RSPO | Roundtable on Sustainable Palm Oil

DRAINABILITY ASSESSMENT PROCEDURE 2021

Drainability Assessment Procedure for

Replanting of Existing Oil Palm on Peatlands

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RSPO Drainability Assessment Procedure

This Procedure was initially developed by RSPO with technical assistance from Wetlands International (Dipa Rais and Arina Schrier) under the guidance of the RSPO Peatland Working Group 2.

The revision in September 2020 to September 2021 was prepared, drawing on experiences of RSPO Member companies on using the earlier edition in the first year of implementation. The revision was made by a team comprising Dato Keizrul Abdullah, Joshua Mathews, Arif Sugandi, Faizal Parish, Devaladevi Sivaceyon and Amir Afham, in conjunction with the RSPO Peatland Working Group-2.

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- Arif Sugandi,
- Faizal Parish,
- Devaladevi Sivaceyon,
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Revision Table

NO	AMENDMENT	VERSION	DATE
1.	Correction of document date	V 1.0	11 June 2019
2.	Addition of section: Prior Drainability Assessments [Section III, Annex 5] (pg. 52)	V 1.0	11 June 2019
3.	Addition of table A5-1 of section: Prior Drainability Assessments [Section III, Annex 5] (pg. 52)	V 1.1	30 November 2019
4.	Addition of revision table (pg. III)	V 1.1	30 November 2019
5.	Update of table A5-1 [Section II, Annex 5] (pg. 51)	V 1.1	30 November 2019
6.	Revision of text [Section II, Annex 5] (pg. 51)	V 1.1	30 November 2019
7.	Update on Introduction of this procedure (pg.1)	V 1.2	September 2020
8.	Update on Background of this procedure (pg.3)	V 1.2	September 2020
9.	Additional text for Section 2.3: A safeguard threshold	V 1.2	September 2020
10.	New sub-topic: 4.1 Steps in Drainability Assessment	V 2.0	September 2020
11.	New section on baseline measurement	V 2.0	September 2020
12.	New section on measuring water level fluctuation at final water outlet	V 2.0	September 2020
13.	Update on Figure 1: Key elements for future Drainability Assessment	V 2.0	September 2020
14.	New section on steps on selecting water outlet	V 2.0	September 2020
15.	New section on measuring water level fluctuation at the final water outlet	V 2.0	September 2020
16.	Updated Figure 14: Future Drainability Assessment flow chart for Tier 1 approach	V 2.0	September 2020
17.	Updated Figure 19: Future Drainability Assessment flow chart for Tier 2 approach	V 2.0	September 2020
18.	New chapter on 'Implementing the DAP'	V 2.0	September 2020
19.	Revised Annex 3: Identification and calculation of water elevation at final outlet	V 2.0	September 2020
20.	Revised Annex 4: DEM and Peat Thickness Generation	V 2.0	September 2020
21.	New illustration for drainage zone	V 2.0	April 2021
22.	Grower's checklist for RSPO Drainability Assessment (DA)	V 2.0	April 2021
23.	Reporting template for DA Report	V 2.0	April 2021
24.	Revised Annex 2: Water Elevation at Final Water Outlet	V 2.0	May 2021
25.	New Annex 8: DA report review process	V 2.0	June 2021
26.	New Annex 9: Transition from DAP Version 1 to Version 2	V 2.0	June 2021

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27.	Grower's checklist renamed into submission checklist	V 2.0	June 2021
28.	The term 'grower' is replaced with 'company' or 'plantation'	V 2.0	June 2021
29	The term drainage base is replaced with Natural Drainage Limit (NDL).	V2.0	August 2021
30	Addition of Annex 3: Subsidence measurements	V2.0	September 2021
31	Explanation on DTM vs DEM vs DSM is added under Annex 5	V2.0	September 2021
32	Section 7: Changes to approved report	V2.0	October 2021
33	Section 5.3: Bundling of Area Updated text on duration of years to bundle replanting area	V2.0	October 2021
34	Section 6: Submission checklist was updated to include 'Proposed replanting year'	V2.0	October 2021
35	Adjustment to DLT	V2.0	October 2021
36	Annex 10: Changes to approved DA report	V2.0	October 2021

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GLOSSARY

Basal contact	Interface between two stratigraphic layers, e.g., peat layer and clay layer, peat layer and sand layer, etc.
Natural Drainage Limit (NDL)	The level below which it is not physically possible to drain the water from the land by gravity alone.
Drainage Limit Elevation	The increase in water level in peat soil in proportion to distance to receiving water body that is required to enable water to flow.
Final Water Outlet	A gated/non- gated water structure located within or at the edge of the plantation area to control the outflow of drainage water from the plantation to a receiving water body
Natural Drainability	Ability of a peatland to be drained by gravity, without mechanical devices such as pumps.
Paludiculture	Productive land use on rewetted peatland with crops that are adapted to the high-water levels in peatlands
Peatland delineation	Differentiation of peatland from surrounding non-peatland on map
Receiving Water Body	River, Lake or Sea into which drainage water is discharged from the plantation.
Replanting Peatland	Area of peat soil to be replanted.
Rotation Cycle	The life cycle of the oil palm, on peatland which is taken to be 20 years.
Subsidence Stratum	Defined area of homogeneous soil subsidence rate.
Tropical Peat	A soil with cumulative organic layer(s) comprising more than half of the upper 80 cm or 100 cm of the soil surface containing 35% or more of organic matter (35% or more Loss on Ignition) or 18% or more organic carbon. Note for management of existing plantations in Malaysia and Indonesia, a narrower definition has been used, based on national regulations: namely soil with an organic layer of more than 50% in the top 100 cm containing more than 65% organic matter. For country/region specific definitions refer to the 'RSPO Organic & Peat Soil Classification'.
Two-Crop Cycle Threshold (TCCT)	A period equivalent to two crop cycles of oil palm on peat – normally considered to be 20 years x 2 = 40 years. However, for companies that historically (or plan in future) to have longer cycles – this may be two times the actual cycle length. This figure is used to determine the buffer period for oil palm phase out in the DAP.

