RSPO GHG Assessment Procedure for New Development

Version 3, 30th October 2016

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Contact:	RSPO Secretariat Unit A-37-1, Menara UOA Bangsar, Number 5 Jalan Bangsar Utama 1 Kuala Lumpur 59000, Malaysia
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Foreword

The RSPO Emission Reduction Working Group (ERWG), formed in November 2013, has developed the RSPO GHG Assessment Procedure for New Development referred to as the Carbon Assessment Tool in Criterion 7.8 of RSPO P&C 2013.

Since the establishment of ERWG, the GHG Assessment Procedure was reviewed and revised based on GHG assessment for new development submissions received during the implementation period (ending 31st December 2016). The implementation period was meant to allow further information and experience to be gathered to enable the ERWG to further improve and finalise the RSPO GHG Assessment Procedure for New Development.

The revised process, aims to provide clarity on the procedure and improvements to the methodologies in accordance to best available research and scientific findings. This progress had also resolved limitations and gaps identified previously. This latest version of RSPO GHG Assessment Procedure for New Development (Version 3, 30th October 2016) will supersede all previous versions of RSPO GHG Assessment Procedure. All GHG Assessments for new development submitted starting from 1st January 2017 must use this version of the RSPO GHG Assessment Procedure for New Development. Assessments submitted prior to 1st January 2017 may use this guidance on a voluntary basis.

As of 1st January 2017, the summary GHG Assessment report for new development under Criterion 7.8 shall be published together with the standard NPP report, in accordance with RSPO New Planting Procedure (NPP) of November 2015.

Acknowledgements

1. Introduction

The Roundtable for Sustainable Palm Oil (the RSPO) is an international multi-stakeholder certification scheme for sustainable palm oil and its mission include advancing the production, procurement, finance and use of sustainable palm oil products; and to develop, implement, verify, assure and periodically review credible global standards for the entire supply chain of sustainable palm oil.

The Principles and Criteria (P&C) for the production of sustainable palm oil is a framework developed by the RSPO (2007) to define sustainable palm oil in practical and implementable terms that allows for palm oil to be certified as sustainable. There are eight Principles in total, of which Principle 7 is on responsible development of new development.

In achieving its mission, the RSPO embraces the concept of continuous improvement and in line with this, the P&C is to be reviewed and improved upon every five years. The first P&C review began with the initial public consultation in 2011 and the process continued throughout 2012 and early 2013 led by the P&C Review Taskforce. The revised P&C was endorsed by the RSPO Executive Board and accepted at the Extraordinary General Assembly by RSPO members on April 25, 2013.

The revised P&C (2013) has a new Criterion 7.8 requiring that **new plantation developments** are designed to minimise net greenhouse gas (GHG) emissions. The indicators under this criterion include the identification and estimation of potential sources of emission and sinks of carbon associated with the new developments. Another indicator is that new developments must be designed to minimise GHG emissions which takes into account avoidance of land areas with high carbon stocks and consideration of sequestration options.

The RSPO GHG Assessment Procedure for New Development is meant to be used as a guidance to identify and estimate carbon stocks prior to and after new developments as well as major sources of emissions that may result directly from the development as required by Criterion 7.8.1. A calculator, known as New Development GHG Calculator[1], was also developed to assist estimation of GHG emissions associated with new plantation developments. In addition, the procedure also provides guidance for developing a plan to minimise net greenhouse gas emissions which takes into account avoidance of land areas with high carbon stocks and/or sequestration options as required by Criterion 7.8.2.

The objective of developing this GHG Assessment Procedure is to **provide guidance to growers for estimating the net GHG emission associated with new plantation development. This procedure should be integrated with HCV and SEIA studies as part of NPP submission. Based on this, the corresponding expected carbon stock fluxes (above and below ground) and GHG emissions associated with the resulting land cover change to oil palm, peat drainage (if appropriate) and emissions from mills and operations can be estimated** and development plans adjusted to avoid

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[1] This has been developed from Simplified Excel PalmGHG with incorporation of new elements, including sequestration from conservation areas, landuse change emissions from road, mill and ditches, correction of emission factor for Urea, and additional explanation.

areas with high carbon stocks and minimise net GHG emissions associated with new plantation development.

The GHG assessment can be conducted by the grower or by an independent consultant, with relevant competencies (refer Box 1) demonstrated; and must have been prepared based on carbon stock assessments and field verification conducted no more than three years prior to the submission of the NPP.

Box 1. Assessment Competencies

The assessment team should:

i.   Have knowledge of carbon emission accounting methodologies for above and below ground carbon stocks including peat.

ii. Have experience in verifying land cover maps and/or conducting carbon stock assessment in agriculture and/or forestry sectors.

iii. Have experience and expertise in using remote sensing technology to estimate carbon stocks

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1.1 Development of the GHG Assessment Procedure

The main steps involved in developing the procedure were a review of literatures related to carbon assessments for the forestry and agriculture sectors in tropical regions of the world (with a particular emphasis on Malaysia and Indonesia); and interviews with relevant people from palm oil producing companies, non-governmental organisations (NGOs), consultant companies, research institutions and remote sensing experts.

In the process of data gathering and developing the tool, much emphasis was given to minimizing the resources that need to be mobilized, by aligning with other processes that are already mandatory under the RSPO's Principle 7, particularly the social and environmental impact assessments (SEIA), the soil survey and the HCV assessment.

Emphasis has also been given to encourage the use of widely available guidance and practices, and technology to ease the application and reporting of this procedure. One key component, inter alia, relying solely on existing guidance would be the initial land stratification or classification process of using remote sensing technology (including radar and optical sensors mounted on satellite and aerial platforms) – which has been well described in the RSPO New Planting Procedure (NPP)[2] and Land Use Change Analysis (LUCA) Guidance[3] of RSPO Remediation and Compensation Procedure.

The Procedure focuses on the process and sequences to be followed and refers users to other sources of guidance and best practices for detailed methodologies. Maps and tables of data provided within

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[2] Mapping guidance provided in page 26, 1.C. Guidelines for NPP map submissions under RSPO NPP (2015), http://www.rspo.org/key-documents/certification/rspo-new-planting-procedure.
[3] The LUCA guidance would be published on RSPO Website under RSPO Remediation and Compensation Procedure once finalised by RSPO BHCVWG, targeted publishing on April 2017, http://www.rspo.org/key-documents/supplementary-materials.

this Procedure are for illustration purposes only to assist the better understanding of expected outputs.

As part of this procedure, a basic reporting framework for projected emissions/sequestrations arising from options of new development has also been developed.

This procedure was first adopted in December 2012, revised in July and December 2014 and was reviewed on feedback received during the implementation period resulting in this new version in October 2016. It will continue to be periodically reviewed, revised and refined, as required by RSPO.

2. An Overview of the GHG Assessment for New Development

This Procedure is not intended as a scientific review or a comprehensive assessment of methodologies for the estimation of carbon stocks; rather it is developed to provide general guidance on key parameters and/or credible methodologies, which are widely available, for the estimation of GHG emission associated with new development plans to minimise GHG emissions. In addition, it provides guidance on the selection of preferred development options and preparation of a plan to minimise GHG emissions from new developments.

The order of the chapters in this GHG Assessment Procedure follows the steps of a GHG assessment for New Development. It starts from the first step of stratifying land cover and land use through satellite image analysis, all the way through to the development of an optimal new plantation development plan that takes into consideration of minimising GHG emissions.

This document also provides some general guidelines on how to integrate other impacts and values (carbon stock-HCV-social) to estimate potential GHG emissions resulting from different development options; and thus, guiding the decision-making process of the new plantation developments which minimises net greenhouse gas (GHG) emissions. The development of a GHG emission management and mitigation plan is also required. A reporting template is developed in Chapter 6 of this document.

The following flow chart (Figure 1) provides a simple step-wise approach of this procedure.

3.1 Preparation of a land cover map from satellite imagery	**Chapter 3. Carbon Stock Assessments**
3.2 Carbon stock estimation	The first step in this GHG Assessment Procedure is to develop a carbon stock map and table for estimating the carbon stocks associated with stratified stratum (land cover stratification).
3.3 Carbon stock map and summary table	Carbon stock map developed should include indicative presence of peat soil (if applicable) and estimated soil
4.1 Integration of carbon stocks with HCV and SEIA findings	**Chapter 4. GHG Emissions Assessment for New Development**
4.2 Scenario testing for new development options	The next step will be to integrate identified HCV areas and findings of SEIA into the carbon stock map developed. Integrated map serves to guide the exercise of projecting GHG emissions from different development options and eventually a summary of GHG emissions associated with final development plan (a development map).
4.3 Projection of GHG Emissions	
4.4 Selection of optimal development scenario	
5 Development of GHG Emission Management and Mitigation Plan	**Chapter 5. GHG Emission Management and Mitigation Plan**
6 Reporting of GHG assessment for new development	**Chapter 6. Reporting of GHG Assessment for New Development**

Figure 1. Key Steps in RSPO GHG Assessment Procedure

3. Carbon Stock Assessment

The objective of this chapter is to explain the two key steps:

> 3.1 Preparation of land cover map from satellite imagery; and
> 3.2 Carbon stock estimation, to estimate the existing carbon stock in the new development area.

These carbon stock estimates can then be used subsequently to estimate GHG emissions (covered in subsequent chapters) resulting from land use change for the proposed development area (PDA). The required carbon stock estimate must include carbon stored in:

1. Above-ground biomass,
2. Below-ground biomass (roots), and
3. (if applicable) Peat soils

The chapter explains how to produce the following specific **outputs**:

1. Location map of the new development area
2. Land cover map of the new development area derived from satellite imagery
3. (if applicable) Map indicating the location and extent of peat soil
4. (if applicable) Carbon stock estimated per ha for peat soil (tC/ha)
5. Table presenting carbon estimated per ha (tC/ha) per land cover class
6. Map and a table summarising the total development areas (ha) and carbon stock estimated per land cover class
7. Carbon stock map of the proposed development area

The RSPO recognises that different methods can be used to produce the above outputs, but strongly recommends following the two steps process outlined in this chapter.

It should be noted that this document is not intended to reproduce in detail information that is already contained in existing manuals and other guidance documents, including other RSPO guidance documents. Detailed descriptions for designing and establishing sample plots and calculating biomass, for example, are well documented in other publications. However, this tool provides references to the recommended online or published resources wherever possible. Growers may also use any other published references relevant to the steps described in this procedure.

3.1 Preparation of a land cover map from satellite imagery

This key step is to produce a) a land cover map and b) map of peat soils (outputs 2 and 3 above). This is carried out in line with the specific steps summarized in Figure 2 and further guidance is provided on each step in the following sections.
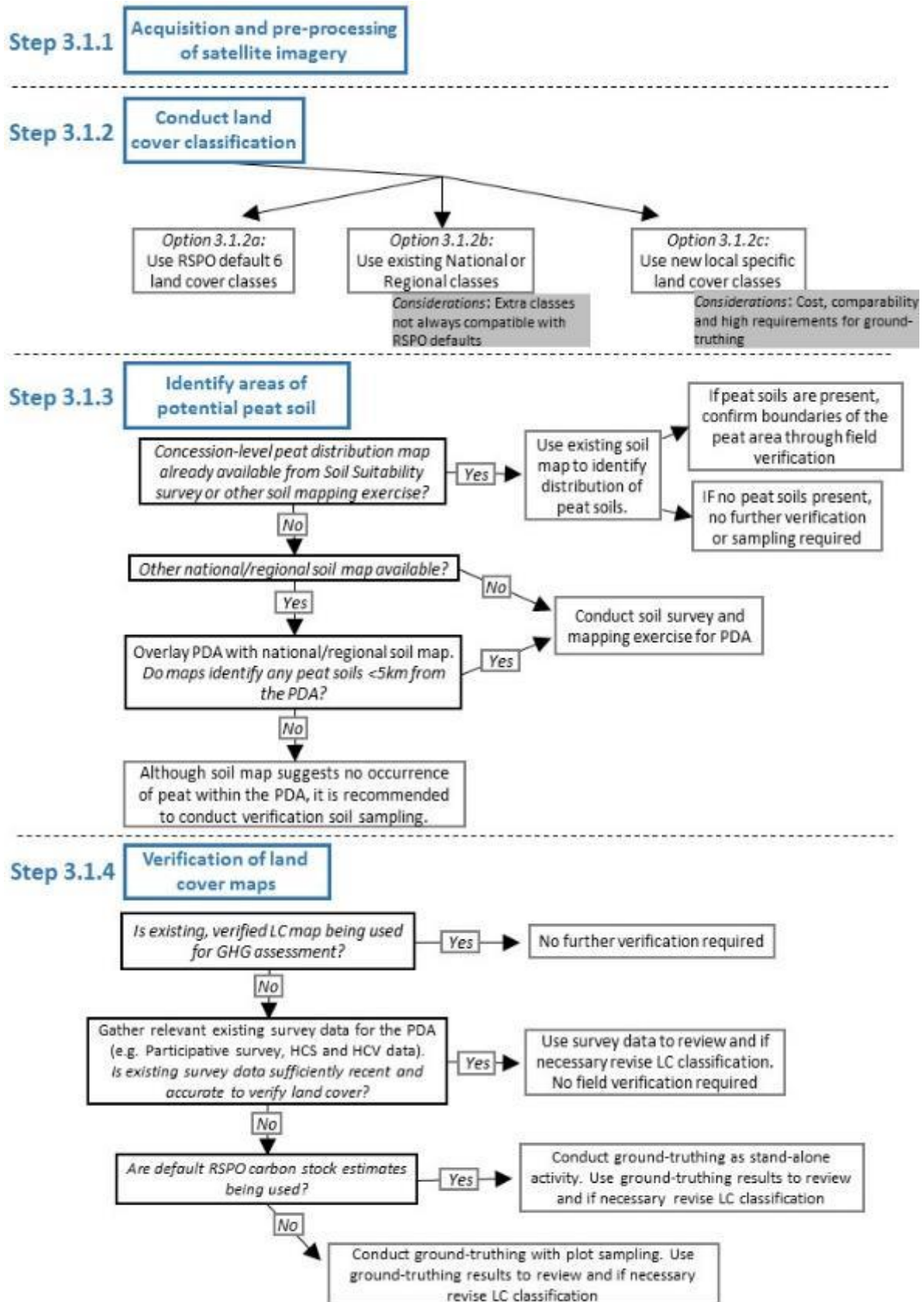
Step 3.1.1 — Acquisition and pre-processing of satellite imagery

Step 3.1.2 — Conduct land cover classification

Option 3.1.2a: Use RSPO default 6 land cover classes

Option 3.1.2b: Use existing National or Regional classes
Considerations: Extra classes not always compatible with RSPO defaults

Option 3.1.2c: Use new local specific land cover classes
Considerations: Cost, comparability and high requirements for ground-truthing

Step 3.1.3 — Identify areas of potential peat soil

Concession-level peat distribution map already available from Soil Suitability survey or other soil mapping exercise? — **Yes** → Use existing soil map to identify distribution of peat soils.
→ If peat soils are present, confirm boundaries of the peat area through field verification
→ IF no peat soils present, no further verification or sampling required

No ↓

Other national/regional soil map available? — **No** → Conduct soil survey and mapping exercise for PDA

Yes ↓

Overlay PDA with national/regional soil map. Do maps identify any peat soils <5km from the PDA? — **Yes** → Conduct soil survey and mapping exercise for PDA

No ↓

Although soil map suggests no occurrence of peat within the PDA, it is recommended to conduct verification soil sampling.

Step 3.1.4 — Verification of land cover maps

Is existing, verified LC map being used for GHG assessment? — **Yes** → No further verification required

No ↓

Gather relevant existing survey data for the PDA (e.g. Participative survey, HCS and HCV data). *Is existing survey data sufficiently recent and accurate to verify land cover?* — **Yes** → Use survey data to review and if necessary revise LC classification. No field verification required

No ↓

Are default RSPO carbon stock estimates being used? — **Yes** → Conduct ground-truthing as stand-alone activity. Use ground-truthing results to review and if necessary revise LC classification

No ↓

Conduct ground-truthing with plot sampling. Use ground-truthing results to review and if necessary revise LC classification

Figure 2. Summary of steps required to develop peat and land cover maps

The GHG assessment procedure is not the only NPP assessment where land cover maps are either required or often produced. Land cover mapping is also typically done for HCV assessments, and Land Use Change Analysis (LUCA), albeit for different purposes. The RSPO LUCA[3] guidance already explains in detail many of the steps involved in land cover mapping as required for the GHG assessment procedures. Therefore, rather than providing additional guidance on land cover mapping, this document makes reference to the existing LUCA guidance wherever relevant.

Furthermore, given the overlap between GHG, HCV and LUCA assessments, growers may be able to streamline the process by combining the assessments: see Box 1.

> **Box 2: Efficiencies between RSPO land cover mapping requirements**
> Land cover mapping is required under the LUCA component of the NPP and is often conducted for HCV assessments. Although not required for RSPO, many growers are also now developing land cover maps for High Carbon Stock assessments.
> Whilst these land cover maps may be developed for different purposes and have different cut-off dates (as is the case for the LUCA), there may be potential overlap. Therefore, land cover maps developed for LUCA, HCV or HCS assessment may be used for the GHG assessment for new development if they meet the Land Cover mapping requirements listed below in section 3.1.1.
>
> Similarly, growers can use recent land cover maps developed by 3rd parties, for example, for scientific studies or research projects (e.g. REDD+) if they meet the requirements in section 3.1.1 of this Procedure.
> Before deciding to use existing land cover maps, growers should review the:
>
> 1. Land cover classes used in the existing map, and
> 2. Availability of existing carbon stock values for those land cover classes.
>
> If the classes used cannot easily be aligned with RSPO default classes AND carbon stock estimates are not already available (e.g. from an HCS assessment), then it will be necessary to estimate carbon stock based on field plot sampling (see section 3.1.1 and 3.2).

