collect field survey data which contains land cover data in enough number of quadrats

Vector data of all the rivers and roads in the project area

ii) Estimation of land cover area change by creating "land cover change matrix (Area-basis)"

Based on the difference of the remote sensing data taken at two different points of time, the "land cover change matrix (Area-basis)" in the project area shall be created.

In this analysis, as shown in the chart below, **classified map between primary and secondary forest in limited area** shall be calculated with using **very high resolution data** and field survey data. After that, **Supervised classification method, such as support vector machine, shall be conducted using that classification map in limited area, field survey data, and both "spectral data" and "textural data" after preprocessing. After the classification, area division between primary forest and secondary forest shall be conducted with optimal segmentation considering characteristics of primary or secondary forest distribution"**. As a result, more detailed and accurate analysis of forest type classification can be performed, as compared to the conventional methodologies.



Land cover map is created in the following manner.

1) Select high resolution remote sensing data, very high resolution remote sensing data, and DEM data
2) Collect field survey data
3) Conduct forest type classification with the very high resolution data and the field

survey data

4) Conduct preprocessing (topographical correction, illumination correction etc.)
5) Texture analysis with the pre-processed reflectance data
6) Pixel-based supervised classification with the classification map in limited area, the reflectance data, texture data, and field survey data
7) Area division between primary forest and secondary forest
8) Limit the potential area for deforestation
9) Acquire land cover map

c) Provision of emission factors by land cover category

Emission factors by land cover category shall be provided in either of the following manners:

<Option 1: On-site sampling survey>

Emission factors by land cover category can be identified based on the results of the on-site sampling survey of the total area.

<Option 2: Application of existing official data>

When official data prepared by the local authorities are available, emission factor can be obtained from the existing data such as RAD-GRK (Local Action Plan for Greenhouse Gas Emission Reduction).

d) Estimation of carbon stock change by creating "land cover change matrix (Carbon-basis)"

By multiplying "land cover change matrix (Area-basis)" with emission factor data, "land cover change matrix (Carbon-basis)" shall be created. The net carbon stock changes in the project area are calculated in the following formula:

$$\Delta CS_{pj,T'} = \sum (A_{i,j,T'} * \Delta EF_{i,j,T'})$$

Where,

$\Delta CS_{pj,T'}$: Net carbon stock change in the project area in the time period of T' [tCO2]

$A_{i,j,T'}$: Total area changed from strata i to strata j in the time period of T' [ha]

$\Delta EF_{i,j,T'}$: The difference between emission factors of strata i and strata j [tCO2/ha]

i : 1, 2, 3, … , M strata

j : 1, 2, 3, … , M strata

T' : 1, 2, 3, … , T' time periods in the project period

Step 2: Identification of project emissions in the project area

Finally, the project emissions in the project area can be calculated in the following formula:

$PE_y = \Delta CS_{pj,T'} * y / y_{T'}$

Where,

PE_y : Project emissions in the project area in the year of y [tCO2/year]

$\Delta CS_{pj,T'}$: Net carbon stock change in the project area in the time period of T' [tCO2]

y : 1, 2, 3, … , y years in the project period

$y_{T'}$: Number of years in the time period of T' [year]

T' : 1, 2, 3, … , T' time periods in the project period

H. Calculation of emissions reductions

Emission reductions are calculated as the difference between the reference emissions and project emissions, as follows:

$ER_y = REL_y - PE_y - LE_y$

Where

ER_y : Emission reduction in year y [tCO2/year]

REL_y : Reference emission level in year y [tCO2/year)

PE_y : Project net emission in year of y after project initiation [tCO2/year)

LE_y : Leakage emission in year y [tCO2/year)

I. Data and parameters fixed *ex ante*

The source of each data and parameter fixed *ex ante* is listed as below.

Parameter	Description of data	Source
EF_i	Emission factors of strata i [tCO2/ha]	RAD-GRK etc.