Preface

The RSPO Drainability Assessment Procedure has been developed to support oil palm companies to assess future subsidence and flood risks of peatlands and adjust their management processes to reduce subsidence rates and prolong the workable lifetime of their plantations. It will enable the companies to phase out oil palm and introduce more water-tolerant crop types or restore natural vegetation prior to the plantations subsiding to river or sea levels. It will also enable compliance with the requirement to undertake Drainability Assessments prior to any replanting on peat as specified in the RSPO P&C 2013 (Indicator 4.3.5) and P&C 2018 (Indicator 7.7.5).

The Procedure was developed with the technical assistance of Dipa Rais and Arina Schrier of Wetlands International under the guidance of the RSPO Peatland Working Group 2 over the period of July 2017-January 2019. During this period, two stakeholder workshops were held to seek input on the principles and practicability of the Procedure. Testing of the Procedure was undertaken by four companies and the Procedure was reviewed by three independent reviewers.

This Procedure was first issued by RSPO in June 2019 and was used for an initial implementation period of 12 months, after which it was reviewed in June 2020 – September 2021 and adjusted and elaborated, where necessary, based on the experience gained and feedback from users and other stakeholders. A public consultation on the revised draft was undertaken in August-September 2021. The final second Version of the Drainability Assessment Procedure was approved by the RSPO Peatland Working Group 2 in October 2021.

Any further feedback on the use of this version can be sent by email to the RSPO Secretariat at ghg@rspo.org.

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Co-chairs RSPO PLWG-2

October 2021

1. Introduction

Drainability Assessments were introduced by RSPO as a requirement prior to replanting mature oil palm on peat. This was introduced in the RSPO Principles and Criteria 2013 (P&C 2013), as a measure to prevent over-drainage of peatlands and at the same time to encourage the application of BMPs in order to reduce the subsidence rate of peatlands planted with oil palm.

The P&C 2013 included specific requirements on drainability as follows:

4.3.5 Drainability Assessments shall be required prior to replanting on peat to determine the long-term viability of the necessary drainage for oil palm growing.

Specific Guidance For 4.3.5: Where Drainability Assessments have identified areas unsuitable for oil palm replanting, plans should be in place for appropriate rehabilitation or alternative use of such areas. If the assessment indicates high risk of serious flooding and/or salt water intrusion within two crop cycles, growers and planters should consider ceasing replanting and implementing rehabilitation.

The 2018 P&C expanded further on the requirements for Drainability Assessment as follows:

7.7.5 (C) For plantations planted on peat, Drainability Assessments are conducted following the RSPO Drainability Assessment Procedure, or other RSPO recognised methods, at least five years prior to replanting. The assessment result is used to set the time frame for future replanting, as well as for phasing out of oil palm cultivation at least 40 years, or two cycles, whichever is greater, before reaching the natural gravity drainability limit for peat. When oil palm is phased out, it should be replaced with crops suitable for a higher water table (paludiculture) or rehabilitated with natural vegetation.

The concept of the Drainability Assessment is to estimate the Natural Drainage Limit (NDL) through site measurements and calculations, and calculate the expected time to reach the 'drainage limit time' (DLT) by taking into consideration the historical subsidence rate of the assessed area.

This Drainability Assessment Procedure (DAP) provides a methodology for determining how the projected future subsidence would affect the relative level of the fields and the respective drainage outlet from the plantation and the ability of water to drain by gravity in the future.

1.1 REQUIREMENTS FOR DAP

The Procedure requires the **drainability assessment to be conducted 15 years**[1] after initial planting (approximately 5 years prior to planned replanting) of existing plantations on peatland. Each assessment report can include a maximum of 5 years of replanting date (between the first proposed replanting year and the last proposed replanting year). Any proposal for replanting 10th years later than the assessment date will require a separate report to be submitted.

The DA report needs to be prepared prior to the clearing or replanting of any Oil palm cultivated on peat. No replanting can take place until the DA report has been submitted, reviewed and approved by RSPO. The companies need to complete all requirements specified in the Submission Checklist (Section 6).

The DA report must be prepared in English or Bahasa Indonesia. If submitted in Bahasa Indonesia, the DA report must have an English Summary which fulfils the requirement from Submission Checklist (Section 6).

RSPO requires that an assessment of future drainability is undertaken before any peatland area is replanted. In order to enable this to take place RSPO has developed this Drainability Assessment Procedure. Also refer to Annex 6, to get information on the transitional arrangement for DAP. This Procedure provides guidance for a two-Tier approach i.e. Tier 1 and Tier 2 with different levels of detail. Tier 1 approach is simple with

[1] Given the difficulty for any company or auditor to determine the exact date of future replanting – the reference date for initial DAP to be prepared is 15 years after the previous planting on peat (which should be recorded in company records).

limited data and use of conservative default parameters while Tier 2 is more complex requiring collection of significant data. For both Tier approaches, the NDL, ground elevation and peat thickness are required to calculate the depth to NDL. The peat subsidence rate is used as a factor to calculate the 'time-to-NDL' (Fig. 1).