3.1.1 Acquisition and pre-processing of satellite imagery

The first step in developing a land cover map for this Procedure is acquiring suitable satellite imagery. The key requirements when choosing imagery for this GHG assessment land cover mapping are that the image is:

- **Recent (from within the last 12 months),**
- **Cloud free (Ideally <5% cloud cover of the PDA),**
- **Minimum spatial resolution at 30m,**
- **At least medium spectral resolution (R, G, B, Infra-red)**

The chosen remote sensing images need to undergo pre-processing and processing, which include radiometric and geometric correction and image enhancement before they are classified into different land cover strata.

Companies may also use active sensors such as Radar Satellite, LiDAR or Aerial Photographs.

Substantial guidance on this step is provided in various other documents, specifically:

- Different types of satellite imagery and their attributes (including resolution and costs):
  - Appendix 2 of this document
  - LUCA guidance: Table 1, Section 2: 'Selecting Satellite Imagery'
- Image pre-processing:
  - LUCA guidance: Section 3: 'Image Pre-processing'
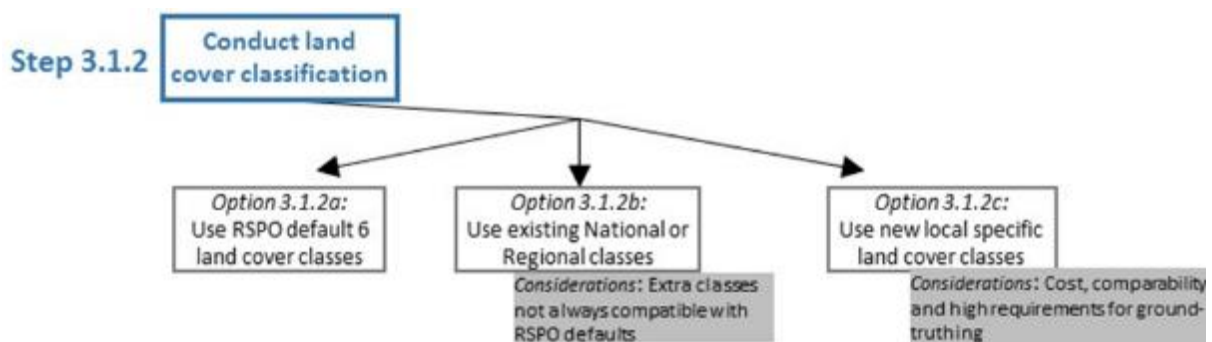
3.1.2 Conduct land cover classification

Figure 3. Options for land cover classification

Having acquired suitable satellite imagery, the next step is to convert this into a land cover map, a process called land cover classification. For the GHG assessment procedure, classification (or stratification) is performed to separate the PDA into discrete, relatively homogeneous land cover units to improve the accuracy and precision of associated carbon stock estimates, that can then be used for estimating changes in carbon stock and GHG emissions under different development scenarios (refer Chapter 4).

This is undertaken by classifying the current above-ground land cover type into classes with relatively homogenous carbon stock (e.g. grassland, shrub land, disturbed forest, oil palm, rubber, food crops, etc.). The critical decision is determining the number and type of land cover classes to use. RSPO allows flexibility here, summarised by the three options in Figure 4 and below:

- Option 3.1.2a: Use RSPO's default 6 land cover classes,
- Option 3.1.2b: Use existing National or Regional land cover classes, or
- Option 3.1.2c: Use new local specific land cover classes.

Growers have the flexibility to choose which option (as summarised in Figure 4) to use for land cover classification, based on a trade-off between the time required and the accuracy of the resulting classification.
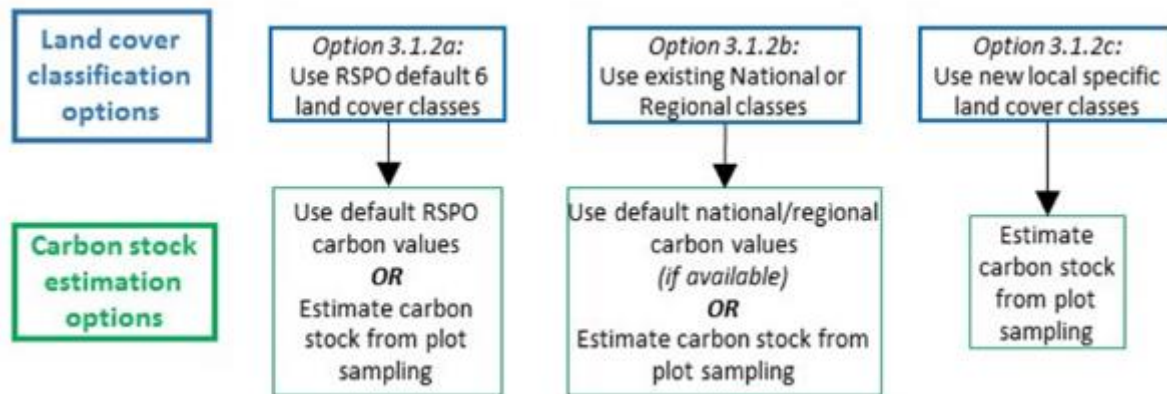
Figure 4. Summary of how choice of land cover classification method relates to carbon stock estimation options. Further guidance on carbon stock estimation methods is given in section 3.2.

In summary, if growers choose to use a more specific and targeted land cover classification then default carbon values are unlikely to be available. If default carbon values are not available, then carbon stock will need to be estimated based on field plots. Further guidance on carbon stock estimation methods is given in section 3.2.

The use of RSPO default land cover classes (Box 3) is the most straightforward option for growers, but may not be appropriate in the following situations:

- If the grower wishes to align carbon estimation with national standards for use in emissions accounting or carbon projects: **recommend to use national land cover classes**, or
- If the PDA contains unusual vegetation types that do not align with RSPO default classes: **recommend to use either national/regional land cover classes OR local specific classes (which has best alignment)**.

> **Box 3: Default RSPO land cover classes**
>
> 1. Undisturbed forest
> 2. Disturbed forest
> 3. Shrub land
> 4. Grassland
> 5. Tree crop,
> 6. Annual/ food crop

Having decided which land cover classification type to use, the next step is to conduct the land cover classification using a GIS software (see Figure 5 for example). **It is recommended to use either Supervised or Visual classification**. Supervised classification is the most commonly used, and represents a good balance between accuracy and time. Visual classification can be accurate but is more time-consuming. It is not recommended to conduct unsupervised classification.

Remotely sensed data must be geo-referenced into a common geodetic system (i.e. UTM) and the land cover classification must be validated with ground-truthed data or high resolution remote sensing image. An accuracy assessment should be provided, based on the Kappa index, to illustrate the accuracy of the classification. A Kappa index value ≥60% is recommended.

For further guidance on how to conduct the land cover classification, including accuracy assessment, it is recommended to refer to existing documents, specifically:

- LUCA guidance: Section 4: 'Image Analysis', and
- The High Carbon Stock Approach Toolkit: Chapter 3.[4]

Some additional guidance is also provided in Widayati *et al*. (undated), Gunarso *et al*. (2013) and GAR & SMART (2012). The output of Step 3.1.1 to 3.1.2 will be the land cover map (refer Figure 5 for example).
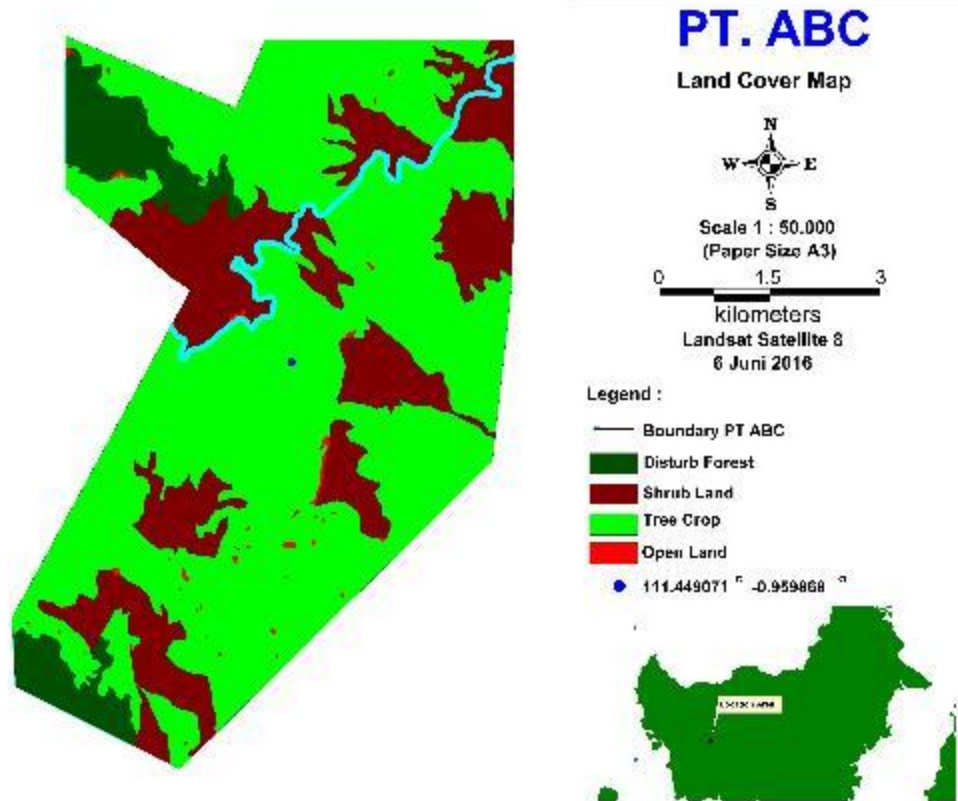

Figure 5. Sample Land cover map of PT ABC

Table 1. Land cover types of PT ABC

Vegetation type	Area (ha)
Disturbed forest	877
Shrub land	1,620
Tree Crop	4,515
Open land	36
Total	7,048

3.1.3 Identification and verification of the presence of peat soil

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[4] http://highcarbonstock.org/the-hcs-approach-toolkit/

Soils are carbon pools that can be influenced by land-use and management activities. The soil carbon stock in mineral soil is relatively low. Therefore, conversion to oil palm on mineral soils does not significantly alter soil carbon stock levels or significantly increase soil GHG emissions.

The soil carbon stock in peat soils is high and the peatland soil carbon stock can change significantly upon conversion to palm cultivation. Peat soils will readily decompose when conditions become aerobic such as following soil drainage for preparation of new development and on-going cultivation.

Tropical peat soils are defined in the RSPO Peat BMP Manual as organic soils with 65% or more organic matter and a depth of 50 cm or more.

For the purpose of the RSPO GHG assessment procedure, the carbon stock of the peat soils in the proposed new development area and the potential emission upon development are considered. Carbon stocks of mineral soils are not considered.

The purpose of estimating the (peat) carbon stock of the proposed development area is to quantify peat areas with high carbon stock where development should be avoided during the land use planning process. While the purpose of estimating potential GHG emissions is to identify options for minimizing such emissions through best management practices (i.e. better water management and better land use planning, including also further avoidance as well as restoration. These scenarios are considered further in Chapter 4 and by using the New Development GHG Calculator.

In order to estimate the carbon stock for peat soils for a PDA, the following steps are required:

1) Identify areas of potential peat soils in the PDA (covered in this section),
2) Verification of peat distribution maps for the PDA (this section),
3) Determine average peat depth for the peat area (section 3.2.1),
4) Determine average carbon content and bulk density and determine total peat carbon stock for the peat area (section 3.2.1).

Step 1 above is done remotely by referring to existing data and maps, whereas steps 2-4 require field work.

In order to estimate the potential sources of peat emissions, the New Development GHG Calculator is used.

Identification of potential peat soils

The first step in estimating potential carbon emissions from peat is to determine whether or not there are any peat soils in the PDA. The best place to start is to refer to existing soil maps and remote sensing data to assess whether there may be peat soils occurring in the area, and to delineate peat soils versus non-peat soils. This should be done in line with the decision tree in Figure 6.
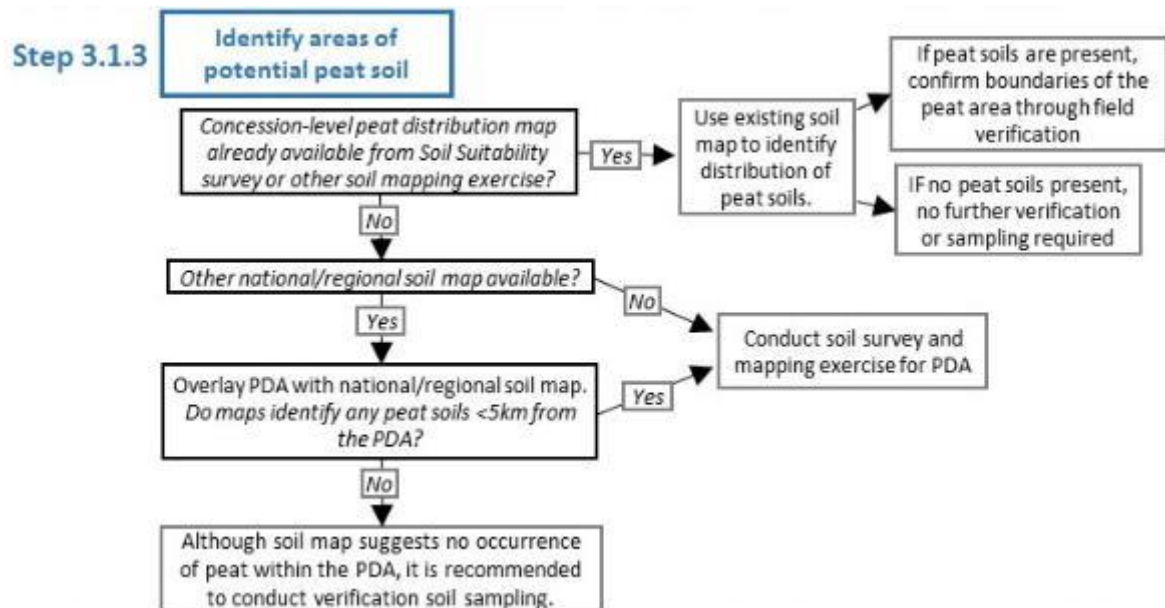
Figure 6. Decision tree for identifying potential peat areas.

In many cases the company may have already developed peat/soil maps as part of a Soil Suitability mapping exercise, as also required for the NPP submission. Alternatively, national/regional (or sometimes global) maps may be available. The decision tree in Figure 6 explains how to use any existing maps.

Soil maps developed specifically for the PDA will typically be most accurate and so should be used as a first priority. **If soil maps developed for the PDA identify peat but have not been verified through field verification, then field verification of the peat distribution will be required as part of this GHG assessment.** National/regional maps can be used as a second choice but will require additional field verification.

Most national soil/peat maps are developed at a low resolution and at a national scale and so are rarely accurate at a concession level. Therefore, national maps should be used only in the absence of more accurate soil maps for the PDA and in a precautionary manner to assess potential peat presence in the PDA. In most countries, soil maps can be procured from relevant government agencies, but there are also publicly available maps that give a useful indication of peat distribution (see Appendix 4). The most recently available and high resolution (peat) maps shall be used. It is recommended to conduct a soil mapping exercise for the PDA if any national soil/peat maps suggest that peat soils are found inside or within 5km of the PDA.

There are three outcomes of the decision tree in step 3.1.3:

1. Peat soils not present in the PDA: no further peat verification or sampling required,
2. Peat is definitely present and its distribution is mapped: proceed to peat carbon estimation (3.2.1),
3. Peat is potentially present: conduct a soil mapping exercise (guidance in this section)

Peat landscape mapping can be done through soil surveys or a combination of high spatial and spectral resolution remote sensing data and soil surveys in the PDA. Remote sensing data can be used as a first step to map topography of the PDA. Tropical peat typically occurs in domes[5] and so understanding topography can inform the potential presence/distribution of peat. Topography can be mapped using either existing Digital Elevation Models (DEMs) or new DEMs can be developed[6]. The resolution of any DEM should be sufficiently high (less than 1m vertical resolution and 30m horizontal resolution) to identify potential peat domes. One new technique for mapping peat distribution combines LiDAR with lower resolution contour maps to develop high resolution Digital Terrain Models (DTMs)[7]. Given the high-water content of peat soils, DEMs can also be combined with indices of soil wetness to refine maps of potential peatlands (see, for example, Gumbricht 2012[8]).

Verification of peat distribution maps for the PDA

Having conducted remote topography mapping or reviewed Peat soil maps, the next step is to conduct field sampling to verify the distribution of peat soils on the ground. If field soil sampling is required then it should be combined, for the sake of efficiency, with peat carbon stock sampling as required under 3.2:

Field sampling should also measure:
- Peat depth, and
- Bulk density and carbon content (if growers choose to use real estimates rather than RSPO defaults)

It is recommended that soil samples and peat depth measurements are taken in transects or sampling grids perpendicular to the (estimated or expected) peat boundary as defined by maps/remote sensing data/ground surveys. Accurate peat boundary needs to be determined through sampling along a transect between the mineral soil and the peat. The results of the plot samples may then be used to refine the boundaries on the peat distribution maps, using manual drawing or GIS modelling to map the peat boundaries. Growers should also state the accuracy of the model used (if any), and ≥60% accuracy is recommended. Further guidance on peat sampling techniques can be found in (Agus *et al.*, 2011; Schrier-Uijl & Anshari, 2013[9]; Barthelmes *et al.*, 2015[10]).

The output of step 3.1.3 will be the map indicating the presence of peat soil (refer Figure 7 for example).

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[5] Note, in some regions, peat may also occur in depressions or river of lake basin and these systems may have concave rather than domed surfaces

[6] It should be noted that Digital Elevation Models (DEMs) mapped the surface of the vegetation, rather than the land and so DEMs need to be adjusted through ground-truthing as appropriate to produce Digital Terrain Models (DTMs)

[7] Deltares. Exploration of efficient and cost-effective use of LiDAR data in lowland/peatland landscape mapping and management in Indonesia. Status update April 2016. https://www.deltares.nl/app/uploads/2015/03/Overview-LiDAR-use-in-peat-management-Indonesia-Deltares-April-2016.pdf

[8] Gumbricht, T. 2012 Mapping global tropical wetlands from earth observing satellite imagery. Working Paper 103. CIFOR, Bogor, Indonesia.

[9] http://www.rspo.org/key-documents/supplementary-materials

[10] Barthelmes *et al.*, December 2015. Consulting Study 5: Practical guidance on locating and delineating peatlands and other organic soils in the tropics. Carbon Stock Study.
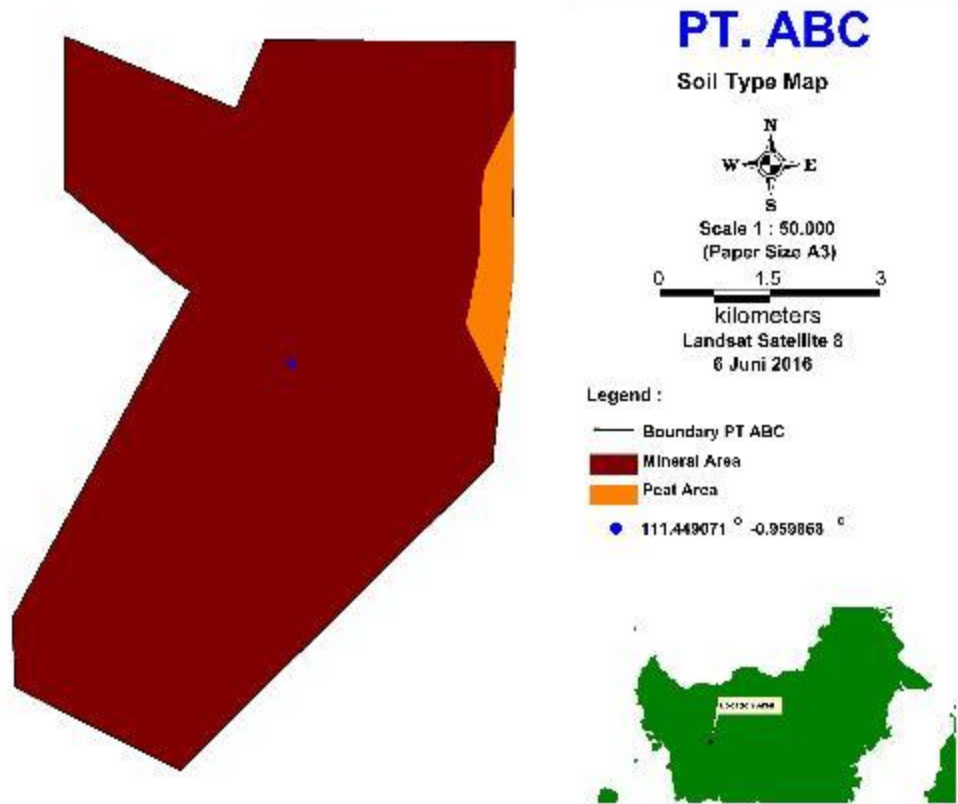
Figure 7. Sample Map indicating presence of peat soil in PT ABC

3.1.4 Verification of land cover map

Once land cover maps have been developed for the PDA, it is necessary to ground truth to verify the accuracy of these maps. The aim of this is to verify the land cover types and the accuracy of strata boundaries that were determined through remote GIS analysis. Verification may not always involve additional field visit, if other existing field survey data is available and accurate enough for verification. This can also be supplemented by cross-checking the land cover classification with other high resolution satellite images.

Additional ground verification is not required if you are using a recently prepared and already verified land cover map for the PDA. For example, a verified land cover map developed for an HCV or HCS assessment. Alternatively, even if a new LC map has been developed for the GHG assessment procedure, ground verification may not be required if existing field survey data is sufficiently accurate for verification.

If a new land cover map has been developed for this Procedure, and existing field data is not suitable or available, then field verification is required. In cases where the grower opts to use default carbon stock estimates then verification should be conducted as a stand-alone activity, but if the carbon stock is being estimated from plot sampling then verification can be conducted simultaneously with the plot sampling.

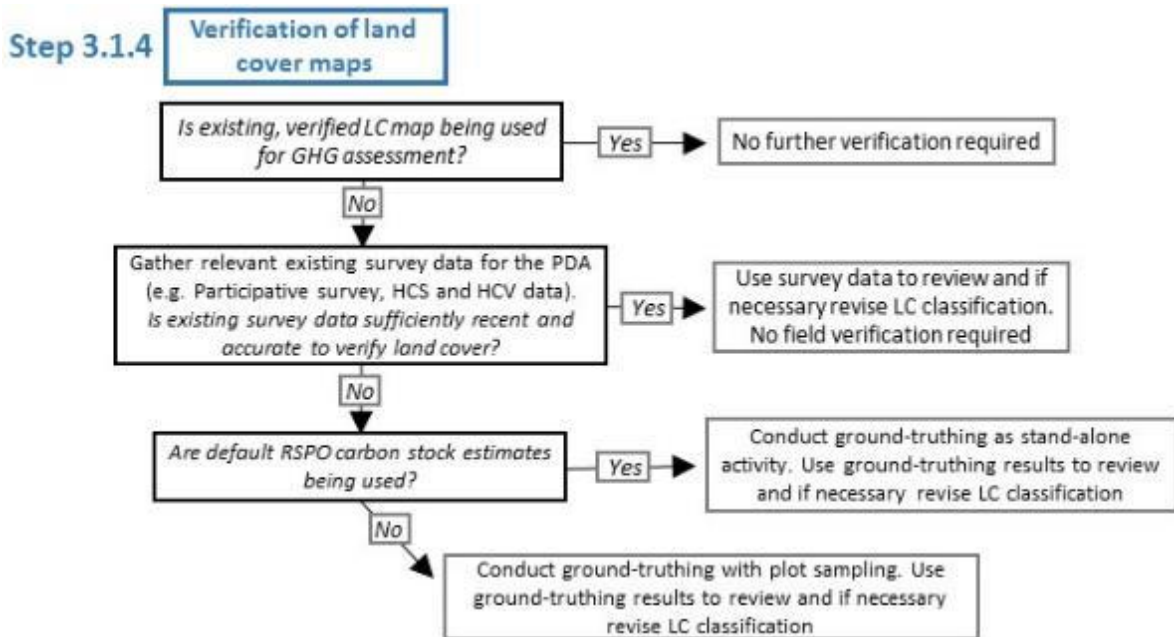The following decision tree can be used to determine what type of verification is required:

Figure 8. Decision tree to determine what land cover verification is required.

In order to maximise the productivity of time spent in the field, adequate preparations should be made prior to the ground-truthing exercise. Land cover maps should be prepared and where possible ground-truthing locations determined in advance manually or through software such as ArcView GIS. Ground-truthing locations should aim to cover all land cover classes identified in the PDA. The exercise of ground-truthing normally consists of, as a minimum, taking photographs and noting the habitat characteristics in each land cover class. The person conducting the ground-truthing should record the GPS coordinates of any location where the ground land cover does not match the land cover classification. On completion of the ground-truthing the land cover classification must be revised.

3.2 Carbon stock estimation

Once the land cover maps have been verified and it has been ascertained whether peat soil is present or not, the next step is to estimate the carbon stock, expressed in tonnes carbon per hectare (tC/ha) in the PDA. Of the five carbon pools (above-ground biomass, below-ground biomass, dead wood, litter and soil organic matter) as defined by the IPCC, this assessment only needs to take into account above-ground biomass (AGB), below-ground biomass (BGB) and soil organic matter. As explained in section 3.1.3 above, soil organic matter only needs to be estimated when peat soils are present.

Section 3.2.1 below describes how peat carbon stock is estimated while Section 3.2.2 provides guidance on above-ground biomass and below-ground biomass estimation. The steps involved are summarised in the decision tree in Figure 9.
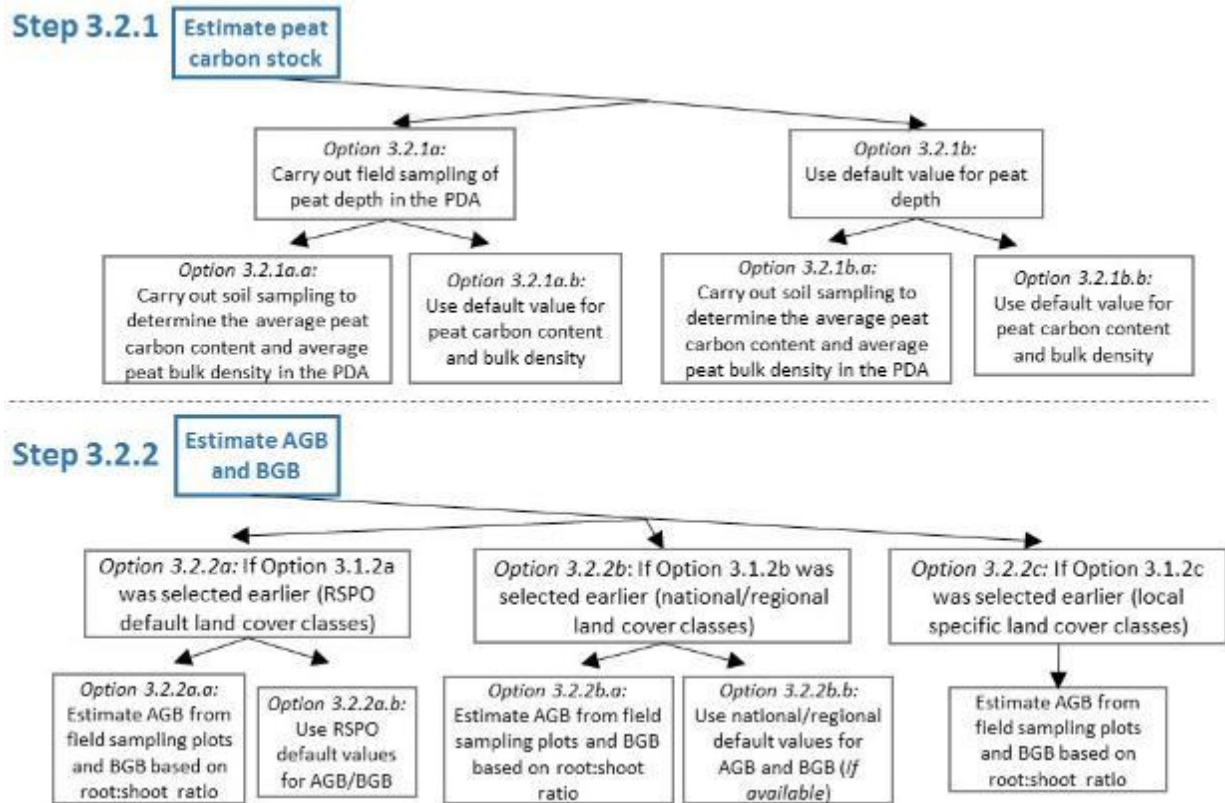
Figure 9. Decision tree showing options for estimating peat carbon stock and carbon stock in AGB and BGB.

3.2.1 Peat carbon stock

Once the boundaries of the peat area are determined, the total area of peat (ha) the carbon stock of the total area of peat (ton C/ha) and the expected GHG emissions (ton CO2-eq/ha) in the proposed new planting area can be calculated. There are three options for estimating the carbon stock of peat soil: (a) using field assessments (b) using defaults and (c) a combination of a and b.

In the New Development GHG Calculator, GHG emissions from the drainage of peatlands are calculated using an equation that relies on drainage depth of peatland (in cm) as the main variable. This does not require the estimation of soil carbon stock prior to the calculation of GHG emission.

If the peat is less than 1m deep, it is likely that the stored carbon in the peat layer will all be lost before the end of the first plantation rotation. In this case an estimate of emissions can be made using the time averaged area of remaining peat. This can only be done where extensive field measurements have been undertaken to determine the depth profile with some accuracy.

Soil sampling conducted as part of the new plantation development should include measurements of the following parameters for calculating soil carbon stock in peatlands:
- Bulk density (g/cm^3 or kg/dm^3 or t/m^3)
- Organic carbon content (% by weight or g/g or kg/kg)
- Peat depth or thickness (cm or m)

- Area of land in which the carbon stock is to be estimated (ha or km^2)

For the assessment of average peat depth based on field measurements, a strategic and representative sample design shall be used referring to appropriate guidance such as Winrock Sampling Calculator[11]. The location of samples shall be shown on the peat map.

As stated in section 3.1.3, field assessment of peat depth can also be combined with field sampling used to map the distribution of peat soils, and (if chosen) for the assessment of the peat carbon content and peat bulk density based on field samples. The number of sample plots required for estimating carbon content and bulk density may be lower than that required for estimating peat distribution and depth.

It is recommended that once the plantation is under development; it is important that companies place permanent monitoring points in each peat block and conservation area with a piezometer (to measure water table depth) and a subsidence pole (to measure peat subsidence over time) or a combined piezometer/subsidence pole).

For growers deciding to use default values, the RSPO provides default values for peat depth, bulk density and peat carbon content in Table 2.

Table 2. RSPO Default values for estimating peat carbon stock.

Parameter	Default value	Notes	References
Peat depth (D)	3m	The use of the default value of 3 m is only applicable if there are valid reasons for not obtaining own measurements. It is strongly encouraged to perform own measurements.	
Bulk density (BD)	0.15 (range 0.05 – 0.25) t per m^3	Depending on compaction and peat type. Own data is preferred	Schrier-Uijl & Anshari, 2013
Peat Carbon Content (C)	47% (range 45 – 65) of total dry weight	Depending on peat type	IPCC 2006

The total peat carbon stock in the proposed new area of development can then be calculated as:

C_{peat} (t C) = A (ha) x 10,000 m^2/ha x D (m) x BD (t/m^3) x C (%)

Where,
A is the total area of peat in hectares (determined in 3.1.3 and 3.1.4)
D is the average peat depth in meters
BD is peat bulk density in tonnes per cubic meter
C is the carbon content of the peat in percentages of dry weight.

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[11] https://www.winrock.org/document/winrock-sample-plot-calculator-spreadsheet-tool/

Using the default values, the carbon stock per ha of peatland would be:

C_{peat} *(t C)* = 1 x 10,000 x 3 x 0.15 x 0.47 = 2,115 tC

Details on measuring the above parameters are provided by Agus *et al*. (2011) and in a scientific review commissioned by the RSPO's Peatlands Working Group (Schrier-Uijl & Anshari, 2013).

3.2.2 Above-ground and below-ground biomass

RSPO allows growers some flexibility in deciding which method to use for estimating above-ground biomass (AGB) while for below-ground biomass (BGB) there is only one option within the context of this procedure.

For AGB, the three options endorsed by RSPO are:

- RSPO Default Values
- Regional/ National Specific Values
- Local Values through field assessment

As discussed in section 3.1.2 above, the choice of land cover classification method would influence the carbon stock estimation options available (refer to Figure 4).

If Option 3.1.2a is used for land cover classification (i.e. using RSPO's six default land cover classes), AGB & BGB can be calculated using the RSPO default values for the six land cover classes or estimate from field sampling plots for AGB and based on root:shoot ratio for BGB.

For Option 3.1.2b (use existing national or regional land cover classes), the RSPO default values cannot be used as the land cover classes are likely to be different. In this case, if there are default values available for the individual national or regional land cover classes, these can be used for AGB & BGB calculations (but adequate references must be given to justify the values). However, if no default values are available, the AGB values will have to be estimated from field sampling plots and the BGB based on root:shoot ratio.

In the case of Option 3.1.2c (using new local specific land cover classes), there will not be any default AGB & BGB values available and so the only option is to derive the AGB values from plot sampling in the field and BGB based on root:shoot ratio.

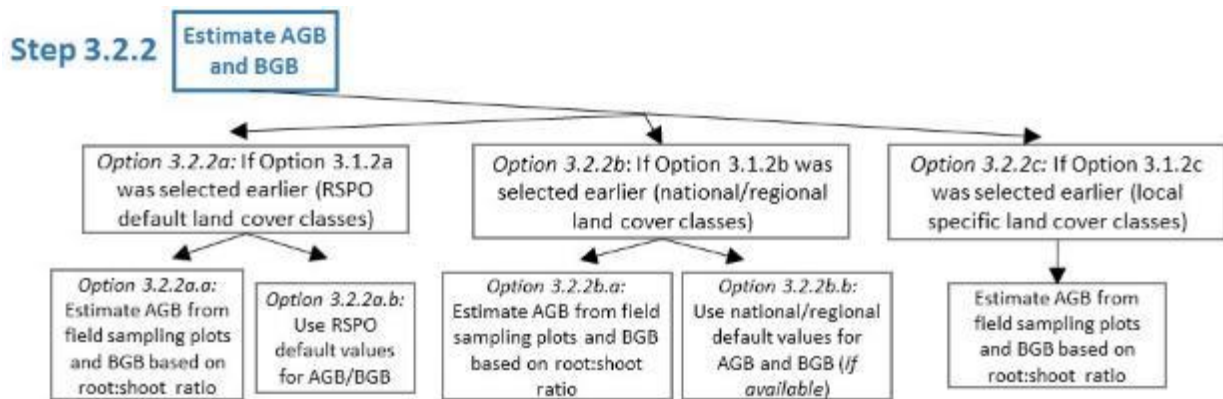These options are summarised in Figure 10 below.

Figure 10. Options for estimating AGB and BGB

Table 3 below provides the RSPO's default AGB&BGB values as determined by the RSPO. If default AGB & BGB values and default RSPO land cover classes are used, there is no need to conduct field sampling and the Palm GHG Calculator would be able to calculate the GHG emission based on the land cover classes present and the size (in ha) of each land cover class.