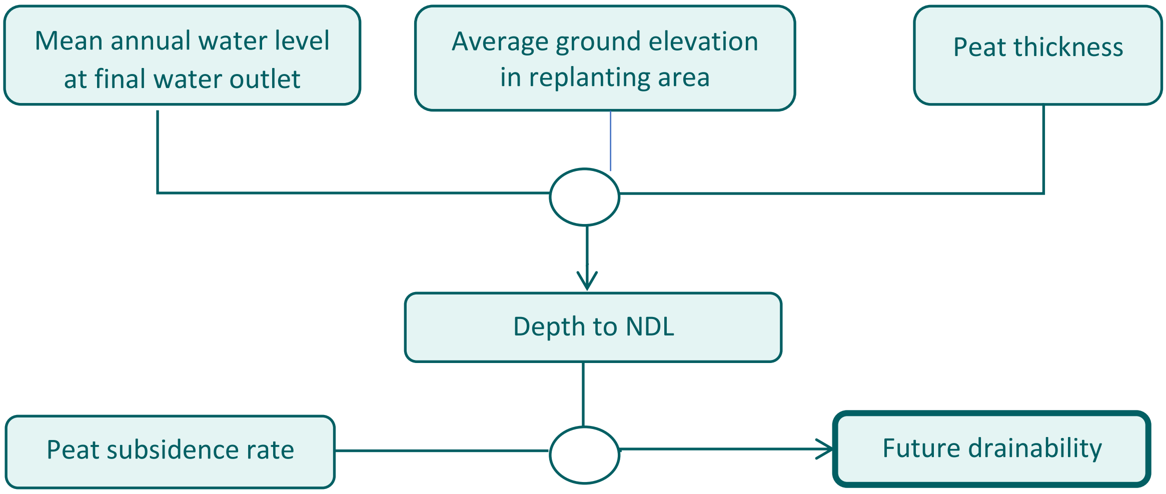

Figure 1: Key elements for future Drainability Assessment

It is up to companies to decide which Tier is most appropriate for them to use. The outcome of the assessment at Tier 2 level has higher precision and confidence, but also requires more resources than that of Tier 1. The outcome of a Tier 1 assessment is a quick and less costly way to determine the allowance for replanting, following RSPO regulations, but this approach is conservative, and therefore a larger caution-range is built in. The details for the Tier 1 and Tier 2 approaches are outlined in the Annexes 1 and 2 respectively. In line with the principle of continuous improvement, a company may undertake an initial assessment at Tier 1 level, but subsequently may gather the data to undertake final assessments at Tier 2 level.

In accordance with Criteria 7.7.5 of the 2018 P&C, the assessment should be conducted at least five years prior to replanting, noting that there is some flexibility on this in the initial period after adoption of the 2018 P&C as specified in Annex 6.

2. Background

2.1 THE DIFFERENT PERSPECTIVES OF DRAINABILITY

There are different ways of looking at drainability. From an agronomic point of view, it is important to maintain high yields and to create a good drainage system, especially in peat. The drainage system must be robust and effective during both dry and wet periods. In other words: the drainability i.e. the ability to drain by gravity alone, must be such that it enables high yields to be obtained, prevents flooding and enables the maintenance of optimum water levels for the crop. From an environmental and economic perspective, an extra dimension comes into the picture: is this drainage viable in the long-term and is this drainage sustainable?

Peatlands emit carbon dioxide (CO_2) when drained contributing to the greenhouse effect and global climate change. Peatlands also subside when they are drained, and in some cases the peatland surface may subside to near or at the NDL. The duration and severity of flooding will increase over time when the peat surface gets closer to the NDL. In the long term, sufficient drainage of a peatland to enable crop production may become a challenge, particularly during wet periods, because drainage by gravity is no longer possible, leading to serious environmental and operational issues such as continuous flooding, saline intrusion, accessibility issues and yield losses.

If assisted drainage in the form of water pumps is applied, increased operational costs will be incurred, possibly to the extent of negative return of investment. In addition, pumped drainage will lead eventually to total loss of the peat layer and permanent flooding when pumping becomes non-viable or the concession period ends. It is therefore critical to stop drainage before reaching a point of no return.

2.2 WHY DRAINABILITY ASSESSMENT

A drainability assessment is conducted to predict the potential lifespan of a plantation planted on peat by estimating the NDL and the expected time that the limit will be reached by taking into consideration the subsidence rate of the assessed area. This differs from determinations of current drainability through field observations and measurements. Current drainability can only be used to help to guide current water and plantation management practices in the plantation, but not predict future risks as required under the RSPO P&C for future planting cycles.

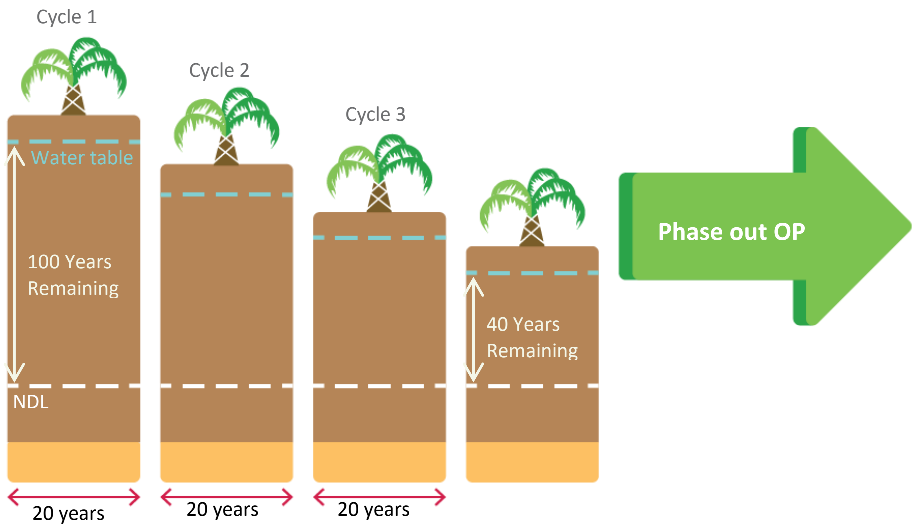

Figure 2: Estimation of the NDL and estimated lifespan left through RSPO Drainability Assessments leads to phasing out of oil palm cultivation 40 years prior to reaching the NDL.