Table 3. RSPO default AGB&BGB values (tC/ha) for 6 land cover classes

No.	Land cover classes	Default value (tC/ha)
1	Undisturbed forest	268
2	Disturbed forest	128
3	Tree crop	75
4	Shrub land	46
5	Annual/ food crop	8.5
6	Grassland	5

If a field-based carbon stock assessment is to be carried out, sample plots which allow for the extrapolation of results to the whole area of interest should be established. The preferred approach is to sample the different land cover strata present but making sure that the locations of sampling plots are randomised within each stratum (Hairiah *et al*., 2001) i.e. located across the stratum in an unbiased way (Walker *et al*., 2012), and not only in areas with the most or least dense (carbon rich) vegetation (Hairiah *et al*., 2011).

There are many manuals and guidance documents available on determining the design (number, size and distribution) of sample plots and for calculating associated sampling errors including by Brown (1997), Pearson *et al*. (2005), Hairiah *et al*. (2011) and Walker *et al*. (2012). In deciding on the sample design, there will be trade-offs involving accuracy, precision and resources needed for the sampling effort (Pearson *et al*., 2007; Walker *et al*., 2012). These documents should be studied in detail before embarking on any sampling exercise. Additional guidance in determining sample plots is provided in Appendix 5.

To perform a reliable carbon stock estimation from each land classes, the sampling size must fulfil 10% of sampling error at 90% confidence interval, and the sampling plots distribution must be proportionally to the area of each land class (Loetsch, F. and Haller, K. 1964. Forest Inventory. Volume 1. BLV-VERLAGS GESE LLSCHAFT, München in VCS VM0015, 2012).

Once the plot design has been decided upon, the field survey team needs to collect the relevant data using standard data sheets. The key measurement to be taken is the diameter at breast height (dbh) of trees in the sample plots. Tree height may or may not need to be measured, based on the allometric equation selected for converting the field data to AGB values.

All allometric equations require dbh values. In addition to dbh, some allometric equations require values for tree height and/or wood density (for generalised equations, a weighted average value for wood density is the norm).

If wood density value is needed in an allometric equation, the range provided by Brown (1997) for tropical tree species in the Asian region is 0.40-0.69 g/cm^3 while some other researchers have used a value of 0.67 for Borneo and the Amazon (Chave *et al*., 2006; Fearnside, 1997; Paoli *et al*., 2008) or 0.60 in Sumatra (Ketterings *et al*., 2001) and Sabah (Morel *et al*., 2011).

Allometric equations allow for the conversion of dbh (and height) value(s) to the AGB value per tree. The total AGB for a particular sampling plot can then be calculated by adding up the AGB value for each tree within the plot, and subsequently the tC/ha value can be calculated (as the size of the plot is known).

It is not practical to measure the BGB (root biomass) directly and the preferred approach is to use a default ratio of BGB to AGB (commonly referred to as root:shoot ratio).

The root:shoot ratio varies depending on the vegetation type and local circumstances (Mokany *et al*., 2006) and for the purpose of this GHG Assessment Procedure it is recommended that a value of 0.18 be used for Southeast Asian tropical rainforests (Germer & Saeurborn, 2008; Niiyama *et al*., 2010;) and Saner *et al*., 2012), while a more generalised value of 0.20 (Houghton *et al.*, 2001; Achard *et al.* 2002; Mokany *et al.*, 2006; Ramankutty *et al.* 2007) is used for tropical rainforests elsewhere in the world, as well as for subtropical moist forest/plantation.

In order to convert AGB and BGB to carbon stock (expressed in tC/ha), the carbon content of the biomass has to be estimated. The default value for the carbon content of above- and below-ground biomass used in the PalmGHG and the New Development GHG calculator is 0.5 (derived from IPCC, 2006)

Appendix 6 provides further details on scaling up of dbh measurement to estimate carbon stock.

Once carbon stock estimates per land cover class have been obtained from either default values or field sampling, it is possible to estimate total carbon stocks per land cover class in the PDA by simply multiplying the area of each land cover class (ha) by the carbon stock estimate (tC). The area of each land cover class can easily be calculated in GIS software.

3.3 Preparation of the carbon stock map and table

With the conclusion of the activities outlined in Section 3.1 and 3.2, a map showing the different land cover strata and estimated carbon stock (above, below and soil carbon) shall be prepared. The values of the estimated carbon stock in each stratum shall also be indicated in a table (see indicative examples as shown in Figure 2, Table 3 and Table 4).

Table 4: Carbon stock in Above and Below ground biomass estimation for PT ABC

Vegetation type	Area (ha)	Carbon Stock (tC/ha)	Total Carbon Stock (tC)
Disturbed forest	664	128	84,992
Shrub land	1,800	46	82,800
Tree Crop	4,548	75	341,100
Open land	36	0	0
Total concession	7,048ha		508,892

Table 5: Peat soil Carbon stock estimated of PT ABC

	Area (ha)	Carbon Stock (tC/ha)	Total Carbon Stock (tC)
Peat soil	213	2,115	450,495

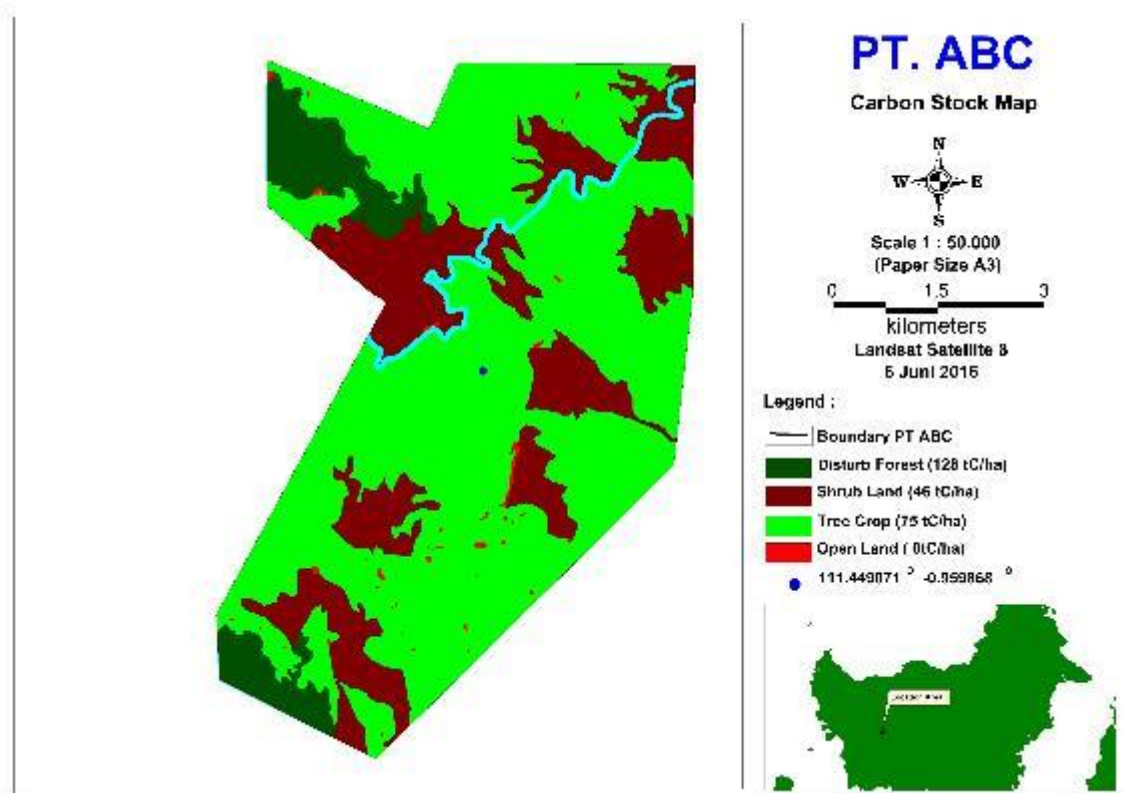Total peat soil carbon stock in PT ABC is 450,495tC

Figure 11: Carbon stock map of PT ABC

3.4 Compatibility and applicability of HCSA and HCS+

The parties behind HCSA and HCS+ have identified areas of synergy and there is an ongoing dialogue on convergence which also involves the RSPO Secretariat and some members of the ERWG. Converged method as the result of current convergence process could be adopted to comply with parts of the Procedure, mainly focusing on the Chapter 3 of this Procedure. Chapter 4 Assessment of GHG Emissions from New Development of this Procedure would still need to be applied.

While the HCSA and HCS+ convergence process is ongoing, either HCSA or HCS+ can be adopted to comply with parts of the Procedure. However additional portions of the Procedure that are not in HCS+/HCSA will still need to be applied, as below:

RSPO member companies that wish to follow the **HCS Approach** toolkit would:
   i.   Apply the methods described by HCSA toolkit to map out potential HCS forest. (Note HCSA does not have a soil carbon estimation process but includes a strict "NO PEAT" commitment. Any company choosing this option must also commit to "NO PEAT" development). Tropical peat soils (Histosols) are defined as organic soils with 65% or more organic matter and a depth of 50 cm or more (see RSPO Manual on Best Management Practices (BMPs) for Existing Oil Palm Cultivation on Peat).
   ii. Develop a plan based on decisions on where to proceed with development and where to maintain/conserve as set aside areas
   iii. Follow RSPO New Development GHG Calculator to:
        a. Predict GHG emissions related to land conversion as well as both the plantation and mill operations
        b. Prepare a management and mitigation plan including emission reduction measures
        c. Set up a monitoring plan

RSPO member companies that wish to follow the **HCS+** Methodology would:
   i.   Apply the methods described by HCS+ to map and estimate the above-ground carbon (Using LiDAR or other high resolution options as discussed in the HCS+ study) and soil carbon and prepare a map of land cover with carbon stock estimates.
   ii. Apply the 75tC/ha carbon stock thresh-hold (AGB, roots and deadwood) and plan for carbon neutral development as per the HCS+ recommendations to determine the area for development.
   iii. Apply the 75tC/ha carbon stock threshold (interpreted as requiring protection of any soils with an organic layer >15cm if it is primarily organic or >30cm if mixed organic and mineral in depth) for soil carbon.
   iv. Take into account the other procedures in HCS+ methodology to achieve carbon neutral approach
   v.   Assess development options taking into consideration carbon stock and results from HCV and social assessments
   vi. Follow RSPO New Development GHG Calculator to:
        a. Predict GHG emissions related to land conversion/management and mill operations
        b. Prepare a management and mitigation plan including emission reduction measures
        c. Set up a monitoring process

4. Assessment of GHG Emissions from New Development

This chapter serves to provide brief guidance and an example on:

i.   development of an integrated (carbon stock-HCV-social) map in the proposed new development area;
ii. develop new development scenarios;
iii. conduct projection of GHG emissions associated with respective scenarios; and
iv. the selection of optimal development scenario taking into account environmental, economic and practical considerations and resulting in a minimization of GHG emissions (while recognizing that the selected option may not have the lowest emissions compared to other scenarios).

4.1 Integration of carbon stocks with HCV and SEIA findings

The results of the carbon stock assessment from Chapter 3 shall be combined with HCV and social findings (see Figure 12 and Table 6 for example). This shall be done by overlaying of the HCV areas and/or any other environmental and/or social sensitive or important areas as identified through SEIA assessment with the carbon stocks map developed.

Map created from overlaying HCV and/or other environmental and/or social sensitive or important areas would then serve to create a map determining areas to be avoided or conserved and potential areas for new development (see Figure 12 for example).
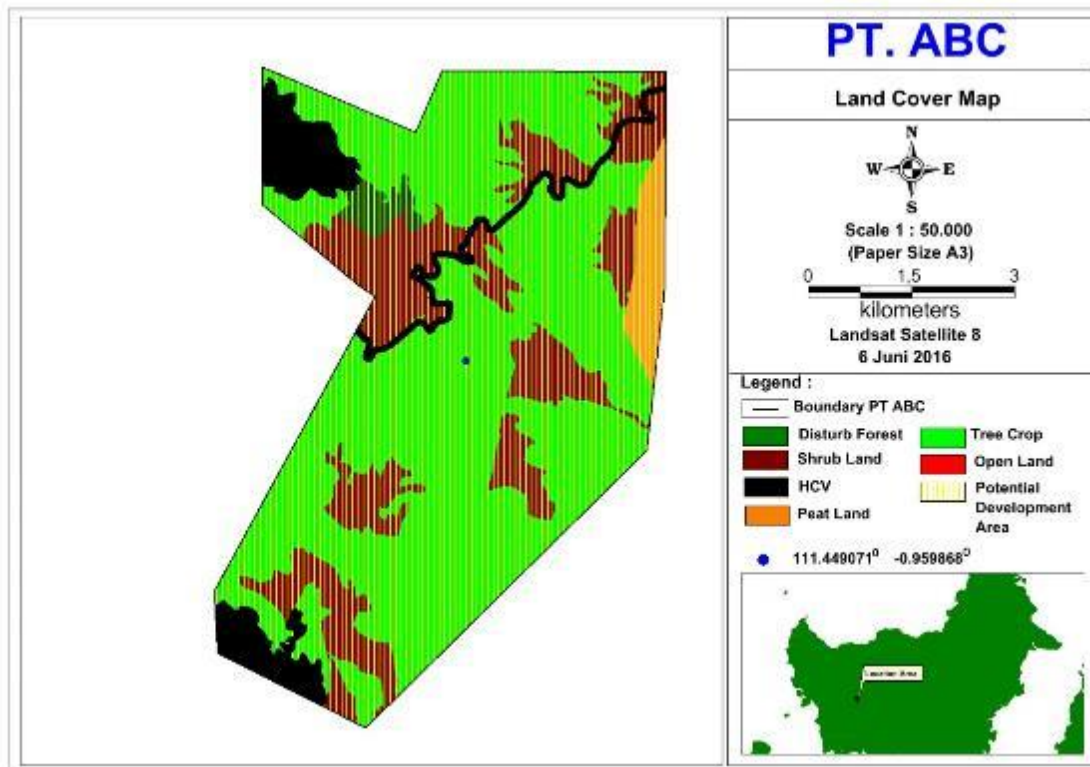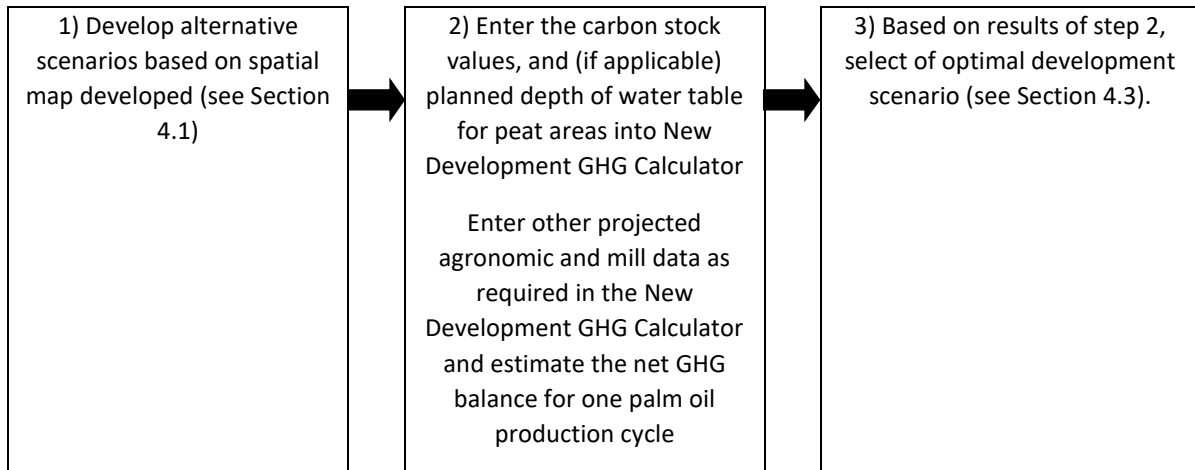

Figure 12: Integrated map with potential development area identified of PT ABC

Table 6: HCV areas of PT ABC

	Area (ha)
HCV area	564.80

4.2 Scenario testing for new development options

Key steps:

1) Develop alternative scenarios based on spatial map developed (see Section 4.1)	→	2) Enter the carbon stock values, and (if applicable) planned depth of water table for peat areas into New Development GHG Calculator Enter other projected agronomic and mill data as required in the New Development GHG Calculator and estimate the net GHG balance for one palm oil production cycle	→	3) Based on results of step 2, select of optimal development scenario (see Section 4.3).

Based on both maps developed from Chapter 4.1, the company shall develop new development scenarios to guide the selection of the optimal development plan taking into consideration the areas that need to be avoided in the development and the operational practices that minimize GHG emissions.

Scenarios are projections of hypothetical land use options and mill design that enable potential GHG emissions to be estimated. The company needs to create 2 or more scenarios for testing. This could be done through reconsidering if there are identified key emission sources or sinks within potential areas for new planting that could be set-aside for conservation; and operational practices options that could be adopted for GHG emissions reduction. Options created should be documented in a table (see Table 7 for example).

Table 7. Description of new development scenarios in PT ABC

Scenario 1	All potential areas for new development cleared for oil palm, including 100 ha of peatland. Remaining peat forest is to be conserved. No methane capture facilities planned for mill. No clearing on HCV areas identified.
Scenario 2	All potential areas for new development cleared for oil palm, including 100 ha of peatland. Remaining peat forest is to be conserved. Methane capture facilities planned for mill. No clearing on HCV areas identified.

		All potential areas for new development cleared for oil palm, except peat forest. All peatlands are to be conserved. No methane capture facilities planned for mill. No clearing on HCV areas identified.
Scenario 3		All potential areas for new development cleared for oil palm, except peat forest. All peatlands are to be conserved. No methane capture facilities planned for mill. No clearing on HCV areas identified.
Scenario 4		All potential areas for new development cleared for oil palm, except peat forest. All peatlands are to be conserved. Methane capture facilities planned for mill. No clearing on HCV areas identified.
Scenario 5		All potential areas for new development cleared for oil palm, except peat and disturbed forest. All peatlands and disturb forests are to be conserved. No methane capture facilities planned for mill. No clearing on HCV areas identified.
Scenario 6		All potential areas for new development cleared for oil palm, except peat and disturbed forest. All peatlands and disturbed forests are to be conserved. Methane capture facilities planned for mill. No clearing on HCV areas identified.

		S1	S2	S3	S4	S5	S6
Area avoided for development	HCV area	565 ha	565 ha	565 ha	565 ha	565 ha	565 ha
	Other Conservation set-aside	113 ha	113 ha	213 ha	213 ha	312 ha	312 ha
Potential areas for new development	Disturbed forest	99 ha	99 ha	99 ha	99 ha	0	0
	Shrub land	1,620 ha	1,620 ha	1,620 ha	1,620 ha	1,620 ha	1,620 ha
	Tree Crop	4,515 ha	4,515 ha	4,515 ha	4,515 ha	4,515 ha	4,515 ha
	Open land	36 ha	36 ha	36 ha	36 ha	36 ha	36 ha
	Shrub land (Peat soil)	100 ha	100 ha	0	0	0	0
POME Treatment	Conventional Treatment	Y	-	Y	-	Y	-
	Methane capture	-	Y	-	Y	-	Y

Note: Table 7 serves as example only. There is no maximum limit for the number of scenarios to be developed. The examples shown have been simplified and in reality, the scenarios may be more complex.

4.3 Projection of GHG Emissions

For each scenario, the estimated GHG emission, should be calculated using RSPO New Development GHG Calculator[12] (see Figure 13 and Table 8 for example). Follow the instructions provided within the New Development GHG Calculator to estimate GHG emissions associated with the development options of the respective scenarios.

Table 8: Projection of GHG Emissions associated with different development scenarios (tCO$_{2e}$/tCPO)

	S1	S2	S3	S4	S5	S6
Land conversion	1.39	1.39	1.4	1.4	1.38	1.38
Crop sequestration	-1.25	-1.25	-1.25	-1.25	-1.25	-1.25
Peat oxidation	0.12	0.12	0	0	0	0
Conservation Sequestration	-0.13	-0.13	-0.16	-0.16	-0.18	-0.18
Fertiliser (mineral soil; manufacture & transport)	0.12	0.12	0.12	0.12	0.12	0.12
N$_2$0 Emissions	0.15	0.15	0.13	0.13	0.13	0.13
Fuel Consumption	0.01	0.01	0.01	0.01	0.01	0.01
Net estate emission	0.4	0.4	0.24	0.24	0.2	0.2
POME	0.65	0.07	0.65	0.07	0.65	0.07
Diesel fuel	0	0	0	0	0	0
Purchased Electricity	0	0	0	0	0	0
Credit	0	-0.09	0	-0.09	0	-0.09
Net Mill emission	0.65	-0.02	0.65	-0.02	0.65	-0.02
Net GHG emission	1.05	0.38	0.89	0.22	0.85	0.18

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[12] RSPO New Development GHG Calculator can be downloaded from RSPO Website, http://www.rspo.org/.
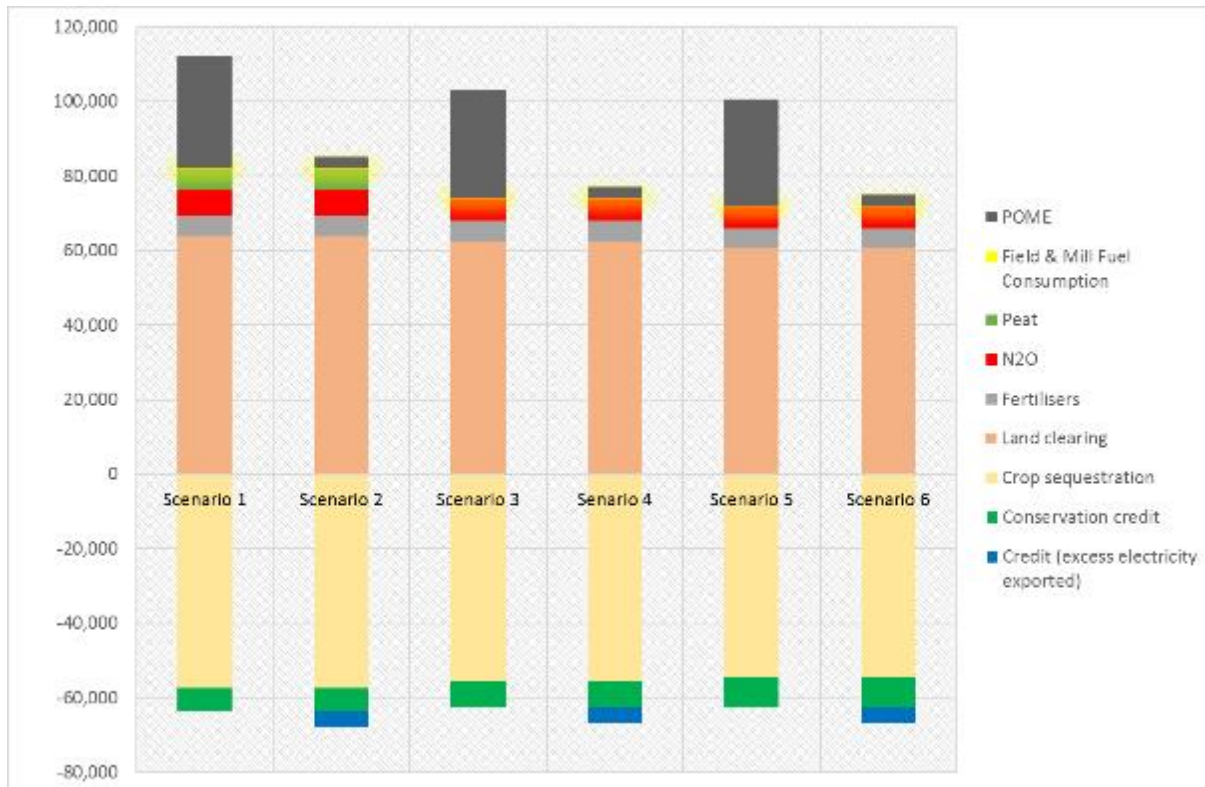
Figure 13. Projection of GHG Emissions (tCO$_{2e}$) associated with different development scenarios.

4.4 Selection of optimal development scenario

Analysis shall be conducted based on results from Chapter 4.2 presenting GHG emissions associated with respective development scenarios. Review the pros and cons of the various scenarios, taking into account:

1. Avoidance of land areas with high carbon stock[13] and/or potential high GHG emissions (if developed)
2. Options to increase the sequestration of carbon (conservation areas, river buffer zones, etc.)
3. Avoidance of HCV areas as determined in HCV assessment.
4. Practical management issues such as access and connectivity, socio-economic concerns, etc.

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[13] Development of existing cultivated land with crop with higher carbon stock than oil palm eg Rubber is permitted

Box 4: Case Study Analysis Findings:

Based on Table 7 example of summary GHG emissions for different development scenarios, it is observed that land clearing, peat cultivation, and POME are key emissions sources; while avoided emissions and sequestration from conservation areas, avoided emissions from peat cultivation, methane capture practices are the key emission savings.

Select optimal development option, provide justification for the selection in the aspect of associated GHG emission and management and mitigation approaches for identified GHG emission hotspots.

Present final selected new development plan and associated GHG emissions using map and table from (see Figure 14 and 15 for example).
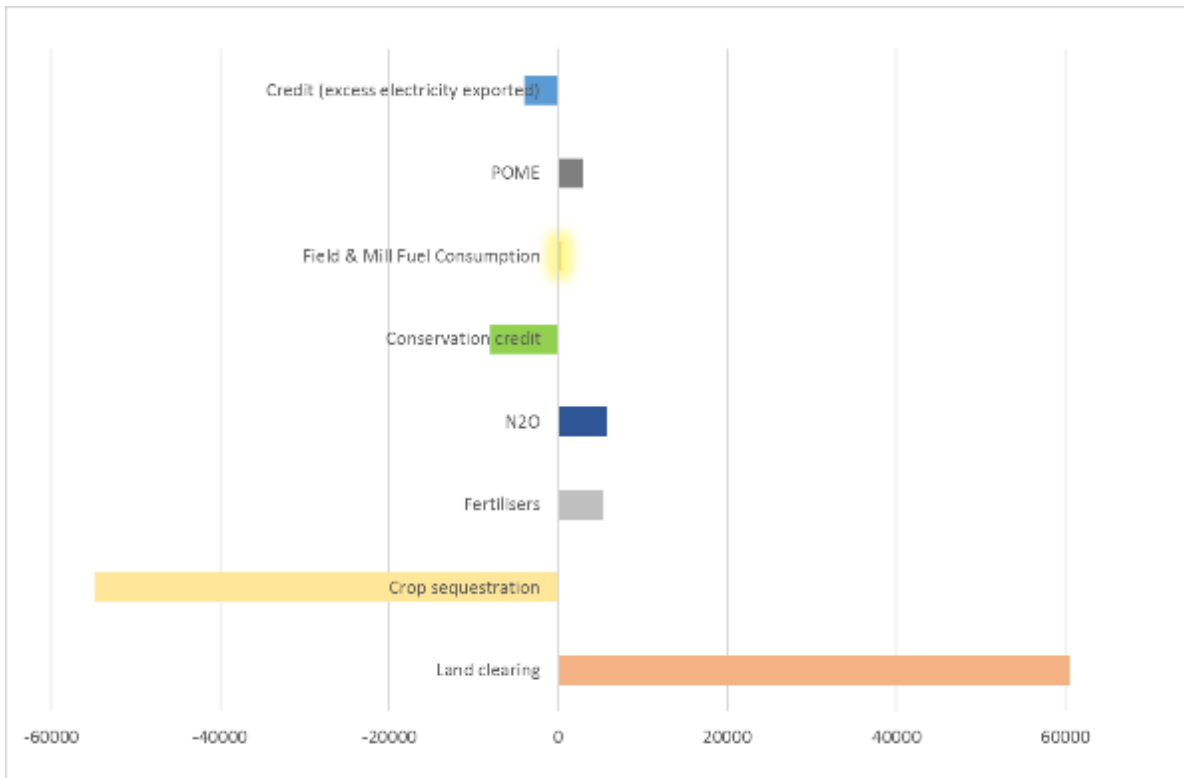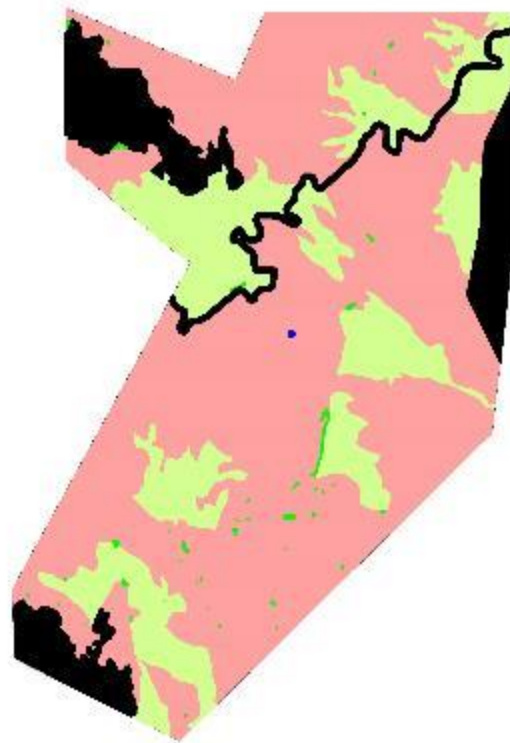

Figure 14. Summary of GHG emissions for new development plan of PT ABC (tCO2e)[14]

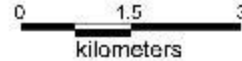[14] Figure 13 & 14 serve as example only. Presentation of data depends on user preferences

Figure 15. New development plan of PT ABC[15]

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[15] Example given for assumption of the selected scenario 6.

5. Developing a GHG emission management and mitigation plan

This chapter focuses on providing brief guidance on the development of the management and mitigation plan based on the projected GHG emissions of the new development plan (refer to GHG emissions associated with development scenario selected from Chapter 4). The management and mitigation plan developed shall focus on minimising net carbon losses and GHG emissions. The plan should describe the specific measures proposed to reduce or offset emissions for example:

- Increasing sequestration (i.e. conservation areas, river buffer zones, etc.)
- Management of the peat soils to minimise subsidence and oxidation (see RSPO criterion 4.3)
- Adoption low GHG emissions management practices such as efficient use of fossil fuels, fertiliser regimes, etc.
- Alternative mill technologies such as POME management, Biogas, etc.

The management and mitigation plan shall also include a process for monitoring the implementation of the plan and periodic review and refinement.

6. Reporting of GHG assessment for new development

The Results from the use of the GHG assessment procedure should be reported using the template in Box 5.

Box 5: Reporting template for GHG Assessment for New Development

Assessment process and procedures
- Assessors and their credentials
- Methods and procedures used for conducting carbon stock and GHG assessments
- Team responsible for developing mitigation plan

Carbon Stock Assessment
- Location maps indicating area of new development at landscape level and property level
- Land cover map of the new development area (include verification process)
- (if applicable) Map indicating the location of peat soil
- Table presenting carbon stock estimated per ha (tC/ha) per land cover class
- (if applicable) Carbon stock estimated per ha for peat soil
- Table summarising the total development areas (ha) and carbon stock estimated per land cover class
- Carbon stock map
- List of references used in the assessment

GHG Emissions Assessment for New Development
- Summary table and map indicates carbon stock estimated with extent of HCV and presence of peat soil
- Map indicates areas to be avoided and potential areas for new development
- Table and chart summarising GHG emissions associated with development scenarios created
- Provide explanation for the selection of optimal scenario
- Development map and GHG emissions projection chart (final)

GHG Emissions Management and Mitigation Plans
- Explain measures taken to maintain and enhance carbon stocks within the new development areas.
- Explain measures that will be taken to mitigate net GHG emissions associated with oil palm cultivation & processing in the new development (e.g. methane capture at the palm oil mill, local sourcing of fertilisers, reducing usage of inorganic fertilisers, reducing fuel consumption, rehabilitation of HCS and HCV areas etc.)
- Plan for monitoring the implementation of selected scenario for new development including measures for enhancing carbon stock and minimising GHG emissions

Internal responsibility
- Formal sign off by assessors and company
- Statement of acceptance of responsibility for assessments.
- Organisational information and contact persons.
- Formal sign off of management and mitigation plans.

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Appendix 1: Examples maps, tables and charts developed from case study 2

Note that the concession boundary is based on a real concession, but all of the land cover, peat areas, local carbon stock estimates and HCV areas are entirely fictional. They are provided to illustrate the use of local-specific land cover classes.
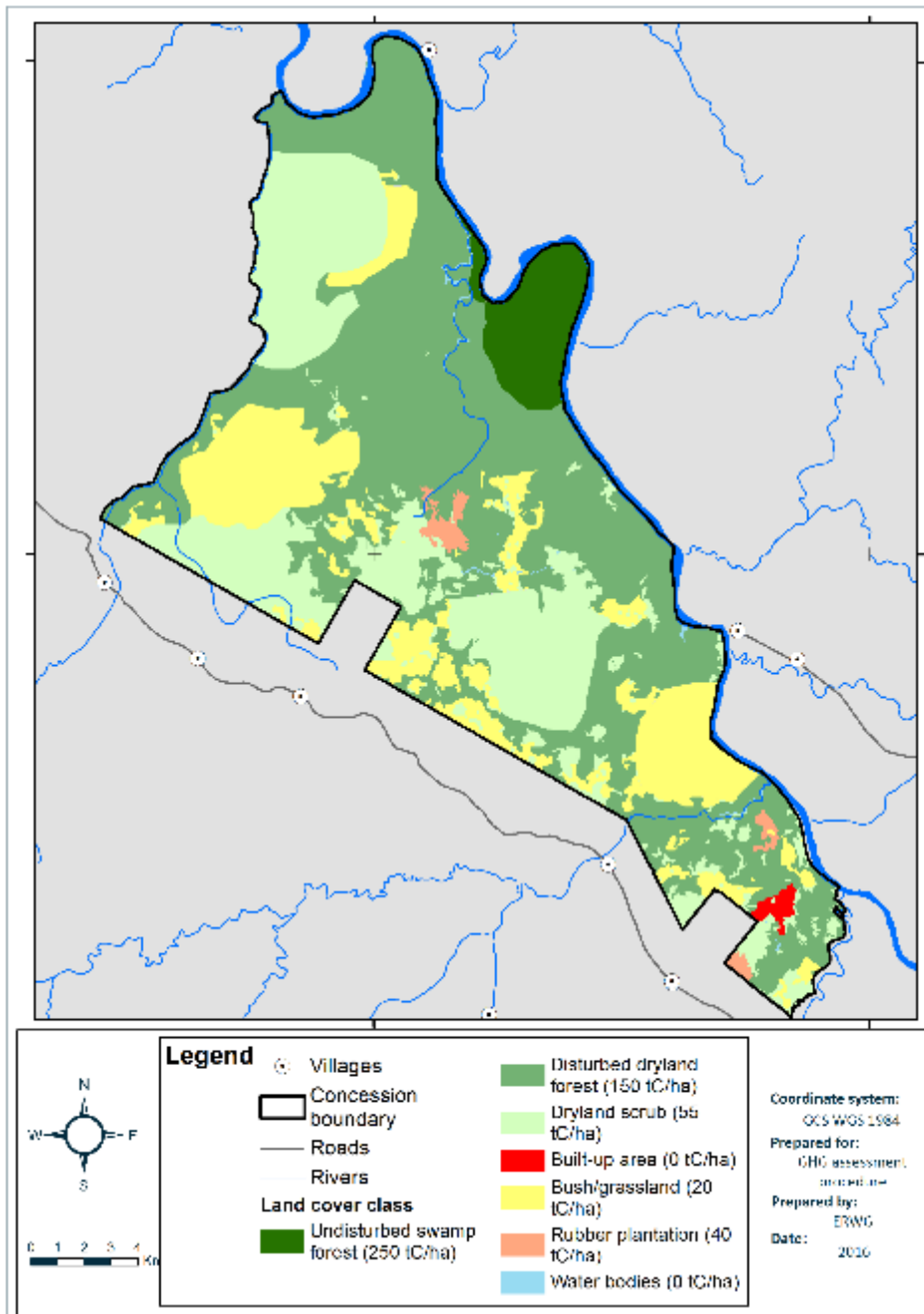