Long before an irreversible stage of land loss is reached, companies should consider these urgent questions: What is the long-term viability of my drainage? Should I replant oil palm considering the long-term drainability perspective? To be able to answer these questions, RSPO requires a Drainability Assessment to be undertaken starting at least 5 years before replanting of the oil palm on peat (refer to Annex 6). The assessment result (see Figure 1) is used to set the timeframe for future replanting, as well as for phasing out of oil palm cultivation at least 40 years, or two crop cycles, whichever is greater, before reaching NDL for peat. When oil palm is phased out, it should be replaced with crops suitable for a higher water table (paludiculture) or rehabilitated with natural vegetation as specified in the RSPO P&C 2018:

> *The assessment result is used to set the time frame for future replanting, as well as for phasing out of oil palm cultivation at least 40 years, or two cycles, whichever is greater, before reaching the natural gravity drainability limit for peat. When oil palm is phased out, it is replaced with crops suitable for a higher water table (paludiculture) or rehabilitated with natural vegetation."*
>
> *-Indicator 7.7.5 (C), P&C 2018-*

2.3 A SAFEGUARD THRESHOLD

It is important to stop drainage before the NDL is reached. The RSPO Drainability Assessment Procedure (DAP) builds in a threshold or safeguard of 40 years, or 1-2 meters above the NDL, because of the seriousness of the medium to long term risks of soil subsidence in peatland areas. Soil subsidence will not stop completely after rewetting, and in the case that the surrounding area is drained there will always be a certain degree of drainage impact.

Global climate change is already happening, and this is leading to sea level rise and increased rainfall events in South East Asia. These two factors combined will increase the impediments to drainage. Therefore, there is a need for an adequate buffer to be included when assessing future drainability. Taking into consideration the future rise of sea levels[2], land that is currently just above the mean sea level is at high risk of becoming unproductive and submerged in the future, even if drainage stops. From a sustainability perspective it is also important to leave a sufficient layer of peat for rehabilitation of vegetation.

This threshold was put in place to ensure that the cultivation of oil palm is phased out before the peatland gets into a situation where it cannot be drained or is permanently flooded. This will then allow other viable alternative use of the land e.g. restoration to peat swamp forest or planting of more water tolerant crops such as sago, jelutong or other paludiculture crops. If this transition is left too long and the site gets frequently flooded, it may be too late to restore or introduce alternative crops.

In addition, the drainability assessment methods are vulnerable to small errors in measurement. For example, water to be drained by gravity needs a slope (along the drainage line) of a minimum of 20 cm per km. This is equivalent to a 1% error in measurement of an elevation of 20m. Errors in measurement of elevation in peatlands, may be up to 5% depending on the methodology. So, there is a high risk of flooding if the plantation still replants to the last possible time, based on measurements that may not be accurate. This could mean that the crop is permanently flooded and cannot be harvested. Having two oil palm crop cycles or 40 years will reduce the risk of this.

2.4 DRAINABILITY ASSESSMENT PROCEDURE (DAP)

This procedure provides guidance on how to assess future drainability. Field observations, mapping and calculations will determine the future drainability. For the future drainability the question that must be answered is: how long will it take for the peat surface to subside to a level equivalent to subsidence during two crop cycles above the NDL (approximately 1-2 meter, depending on the rate of soil subsidence).

[2] Sea levels are predicted to rise by between 0.3-2.5m by the end of the current century (NOAA, 2017)

3. Drainability explained

3.1. DRAINABILITY

Drainability refers to the ability to drain an area by gravity, i.e. drainage without mechanical devices such as pumps. In drained peatlands, the drainability may change over time because the peat soil is continually subsiding. At a certain point in time, the peat surface will subside too close to the NDL. The NDL (see Figure 2) is defined as the level below which it is no longer possible to drain the land by gravity alone. Over time, the peat layer above the NDL may become too shallow to permit replanting.

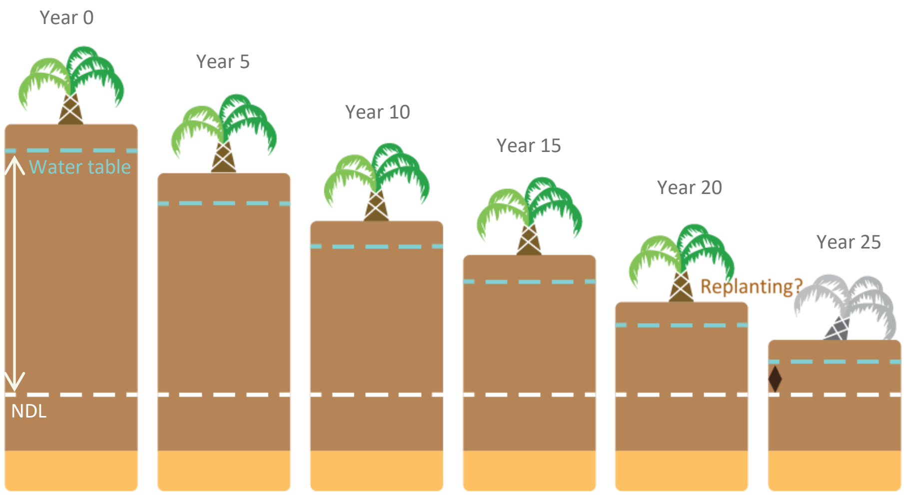

Figure 3: How peat soil subsidence impacts the depth to the NDL.

Figure 3 explains the drainability process over time. In year zero, drainability is good, and the palms grow well. The drainage however causes the peat soil to subside, and over a period of 15 years, the peat surface has subsided (e.g. at a rate of 5 cm per year) closer to the NDL. The drainability may still be good and therefore the plantation does not experience any problems in year 15. Between years 15 and 20 the company starts to consider replanting. The question now is: is the area still suitable for replanting of oil palms? What is the thickness of the peat layer above the NDL? And how many years will it take before problems, such as increasing occurrence and duration of flooding, are experienced?

This procedure provides guidance on how to assess the drainage (based on field observations) and how to determine the time that it takes for the peat surface to subside to a level where the peat surface is 'two crop cycles away' from the NDL. The Two Crop Cycles Threshold (approximately 40 years) is built in to ensure a certain degree of conservativeness which is needed to avoid flood problems timely and to capture tidal influences. Note that plantations will rarely be flooded by sea water, and often not by river water except for relatively narrow riparian zones of a few km. Instead, plantations on peat are usually flooded by rain water that cannot be drained out anymore once subsidence has reduced the peat surface elevation and gradient below critical levels.

3.2. THE NATURAL DRAINAGE LIMIT (NDL)

The NDL inside the plantation is in most cases based on the water level in the closest receiving water body and on the distance to this water body. If the receiving water body is very near, the relation between the water level in the water body and the NDL inside the plantation is strong. If the closest receiving water body is at a further distance, the NDL inside the plantation will be at higher elevation than the water level in the water body. This is because there must be a difference in the water level before the water can flow. A general rule of thumb is that for each kilometre of distance into the plantation, the elevation of the drainage limit increases by 20 cm relative to mean sea level (DID Sarawak, 2001) (Figure 4) i.e. the water profile in the peat soil must have a minimum gradient (slope) of 1 in 5,000 for the water to flow through the peat to the water body. In this procedure, we consider the NDL and we exclude (mechanical) pumping which may create an unnatural NDL in some areas.

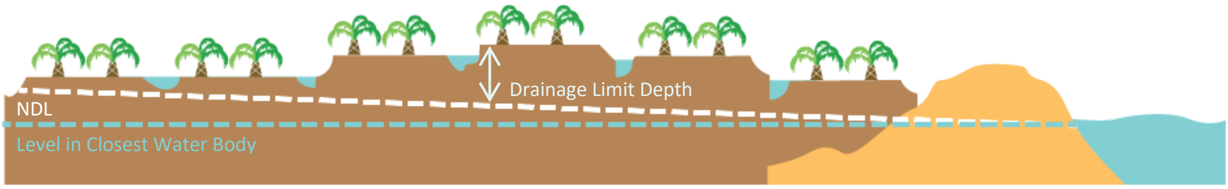

Figure 4: Original condition where oil palm grows well (with NDL – white dashed line – well below the palms)

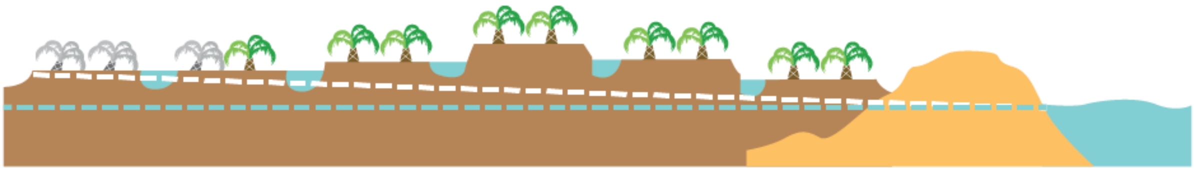

Figure 5: As the soil subsides, occurrence of flooding is witnessed in area closer to NDL

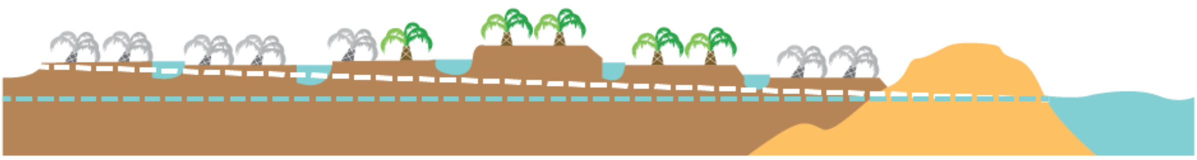

Figure 6: Fate of oil palm at later stage as drainability further decreases

Figure 4, 5 and 6 shows a cross-section through a peat area which is close to a natural receiving water body. The cross-section illustrates the impact of soil subsidence on the drainability of a peatland as shown at three points in time. If the peat surface subsides to near to the NDL, plantation drainability will decrease, there will be extensive flooding during the wet season and palms that have their roots in the water for too long will die. As the frequency and duration of flooding increases the land will become unsuitable for cultivation.

This explains how drainability problems may develop over time. It shows the NDL relative to the average water level in the receiving water body. Plantations located further away from the receiving water body will have a shallower NDL. Although in the early stage (Figure 4) all palms may grow well and there will be no drainage problems, in the later stages (Figures 5 and 6) problems may develop because of peat subsidence. The closer the peat surface subsides to the NDL, the more difficult it will be to maintain gravity drainage from the plantation into the receiving water body and, conversely, to prevent water from entering the plantation at times of high-water level in the receiving water body. Figure 6 shows that in this example more than 50% of the peat surface area has subsided to near the NDL and as a result the palms in these areas will suffer from a water-saturated root environment.

3.3 TIDAL INFLUENCE

For coastal plantations, the ability for water to drain out from an estate is influenced by the tides. During high tide, the raised water level may reduce drainage, while during low tide level, drainage may be enhanced. For the purpose of calculating the NDL in coastal plantations the mean tide level is taken (a detailed explanation is given in Annex 6). Along the coastline of South East Asia, the mean spring tidal range varies between 0.4m along the west coast of Aceh through 3.8m in the Straits of Malacca to 5.4m in the Papua province. This means that the high tide level may be between 0.2 and 2.7m above the Mean Tidal Level. In the Drainability Assessment Procedure, the assumption made is those tidal influences are minimized by leaving a buffer of 40 years or two crop cycles before the plantation subsides to the NDL.

4. Drainability Assessment

It is important to assess the drainability status of a plantation on peat not only before replanting, but also in general. This is to determine whether there will be long-term viability of the drainage in the peatland.

The Drainability Assessment involves a total of 9 main steps as follows:

1. Describe the characteristics of the plantation and proposed replanting area(s).
2. Determine the drainage zone(s) and identify the final water outlet(s)
3. Determine the average ground elevation and calculate the elevation of each peatland replanting area/block (Z_S)
4. Determine the annual mean water level at the final water outlet(s)
5. Measure the peat thickness and calculate the average peat thickness of each peatland replanting area/block
6. Calculate average NDL elevation of each peatland replanting area/block
7. Calculate depth to NDL of each peatland replanting area/block
8. Use the default subsidence rate or calculate the average subsidence rate of each peatland replanting area/block
9. Project the future drainability of peatland replanting area

These are described below:

4.1 STEPS IN DRAINABILITY ASSESSMENT

Step 1. Describe the characteristics of the plantation and proposed replanting area

It is important to describe the key characteristics of the area being assessed under the Drainability Assessment Procedure. This includes preparing a map of the plantation showing:

i) the whole plantation showing rivers, road surrounding the plantation and central coordinates of the replanting area
ii) area proposed for replanting (can be combined with (iii) and (iv)with clear label on the map)
iii) areas planted and not planted with oil palm,
iv) areas with mineral soil and peat areas
v) the existing drainage system/layout
Some basic information on the history of planting should be given in the following table:

Parameter	Data
Total area of plantation, concession or management unit	
Area currently planted with oil palm	
Area not planted with oil palm (including conservation areas)	
Area of mineral soil in the planted area	
Area of peat in the planted area	
Year of first oil palm planting in the overall plantation*	
Central coordinate of the replanting area	
Area of proposed replanting on peat*	
Year of first oil palm planting in proposed replanting area**	
Year of planting of oil palm in current planting cycle in proposed replanting area**	

*Based on the most updated information available

**If there are more than one separate areas of replanting, add additional rows and label the area 1,2,3, etc. corresponding with the map.