Figure A1-1. Land cover map of Case Study 2

Table A1-1. Land cover types of Case Study 2

Vegetation type	Area (ha)
Undisturbed swamp forest	1,721
Disturbed dryland forest	17,566
Dryland shrub	9,386
Built-up area	147
Bush/grassland	6,215
Rubber plantation	360
Water	103
Total	35,498

Table AI-2: Carbon stock in Above and Below ground biomass estimation for Case Study 2

Vegetation type	Area (ha)	Carbon Stock (tC/ha)	Total Carbon Stock (tC)
Undisturbed swamp forest	1,721	250	430,250
Disturbed dryland forest	17,566	150	2,634,900
Dryland shrub	9,386	55	516,230
Built-up area	147	0	0
Bush/grassland	6,215	20	124,300
Rubber plantation	360	40	14,400
Water	103	0	0
Total concession	**35,498ha**		**3,720,080**

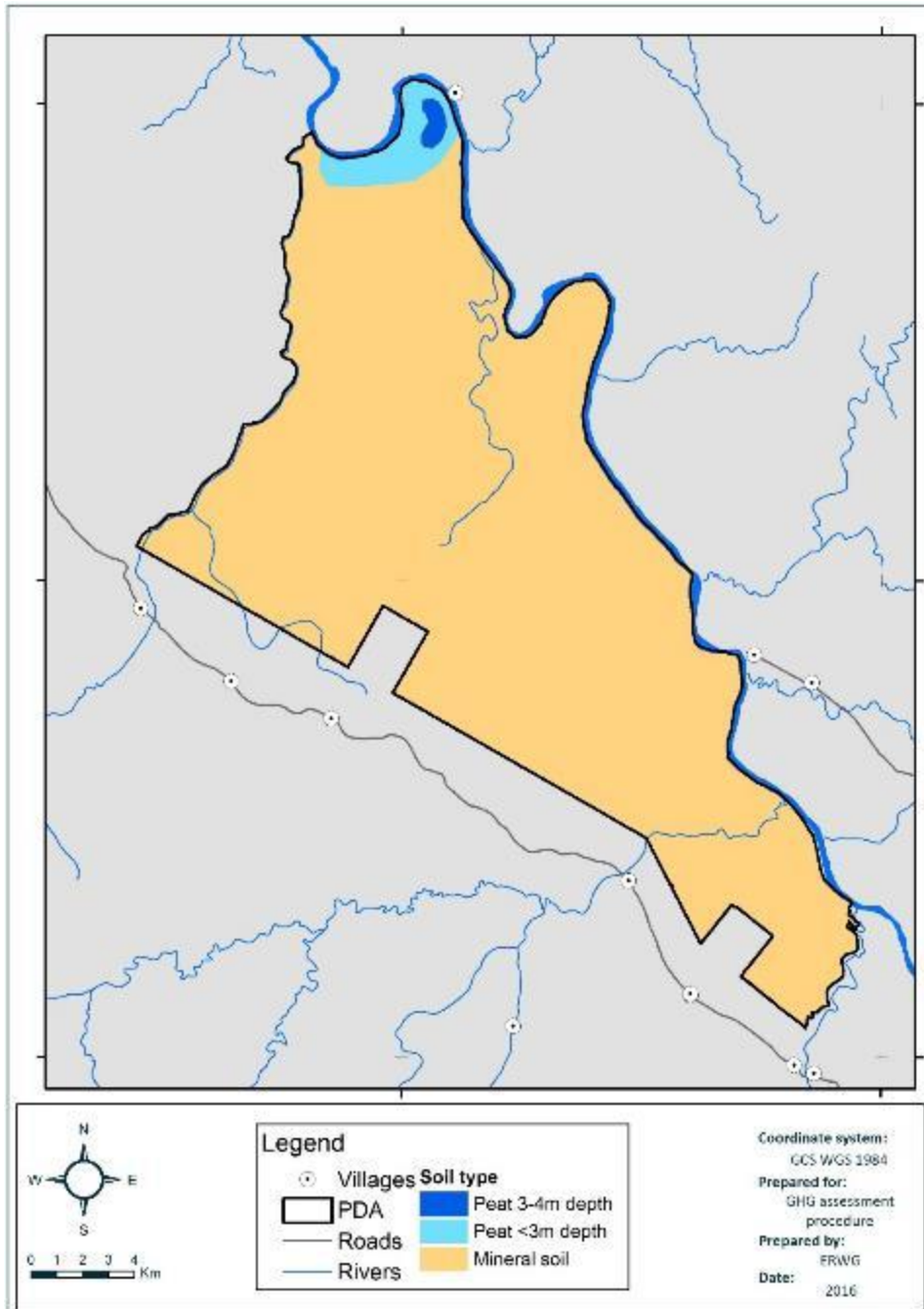Figure A1-2. Peat map of case study 2

Table A1-3: Peat soil Carbon stock estimated of Case Study 2

	Area (ha)	Carbon Stock (tC/ha)	Total Carbon Stock (tC)
Peat <3m depth[16]	932.0	1,057.5	985,590
Peat 3-4m depth[17]	136.9	2,467.5	337,800.75

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[16] Carbon stock assuming average depth of 1.5m
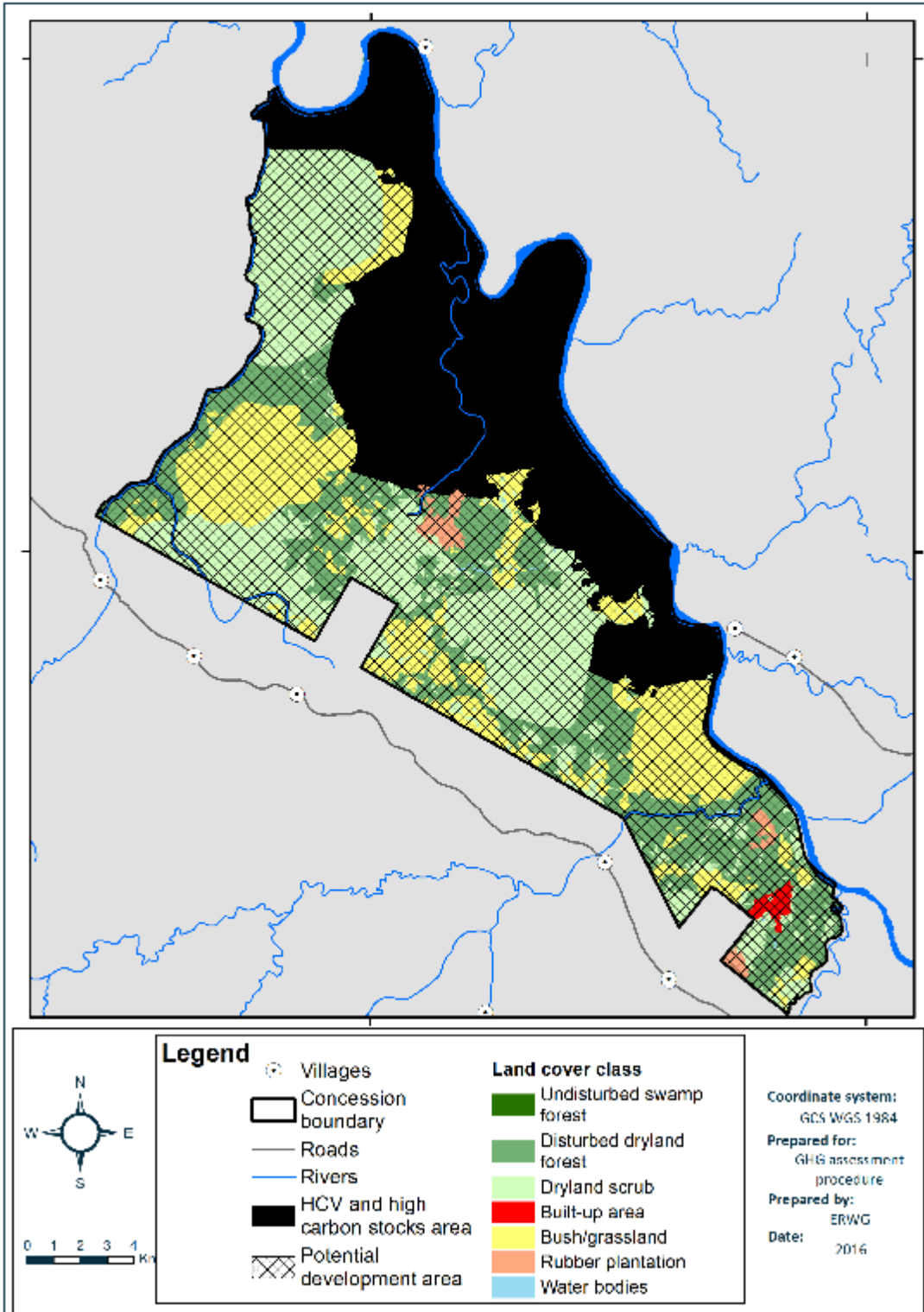[17] Carbon stock assuming average depth of 3.5m

Figure A1-4. Integrated map with potential development area identified of Case Study 2

Table A1-4: HCV areas of Case Study 2

	Area (ha)
HCV area	6,783

Table A1-5: Description of new development scenarios of Case Study 2

Scenario 1	All potential areas for new development cleared for oil palm. No clearing on HCV areas identified. All peat soils are included within HCV areas. No methane capture facilities planned for mill.
Scenario 2	All potential areas for new development cleared for oil palm. No clearing on HCV areas identified. All peat soils are included within HCV areas. Methane capture facilities planned for mill.
Scenario 3	All potential areas for new development cleared for oil palm, except 5,500 ha of disturbed dryland forest with high carbon stocks. No clearing on HCV areas identified. All peat soils are included within HCV areas. No methane capture facilities planned for mill.
Scenario 4	All potential areas for new development cleared for oil palm, except d 5,500 ha of disturbed dryland forest with high carbon stocks. No clearing on HCV areas identified. All peat soils are included within HCV areas. Methane capture facilities planned for mill.

		S1	S2	S3	S4
Area avoided for development	HCV area	6,783 ha	6,783 ha	6,783 ha	6,783 ha
	Other forested conservation set-aside	0	0	5,500 ha	5,500ha
	Other non-forested set-aside	424 ha	424 ha	424 ha	424 ha
Potential areas for new development	Disturbed dryland forest	12,404 ha	12,404 ha	6,904 ha	6,904 ha
	Rubber	355 ha	355 ha	355 ha	355 ha
	Bush/ Grassland	6,145 ha	6,145 ha	6,145 ha	6,145 ha
	Dryland shrub	9,140 ha	9,140 ha	9,140 ha	9,140 ha
	Built-up area	147 ha	147 ha	147 ha	147 ha
POME Treatment	Conventional Treatment	Y	-	Y	-
	Methane capture	-	Y	-	Y

Table A1-6: Projection of GHG Emissions (tCO$_{2e}$/tCPO)

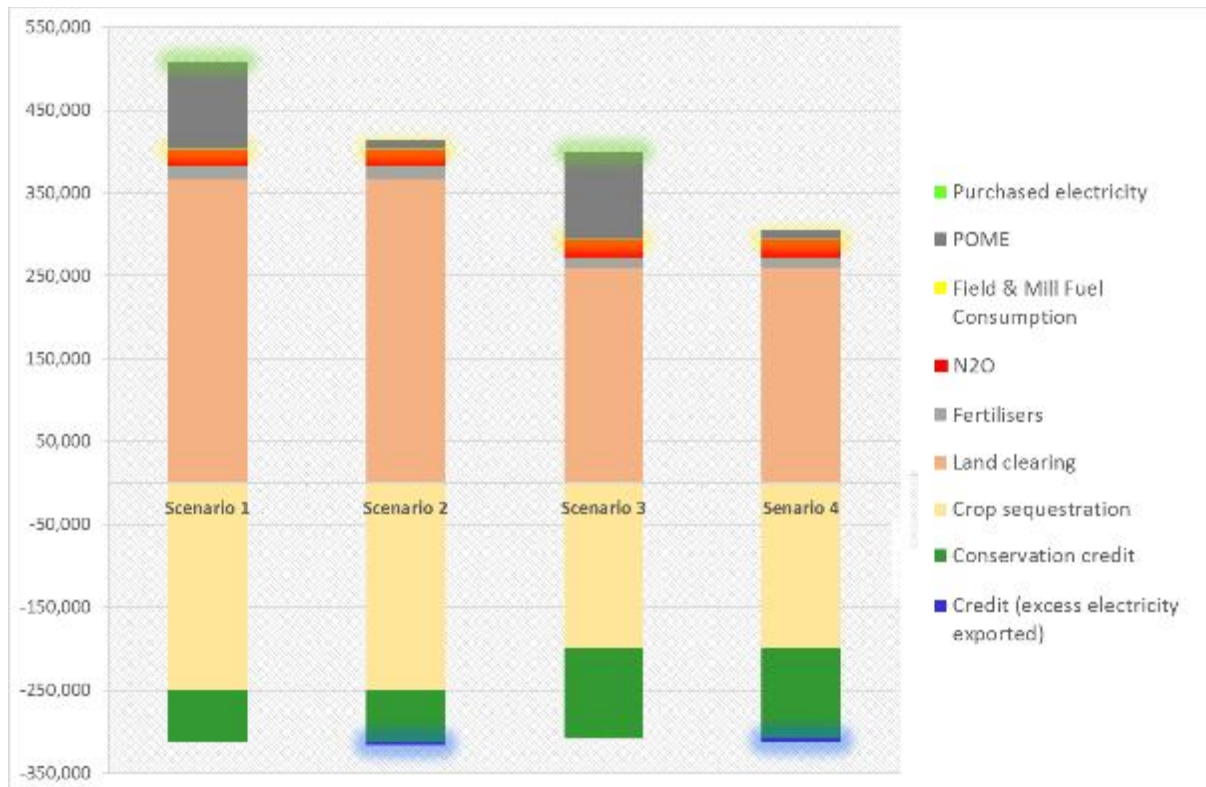|	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Land conversion	0.69	0.69	0.57	0.57
Crop sequestration	-0.47	-0.47	-0.47	-0.47
Conservation Sequestration	-0.12	-0.12	-0.25	-0.25
Fertiliser	0.03	0.03	0.03	0.03
N2O Emissions	0.04	0.04	0.04	0.04
Fuel Consumption	0.00	0.00	0.00	0.00
Net estate emission	0.17	0.22	-0.07	-0.07
POME	0.20	0.02	0.20	0.02
Diesel fuel	0.00	0.00	0.00	0.00
Purchased Electricity	0.00	0.00	0.00	0.00
Credit	0.00	-0.01	0.00	-0.01
Net Mill emission	0.20	0.01	0.20	0.01
Net GHG emission	0.37	0.23	0.13	-0.06

Figure A1-5: Projection of GHG Emissions (tCO$_{2e}$) associated with different development scenarios