Step 2. Determine drainage zone(s) and identify the final water outlet(s)

The main function of a drainage system in a plantation is to manage the ground water table and hence to create the right environment to maximize crop production. The drainage system must be robust and effective during dry periods to maintain optimum water levels for the plant to produce high yields, and during wet periods to prevent water logging and flooding. Typically, in a plantation, the design of the drainage system needs to take into consideration the ground terrain and topography as well as the natural streams and water courses that crisscross the area.

Consider an oil palm plantation consisting of 3 separate replanting division A, B and C. Areas A and B are wholly on peat while area C is on both peat and mineral soil (Figure 7).

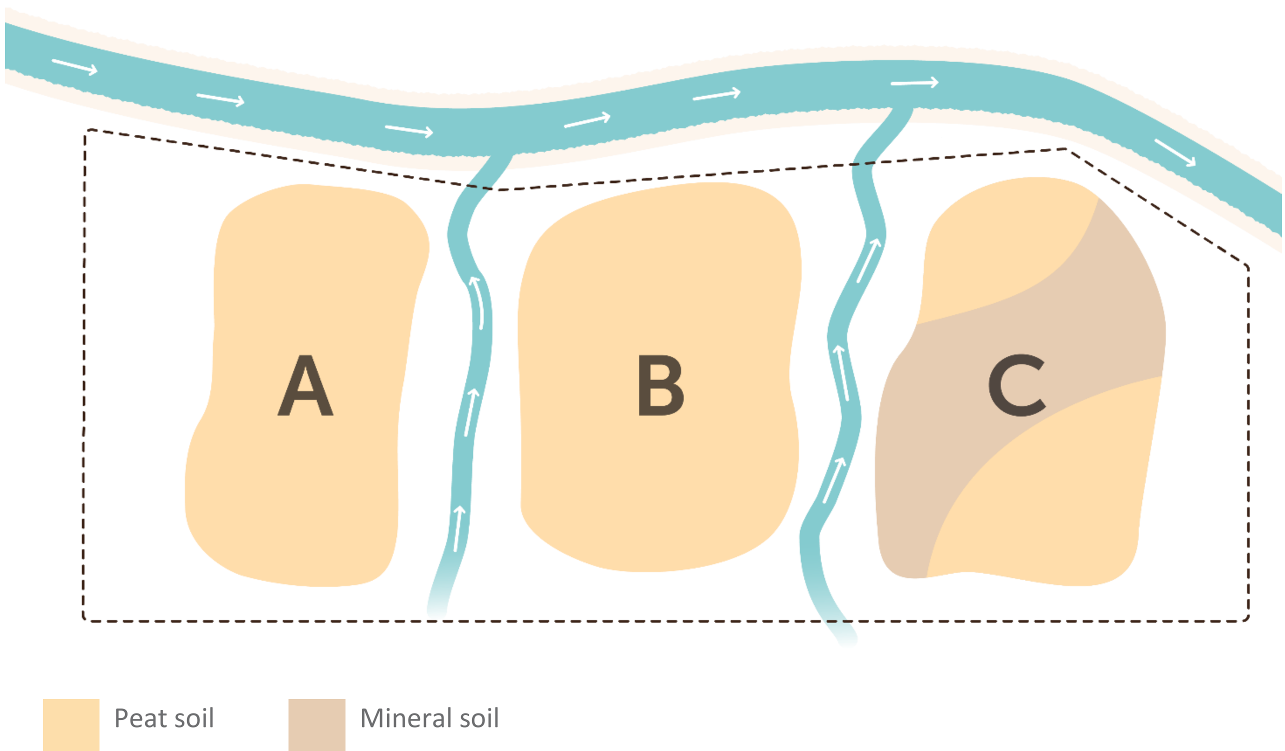

Figure 7: Illustration of an oil palm concession consisting of 3 separate replanting division A, B and C within a plantation. Area A and B are on peat while C is on both peat and mineral soil.

As the areas A, B and C are fairly large, each area is further demarcated into smaller drainage blocks (Figure8).

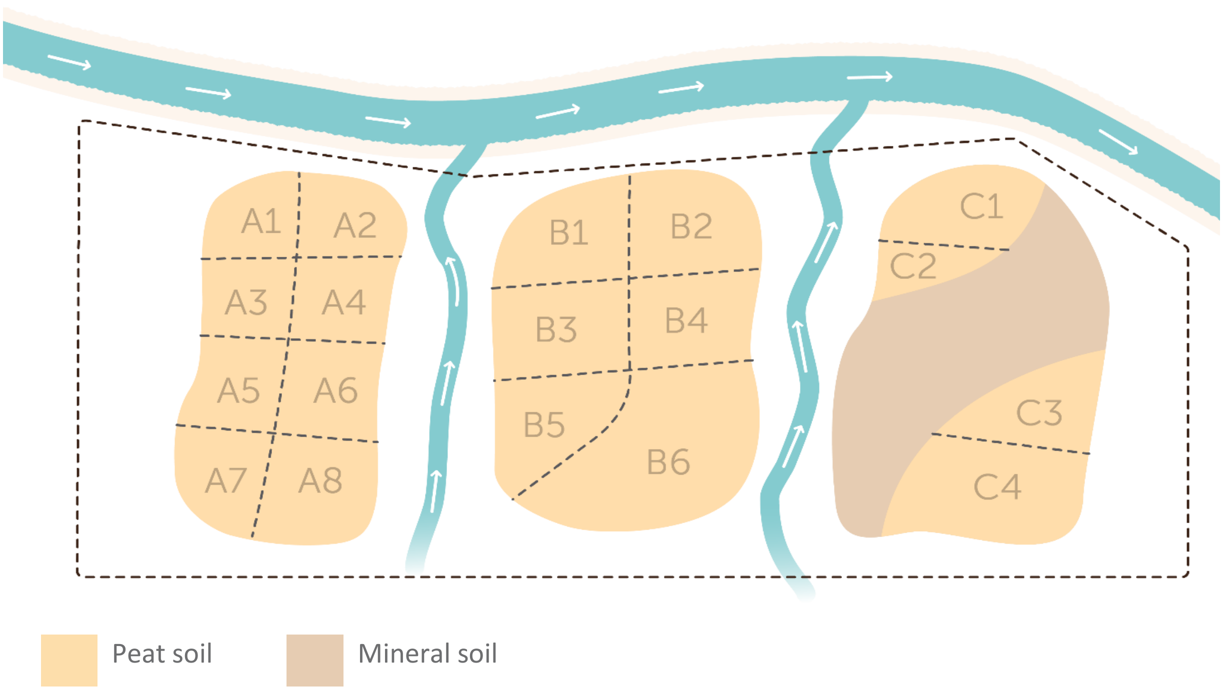

Figure 8: Illustration of oil palm concession showing demarcation of the area into different drainage blocks

Each block has its own internal drainage system which will ultimately discharge into the nearest river through a water gate (final water outlet). The drainage of any one block may be direct to the final water outlet or may have to pass through one or more adjoining blocks before reaching the final water outlet (Figure 9).

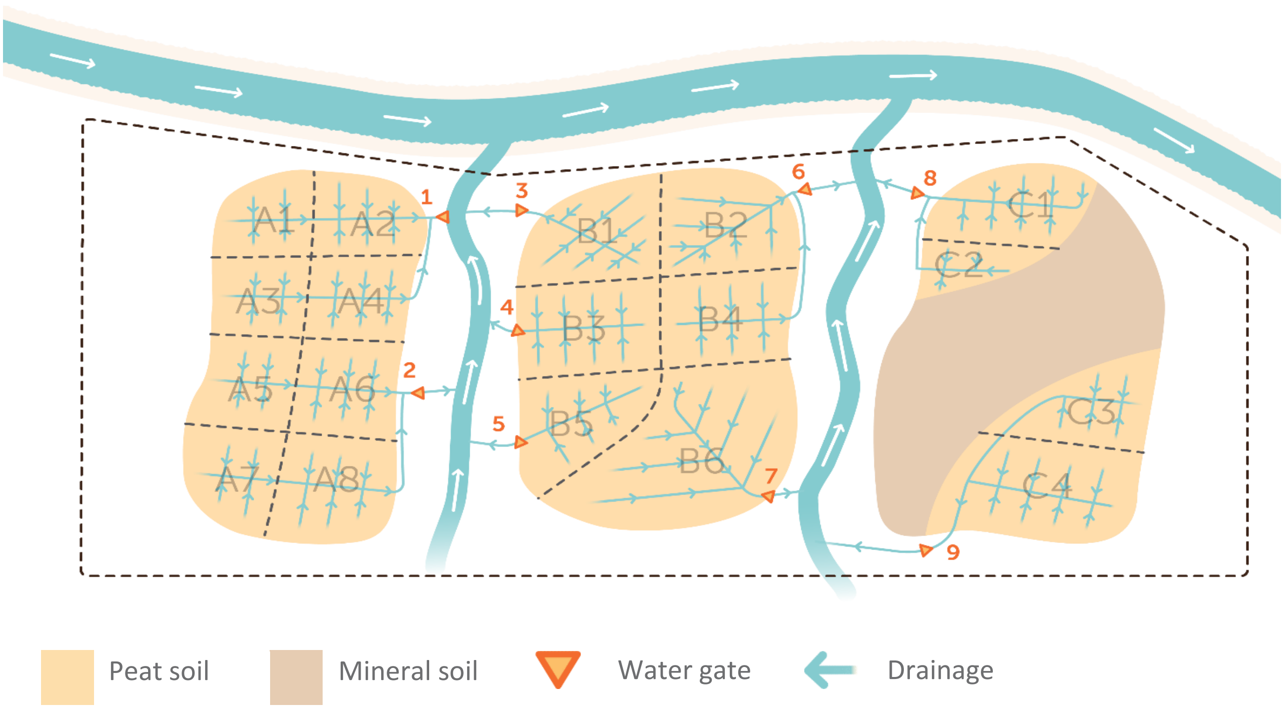

Figure 9: Illustration of an oil palm concession showing the internal drainage system into separate water gates (final water outlet)

The final water outlet is a gated/non-gated water structure located within or at the edge of the plantation area to control the outflow of drainage water from the plantation to a receiving body. For gravity drainage, the final water outlet is generally located at the lowest part of the plantation.