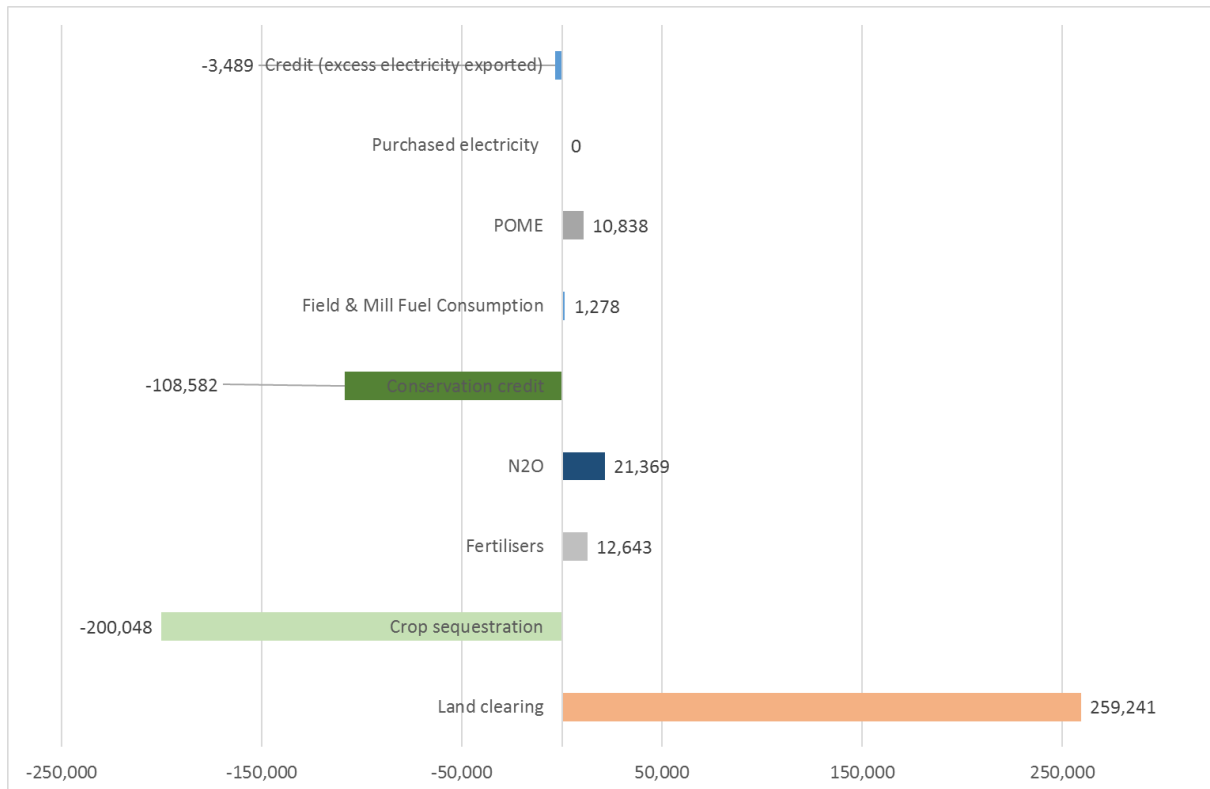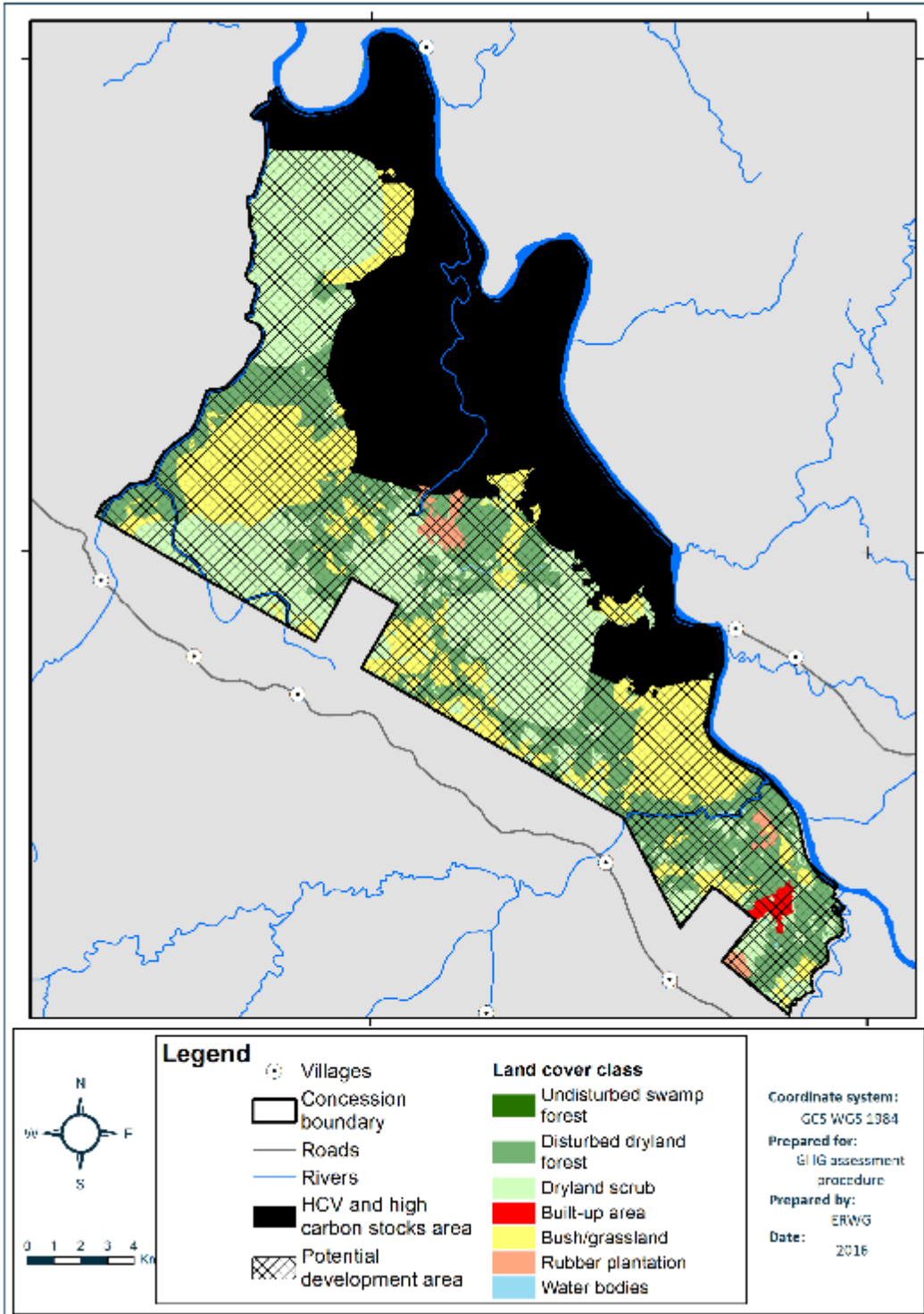**Figure A1-6: Summary of GHG emissions for new development plan for Case Study 2 (tCO2e)**

Figure A1-7. New Development Plan of Case Study 2[18]

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[18] Example given for assumption of the selected scenario 4.

Appendix 2: An Overview of Satellite Image Options

Satellite Name	Overview	Spatial Resolution (m)	Temporal Resolution	Image capture dates	Cost per scene (USD)	Available Bands	Size of images	Comments
Landsat 7	US government's earth-observing satellite missions, jointly managed by NASA and the US Geological Survey. Band designations include: ● Multi-spectrum Scanner (MSS) ● Thematic Mapper (TM) ● Enhanced Thematic Mapper Plus (ETM+) http://landsat.gsfc.nasa.gov/ http://glcf.umd.edu/data/ Since 2003, Landsat 7 image data have been affected by a stripping problem that reduces the quality of these images.	30m	16 days	April 1999 – Present	Free	8 Bands: 1) 0.45 - 0.515 30m; 2) 0.525 - 0.605 30m 3) 0.63 - 0.69 30m 4) 0.75 - 0.90 30m 5) 1.55 - 1.75 30m 6) 10.40 - 12.5 60m 7) 2.09 - 2.35 30m Pan Band) 0.52 - 0.90 15m	170km by 183km	
Landsat 8	http://landsat.usgs.gov/landsat8.php	30m	16 days	Feb 2013 – Present	Free	11 Bands 1) 0.433–0.453　　30 m 2) 0.450–0.515　　30 m 3) 0.525–0.600　　30 m 4) 0.630–0.680　　30 m	185km by 180km	

							5) 0.845–0.885 30 m	
							6) 1.560–1.660 30 m	
							7) 2.100–2.300 30 m	
							8) 0.500–0.680 15 m	
							9) 1.360–1.390 30 m	
							10) 10.6-11.2 100 m	
							11) 11.5-12.5 100 m	
Radarsat 2	http://www.asc-csa.gc.ca/eng/satellites/radarsat2/ Although radar data does not have infrared band, it has other important backscattering information. It is also able to penetrate through cloud cover and operate day and night. However, the data processing is more tedious as compared to optical data.http://www.asc-csa.gc.ca/eng/satellites/radarsat2/http://www.asc-csa.gc.ca/eng/satellites/radarsat2/	3m – 100m*	24 days	Dec 2007 - Present	$3,300 – $7,700	C Band SAR Antenna- Transmit & Receive Channel: 5405.0000 MHz (assigned bandwidth 100,540 kHz)		Radar data lacks an infrared band and therefore requires additional care to classify different vegetation classes.
SPOT-5	Satellite network run by the French Space Agency. http://www.spotimaging.com	2.5m to 10m	24 days	1986-Present	$1,500 - $2,500	5 bands Panchromatic (450 – 745 nm) Blue (450 – 525 nm) Green (530 – 590 nm) Red (625 – 695 nm)	60km by 60km	

					Near-infrared (760 – 890 nm)		
ALOS (AVNIR-2, PRISM)	http://www.alos-restec.jp/en/	10 m	46 days	Jan 2006 – May 2011	1270 MHz (L-band), Polarization HH+VV		
Quickbird	http://www.digitalglobe.com http://glcf.umd.edu/data/	2.4m	4 days	2001 - Present	$5,000-11,500/scene $16-45/km2	•Multispectral 1=Blue 2=Green 3=Red 4=NIR •Panchroma-tic Pan	16.5km x16.5km
RapidEye	http://www.rapideye.de/	5m	5.5 days	2009	$1.5 / km2	1) 440 – 510 nm (Blue) 2) 520 – 590 nm (Green) 3) 630 – 685 nm (Red) 4) 690 – 730 nm (Red Edge) 5) 760 – 850 nm (Near IR)	25km x 25 km
IKONOS	http://geofuse.geoeye.com/landing/ http://glcf.umd.edu/data/	4m	14 days	2000-	$16-56/Km2	1 (Blue) 2 (Green) 3 (Red) 4 (Near-IR)	14km by 14km
Sentinel-1 (Detail)	https://scihub.esa.int/	5 m*5m 5m*20m 20m*40m	12 days	April 2014 - Present	Free	C band	80 Km 250 Km 400 Km Stripmap Mode Interfero-metric Mode

https://sentinel.esa.int/web/sentinel/missions/sentinel-1/instrument-payload/resolution-swath http://sentinel-pds.s3-website.eu-central-1.amazonaws.com/ Although radar data does not have infrared band, it has other important backscattering information. It is also able to penetrate through cloud cover and operate day and night. However, the data processing is relatively more tedious compared to optical data. Data could be acquired at different modes such as Stripmap, Interferometric Wide swath, Extra wide swath and Wave Level-1 SLC, Level-1 GRD, Level-2 OCN Data Products are available for ready to use. PolinSAR is a promising emerging technique for a diverse range of classification applications by deriving canopy height and analysing the large amount of information it contains. https://earth.esa.int/web/guest/pi-community/events/-/article/polinsar-2015-and-1st-biomass-science-workshop	5m*5m			20X20 Km	Extra wide Mode Wave Mode PolinSAR 2015 Biomass workshop is worth-while to explore

Worldview-1	http://www.satimagingcorp.com/satellite-sensors/worldview-1/	0.50 meter GSD at Nadir 0.55 meter GSD at 20˚ off-nadir	1.7 days at 1 meter GSD or Less 5.9 days at 20˚ off-nadir or less 0.51 meter GSD	September 2007 to Present		Panchromatic	17.6 KM at Nadir 17.6 km X 14 Km or 246,4 KM²at Nadir	Maximum view Angle or Accessible Ground Swath 60Km by 110 Km Or 30 km by 110 Km Stereo Image acquisition
Worldview-2	http://www.satimagingcorp.com/satellite-sensors/worldview-2/	Ground Sample Distance (GSD) Panchromatic: 0.46 meters GSD at Nadir, 0.52 meters GSD at 20° Off-Nadir Multispectral: 1.84 meters GSD at Nadir, 2.4 meters GSD at 20° Off-Nadir	1.1 days at 1 meter GSD or less 3.7 days at 20° off-nadir or less (0.52 meter GSD)	October 2009 to Present		Panchromatic 8 Multispectral (4 standard colors: red, blue, green, near-IR), 4 new colors: red edge, coastal, yellow, near-IR2	16.4 kilometers at nadir	Maximum viewing angle or Accessible Ground Swath Max Conti-guous Area Collected in a Single Pass: 96 x 110 km mono, 48 x 110 km stereo
Worldview-3	http://www.satimagingcorp.com/satellite-sensors/worldview-3/	Panchromatic Nadir: 0.31 m GSD at Nadir 0.34 m at 20° Off-Nadir	1 m GSD: <1.0 day 4.5 days at 20° off-nadir or less	August 2014 to Present		Panchromatic @ 450-800nm 8 Multispectral bands @ 400 – 1040 nm 8 SWIR bands @ 1195 – 2365 nm	At nadir: 13.1 km	Max Conti-guous Area Collected in a Single Pass (30° off-nadir angle) Mono: 66.5 km x 112 km (5 strips)

		Multispectral Nadir: 1.24 m at Nadir, 1.38 m at 20° Off-Nadir SWIR Nadir: 3.70 m at Nadir, 4.10 m at 20° Off-Nadir CAVIS Nadir: 30.00 m				12 CAVIS Bands @405 – 2245 nm		Stereo: 26.6 km x 112 km (2 pairs)

Appendix 3: Emerging Remote Sensing Technologies

Sensor	Website	Spatial Resolution	Temporal Resolution	Image Capture date	Cost of Image	Available Bands	Swath
Ebee unmanned aerial vehicles (UAVs)	www.sensefly.com For mapping topography, land use, land cover and changes at very high resolution It is very good tool for monitoring changes of an area. Note that in some areas only certified pilots may use this technology. Several multirotors UAV and fixed wing drone should be explored by analysts, as the UAV technology is changing fast.	Sub meter to 5 meter	Any day and time with good weather	Any date the team selected to fly	35 USD per sq.km for stereo images acquisition 700 images per single flight 10 sq.km per 45 minutes per single flight Processing time is 12 hours per 100 images @ ~800 USD per working day	Visible (blue, green and red) with visible camera Near infrared with near infrared camera	10 km by 10 km
Microwave or SAR - Synthetic Aperture Radar ERS, ENVISAT (retired) and **Sentinel-1**, launched in April 2014	https://earth.esa.int/web/guest/missions/esa-future-missions https://earth.esa.int/web/guest/missions/esa-future-missions/sentinel-1 https://sentinel.esa.int/web/sentinel/sentinel-data-access Old archives of ERS and ENVISATS are available until 2012	Sentinel-1: 20m Resolution	Sentinel-1: 12 days revisit	Sentinel-1: Since April 2014	Sentinel-1: Free download with Registration	Sentinel-1: C-Band SAR	Sentinel-1: 250 KM Swath
LiDAR data Airborne LiDAR	http://www.lidarbasemaps.org/	See website 30000 points per	See website	See website	See website	See website	See website

	For mapping topography, DTM Creating contours, Not for Land use or land cover mapping and detection of changes	second at 15 meter accuracy	Any time of good weather	Choice by the analysts			

Appendix 4: Suggested Soil/ Peat Map References

Malaysia

- The Department of Agriculture has a database of soil maps of various resolutions that can be requested or purchased[19],
- Atlas of peat lands in Malaysia in 2004, developed by Wetlands International and visualised by World Resources Institute (WRI)[20]

Indonesia

- An atlas of peat lands in Indonesia with indicative peat depths published by Wetlands International (Wahyunto *et al.* 2003, 2004, 2006).
- The Ministry of Agriculture has produced a 2012 peat map that has been visualised by the WRI,

Additional peat datasets for Indonesia include:

- Those developed by the Indonesia Center for Agricultural Land Resources Research and Development (ICALRRD),
- The 1980s RePPProT Land Systems map,[21] and

Indonesian growers should also note that the newly formed Badan Restorasi Gambut is in the process of developing peat restoration maps that should be referred to once available.

Other countries

Peatlands have a relatively restricted distribution globally, with the most significant known tropical peatlands occurring in Malaysia and Indonesia, where the best peat maps are available. Peatlands do occur elsewhere in the tropics and although high resolution maps are generally lacking, the Harmonised World Soil Database (HWSD) provides a coarse global soil map, with peat soils mapped as Histosols.[22]

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[19] A list of available soil maps for Malaysia can be accessed at : http://www.doa.gov.my/senarai-peta-yang-disediakan-doa
[20] http://www.globalforestwatch.org/map/7/4.33/108.96/MYS/grayscale/none/732?tab=analysis-tab&dont_analyze=true
[21] The RePPProT map is accessible here (note that this is not an official government source) : https://databasin.org/datasets/eb74fe29b6fb49d0a6831498b0121c99
[22] http://www.simedarbyplantation.com/sustainability/high-carbon-stock

Appendix 5: Additional guidance in determining sample plots

Nested plots are recommended for land cover with a wide range of tree diameters and stem densities with an uneven size distribution (Pearson *et al.*, 2007) such as in tropical forests. Nested plots could be rectangular or circular (see Figure 5 below) but some researchers prefer rectangular plots as they tend to include more of the within-plot heterogeneity, and thus will be more representative than square or circular plots of the same area (Hairiah *et al.*, 2011). The most appropriate size and shape may also be dependent on the land cover found in the sampling area (Walker *et al.*, 2012)

Figure A5-1: Schematic diagram showing a three-nest sampling plot in both circular and rectangular forms
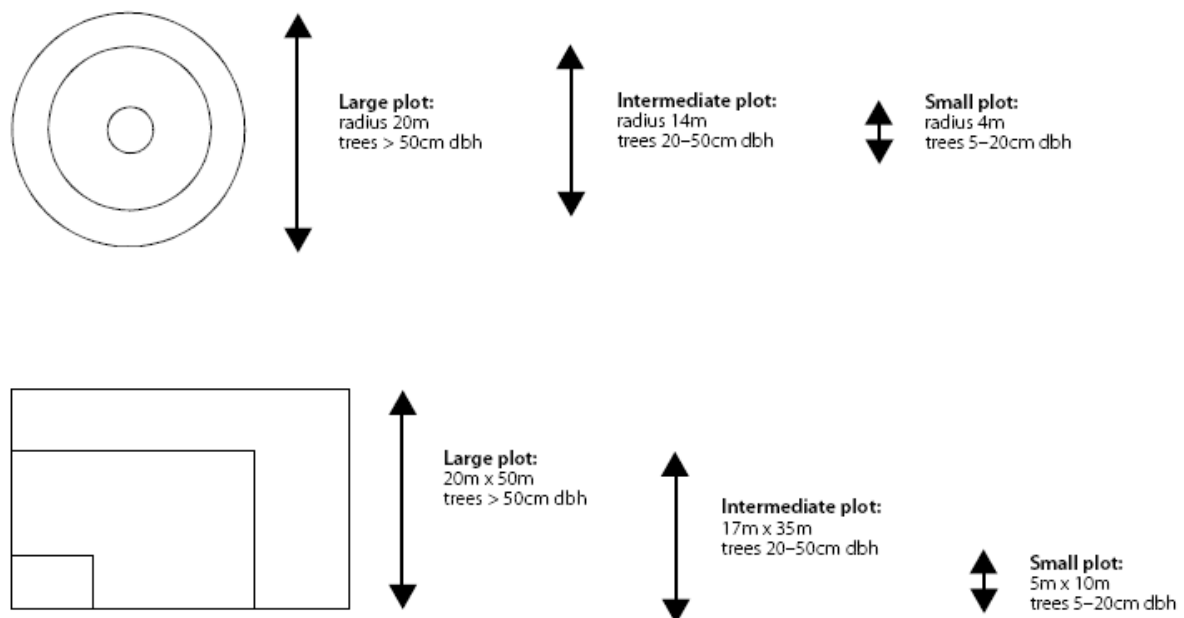
Source: Pearson *et al.* (2005)

It is advisable to select a larger set of sampling locations than the actual number required, in order to provide alternatives in case of unexpected field conditions, such inaccessibility (Hairiah *et al.*, 2011). Ground-truthing (which could be done in conjunction with Step 3) prior to the actual plot sampling is important to finalise the location of sampling plots and identify the most efficient routes to reach them.

Winrock International (2008) has developed an online Excel tool called the Winrock Terrestrial Sampling Calculator that helps in the calculation of the number of samples and the cost involved for base line studies as well as monitoring. This calculator is available at: http://www.winrock.org/Ecosystems/tools.asp.

Estimating above-ground biomass

Tree measurements are taken within the sampling plots. The most important measurement is the diameter at breast height (dbh) which is usually set at 1.3m above ground level. Detailed guidance on how to take dbh measurements and the equipment needed can be found in many publications including Brown (1997), Pearson *et al*. (2005), Hairiah *et al.* (2011) and Walker *et al*. (2012). In a nested plot, larger trees (e.g. dbh>50cm) are measured in the larger plot while the smaller plots are for measuring trees of smaller dbh classes (as illustrated in Figure 5 above).

Although measuring both the dbh and height of a tree would provide a more accurate estimation of its biomass, measuring tree height can be time-consuming (Pearson *et al*., 2005) and often difficult because treetops are hidden by the canopy layer. A decision should be made during the planning phase of sampling – based on resources available, data gathered on the land cover and field conditions – whether or not to measure tree height. There are allometric equations available for estimating above ground biomass with or without height measurement.

Once the dbh measurements of the trees in a sampling plot have been obtained, the above-ground biomass can be calculated using an allometric equation that relates tree biomass with the dbh, height (optional), and wood density.

There are generally two approaches in using allometry to convert dbh measurements into above ground biomass. If the trees can be identified up to species or at least genus level, and their respective wood density is known, species- or genus-specific allometric equations can be used to estimate the above-ground tree biomass. Average wood density values for a range of species or genus are available from Brown (1997), IPCC (2006) and the World Agroforestry Center's Wood Density Database.

However, tree diversity in the tropics is very high with one hectare of tropical forest containing as many as 300 different species (de Oliveira & Mori, 1999), making species-specific allometry not practical (Chave *et al*., 2005). Instead, grouping all species together within a particular land cover strata and using generalised allometric equations, is highly effective for tropical regions because dbh alone accounts for more than 95% of the variation in above-ground tropical forest carbon stocks, even in highly diverse regions (Brown, 2002). Generalised allometric equations are based on large numbers of trees covering a wide range of diameters (Brown, 1997; Chave *et al*., 2005).

All allometric equations require dbh values. In addition to dbh, some allometric equations require values for tree height and/or wood density (for generalised equations, a weighted average value for wood density is the norm). Brown (1997) provides an allometric equation for tropical moist forests using data collected from Kalimantan and other tropical regions while others have developed allometric equations for specific forest types e.g. lowland dipterocarp forests (Basuki *et al*., 2009). The RSPO Secretariat has compiled a database of relevant allometric equations for a range of vegetation/ecosystem types and geographical regions and this will be made available to interested parties. As a general guideline, allometric equations should be chosen on the basis of similarities between the vegetation type that the particular equation was developed and that of the proposed new planting area, and also the geographical regions concerned. For example, if the proposed new planting area is a degraded secondary forest in Papua New Guinea (PNG) it makes sense to select an allometric equation that was developed for a similar area in Sulawesi if there is no equation available for PNG itself or surrounding areas, rather than selecting an allometric equation developed for an area

in Peru. An alternative is to select allometric equations that were developed using data from more than one region, as in the case of pan-tropical allometric equations developed by Brown (1997).

If wood density value is needed in an allometric equation, the range provided by Brown (1997) for tropical tree species in the Asian region is 0.40-0.69 g/cm^3 while some other researchers have used a value of 0.67 for Borneo and the Amazon (Chave *et al.*, 2006; Fearnside, 1997; Paoli *et al.*, 2008) or 0.60 in Sumatra (Ketterings *et al.*, 2001) and Sabah (Morel *et al.*, 2011).

Above-ground non-tree or understory biomass is only to be measured if it is a significant component, such as for grassland or shrub land where trees are only present at low densities (Pearson *et al.*, 2005). For forested land cover, above-ground non-tree biomass is generally not a significant component.

Appendix 6: Scaling up of dbh measurement to estimate carbon density for each stratum

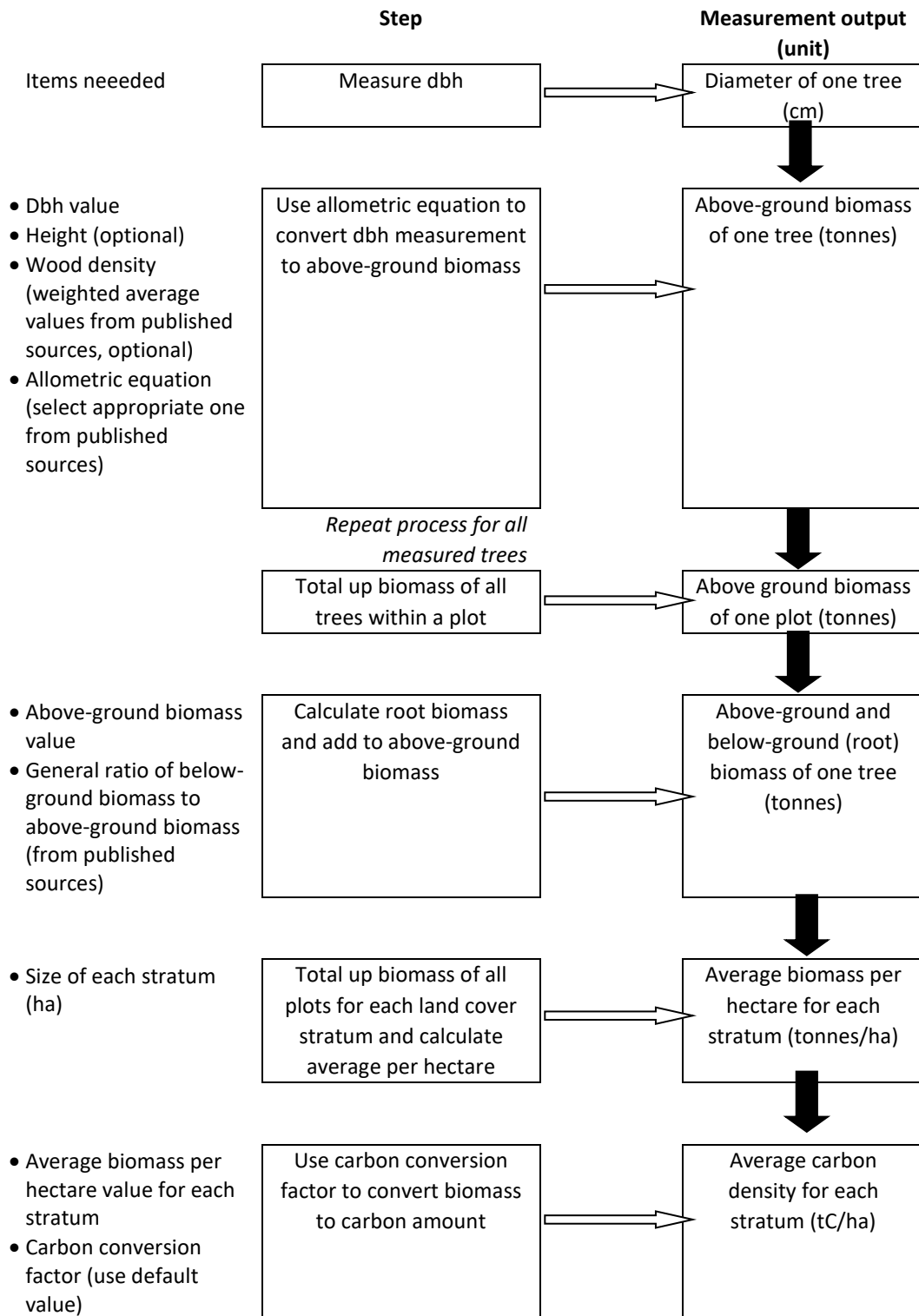|	Step	Measurement output (unit)
Items neeeded	Measure dbh	Diameter of one tree (cm)
• Dbh value • Height (optional) • Wood density (weighted average values from published sources, optional) • Allometric equation (select appropriate one from published sources)	Use allometric equation to convert dbh measurement to above-ground biomass	Above-ground biomass of one tree (tonnes)
	Repeat process for all measured trees Total up biomass of all trees within a plot	Above ground biomass of one plot (tonnes)
• Above-ground biomass value • General ratio of below-ground biomass to above-ground biomass (from published sources)	Calculate root biomass and add to above-ground biomass	Above-ground and below-ground (root) biomass of one tree (tonnes)
• Size of each stratum (ha)	Total up biomass of all plots for each land cover stratum and calculate average per hectare	Average biomass per hectare for each stratum (tonnes/ha)
• Average biomass per hectare value for each stratum • Carbon conversion factor (use default value)	Use carbon conversion factor to convert biomass to carbon amount	Average carbon density for each stratum (tC/ha)

Figure A6-1. Steps for Scaling up of dbh measurement to estimate carbon density for each stratum

The average carbon density value for each stratum should be compared with the relevant RSPO default value for the stratum (see Table 3). If the two values are very different (e.g. the calculated value is close to the default value of another stratum), it is necessary to check if the land cover stratification has been done correctly and if the sampling plots are actually in the stratum that they are supposed to be. Independent verification (Pearson *et al.*, 2005) by a third party may also be considered. If the discrepancy in values remain after these additional efforts, the calculated value may be used instead of the default value if there is a high level of confidence in the robustness of the field sampling exercise, which is likely to yield more accurate results as compared to the default values which are average values that may not be applicable in all cases.

Appendix 7: GHG Assessment Procedure: FAQ

1. What is the RSPO GHG Assessment Procedure for New Development?

The RSPO GHG Assessment Procedure for New Development provides a practical methodology to growers for estimating the carbon stock for land earmarked for new plantation development. Based on this, the corresponding expected carbon stock changes (above and below ground) and GHG emissions associated with the resulting land cover change to oil palm and peat drainage can be estimated and development plans adjusted to minimise net greenhouse gas emissions associated with new plantation development. This procedure is referred to in the RSPO P&C 2013, as the RSPO Carbon Assessment Tool and is to be referred to in order to meet compliance with Criterion 7.8. The procedure is intended to be compatible with current processes required under Principle 7 – primarily the soil survey, SEIA and HCV assessments.

2. What is Criterion 7.8?

Criterion 7.8 is a new criterion that was introduced in the RSPO P&C 2013. It requires that new plantation developments are designed to minimise net greenhouse gas (GHG) emissions. The indicators under this criterion include the identification and estimation of potential sources of emission and sinks of carbon associated with new developments. Another indicator is that new developments must be designed to minimise GHG emissions which takes into account avoidance of land areas with high carbon stocks and consideration of sequestration options.

3. When does Criterion 7.8 become effective?

The application of Criterion 7.8 comes with an implementation period that ends on 31st December 2016, after which the report will be uploaded as part of the NPP notification documents. The purpose of the implementation period is to allow the RSPO Emission Reduction Working Group (ERWG) to review and fine tune the tools, emission factors and methodologies, and provide additional guidance, recognising the challenges associated with estimating carbon stocks and projecting GHG emissions from new developments. During this time, public reporting is voluntary.

4. Is compliance to Criterion 7.8 voluntary during the implementation period?

Compliance to Criterion 7.8 is mandatory for all NPP submissions as of 1st January 2015. Companies must submit their summary report to the ERWG via the RSPO Secretariat. Only public reporting is voluntary during the implementation period. As of 1st January 2017, when public reporting becomes mandatory, requirements under Criterion 7.8 will be published together with the standard NPP report.

5. Are historic land use change emissions considered under Criterion 7.8?
No. This should not be confused with the land use change analysis to determine changes in vegetation since November 2005 under Criterion 7.3. Companies should only assess the current carbon stock prior to the planned new development.

6. What is the threshold to determine High Carbon Stock?
RSPO recognises the challenges of placing a quantitative threshold to determine High Carbon Stock especially when taking into account regional differences in vegetation types, governance and socio-economic needs.

RSPO does not define what is High Carbon Stock. A definition for Low Carbon Stock is provided in Annex 2 of the RSPO P&C 2013 - Low carbon stock areas are defined as those with (above and below ground) carbon stores, where the losses as a result of conversion are equal or smaller to the gains in carbon stock within the new development area including set aside areas (non-planted areas) over the period of one rotation.

This GHG Assessment Procedure has been developed for members to identify the carbon stock changes and GHG emissions associated with a particular development. By integrating the findings together with the results of the HCV assessment and the community assessments (as part of SEIA), members can select the optimal development scenario and develop a plan to mitigate the possible impacts and to report on what the projected changes and emissions will be.

Companies are required to review the pros and cons of the various development scenarios, taking into account:
- Avoidance of land areas with high carbon stock and/or potential high GHG emissions (if developed)
- Options to increase the sequestration of carbon (conservation areas, river buffer zones, etc.)
- Avoidance of HCV areas as determined in HCV assessment.
- Avoidance of peatland
- Practical management issues such as access and connectivity, socio-economic concerns, etc.

Reasons for selecting the preferred development option shall be given.

7. What are the contents of the summary report that need to be submitted for compliance to Criterion 7.8?
The submission shall contain a summary of the carbon stock assessment (refer to indicator 7.8.1) and a summary of a management plan (refer to indicator 7.8.2). The GHG assessment

procedure provides a comprehensive outline of the reporting requirements. Companies are advised to adhere to the reporting framework provided in the GHG assessment procedure when preparing their reports for submission.

8. What are the common issues encountered when reviewing submissions?

The common issues encountered are listed below:

- Confusion with Land Use Change Analysis (C7.3). In some cases, the carbon stock was estimated based on the November 2005 baseline which is not required.
- Maps are not well explained (i.e. areas of planned development and conservation areas, impact of ground truthing on stratification)
- Poor description of the vegetation strata and corresponding carbon stock
- In the cases of ongoing development (where the new plantation development started before January 2010 and continued thereafter) or in cases where new planting is being proposed in management units that are already in operation (there are existing estates and a mill in operation), emissions from proposed new development are not clearly differentiated from existing operations
- Lack of scenario testing and mapping overlay (integrated map showing results of HCV assessment, SEIA and carbon stock assessment). In cases where companies already have specific policies on the issues of deforestation and peat development, some scenario setting is also expected within the scope of their policy.
- Scenarios poorly explained and scenario choice also not well justified
- Unclear if the carbon stock assessment resulted in additional areas outside of identified HCV areas that will be set aside
- Poor description on how or whether the carbon stock assessment together with the other related assessments such as HCV and SEIA, influenced the outcome of plantation plan and design.

9. How are smallholders expected to comply with Criterion 7.8?

The compliance for scheme smallholders is the responsibility of the company that is managing the scheme. There is no mechanism in-place at this time for the independent smallholder to comply with Criterion 7.8.

10. Can RSPO member companies use the methodologies outlined in the HCS+ Study to comply with Criterion 7.8?

RSPO member companies that wish to follow the HCS+ Methodology would:

i) Apply the methods described by HCS+ to map and estimate the above ground carbon (Must use the high-res mapping tool, i.e. Lidar/other tool) and soil carbon and prepare a map of land cover with carbon stock.
ii) Apply the 75tC/ha carbon stock thresh-hold (AGB, roots and deadwood) and plan for carbon neutral development as per the HCS+ recommendations to determine the area for development.
iii) Apply the 75tC/ha carbon stock thresh-hold for soil carbon.
iv) Follow RSPO GHG Procedure/New Development GHG Calculator to:

a. Predict GHG emissions related to mill operations;
b. Prepare a management and mitigation plan including emission reduction measures; and
c. Set up a monitoring process

11. Can RSPO member companies use the HCS Approach toolkit to comply with Criterion 7.8?

RSPO member companies that wish to follow the HCS Approach toolkit would:

i) Apply the methods described by HCSA toolkit to map out potential HCS forest. (Note HCSA does not have a soil carbon estimation process due strict "NO PEAT" commitment. Any company choosing this option must also commit to "NO PEAT" development). Tropical peat soils (Histosols) are defined as organic soils with 65% or more organic matter and a depth of 50 cm or more (see RSPO Manual on Best Management Practices (BMPs) for Existing Oil Palm Cultivation on Peat).

ii) Develop a plan based on decisions on where to proceed with development and where to maintain/conserve as set aside areas.

iii) Follow RSPO GHG Procedure/New Development GHG Calculator to:
   a. Predict GHG emissions related to both the plantation and mill operations;
   b. Prepare a management and mitigation plan including emission reduction measures; and
   c. Set up a monitoring process

12. Can RSPO member companies use the HCS Approach and HCS+ Study converged methodology to comply with Criterion 7.8?

The parties behind HCSA and HCS+ have identified areas of synergy and there is an ongoing dialogue on convergence which also involves the RSPO Secretariat and some members of the ERWG. Converged method as the result of current convergence process could be adopted to comply with parts of the Procedure, mainly focusing on the Chapter 3 of this Procedure. Chapter 4 Assessment of GHG Emissions from New Development of this Procedure would still need to be applied.

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