A drainage map should be prepared showing:

i. the drainage zone for the area proposed for replanting showing final water outlet at the plantation boundary that receives water from the proposed replanting area
ii. direction and route of water flow from the proposed replanting area to the water outlet

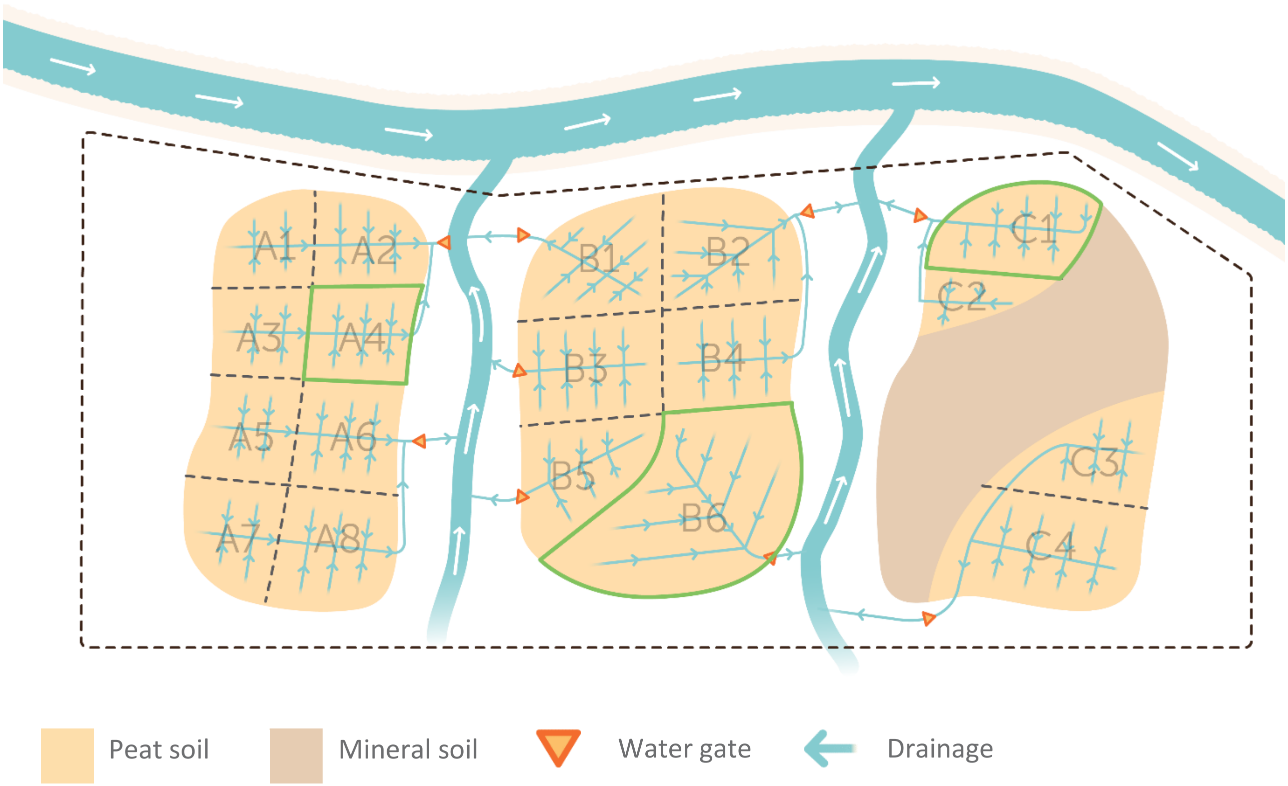

Figure 10: Illustration of an oil palm plantation consisting of 3 separate peatland areas. Replanting is planned to take place in green boundaries.

Based on the mapping and any other information, the final water outlet on the boundary of the plantation that receives water from the proposed replanting area should be identified. If there are more than one replanting areas or the replanting area is large or on a peat dome, then there may be more than one final water outlet linked to the replanting area(s).

A table should also be included as follows in the report

Replanting area (RA)	Coordinates of centre of replanting area	Final water outlet linked to respective replanting area	Coordinates of final water outlet
RA A4		Final Water outlet 1	
RA B6		Final Water outlet 7	
RA C1		Final Water outlet 8	
etc		etc	

Step 3. Determine the average ground elevation and calculate elevation of peatland replanting area/block (ZS)

The average ground elevation of the peatland replanting area/block and final water outlet needs to be determined to a significant degree of accuracy. This can be undertaken by a number of different methods (refer to Annex 1 and 2 for details).

Step 4. Determine the annual mean water level at the final water outlet(s)

The water level elevation to be maintained at the final water outlet is subjected to the water level elevation of the receiving water body (i.e. a river, lake or sea). It is necessary to measure the mean water level elevation based on 12 months of water level measurements of the receiving water body adjacent to the final water outlet.

The average water level at the final water outlet should be determined through regular observation of a Pie-scale or staff gauge installed at the immediate downstream side of the outlet. Such data collection should be carried out for at least 12 months so as to cover the minimum and maximum water level at the outlet. The water level at the outlet will vary seasonally between the wet season and the dry season for inland location and on an hourly basis linked to tidal fluctuations for coastal plantations. For inland plantations, it may be sufficient to measure the water level on a daily basis to determine the monthly average water level, whereas for plantations where the outlet is affected by tidal movements continuous measurements (such as by a data logger) are needed to determine the average level. In addition to the average, it is useful to determine the range of water level fluctuations.

Where credible official records are available, the company may make reference to water elevation measurements from such sources. Such data may be available from flood measuring stations, tide tables or other official records. For such cases, the water level data may be based on a different datum from the datum used to measure the elevation of the plantation and it would be necessary to adjust all the data to a common datum, e.g. mean sea level or to an elevation reference point used for the plantation. The source of data for water elevation must be credible, such as official record, based on river gauging measurements, land survey, etc.

Details of the methodologies for water level measurement are given in Annex 4.

Step 5. Measure the peat thickness and calculate average peat thickness of peatland replanting area/block

Step 5.1. Measure or collate data on peat thickness

Collate existing peat depth measurements or undertake a peat depth survey to gather existing data on the peat thickness. Methodologies for measuring the peat thickness are given in Annex 5**.**

Step 5.2 Develop peat thickness map

Provide a peat thickness map of the peatland replanting area. If the replanting area comprises several blocks/individual peatlands, each block must be delineated as a single entity. The map must be as accurate as possible, with 10 cm vertical resolution or finer. If a peat thickness map is available in raster format, its horizontal resolution must be 100 meters or finer.

Step 5.3 Calculate average peat thickness

If the peat thickness map is in raster format the average value can be calculated based on individual pixel values. If the peat thickness map is in vector format, the average peat thickness can be calculated based on class(area)-weighted values.

Step 6 Calculate average NDL of each peatland replanting area/block

The average NDL of a peatland replanting area/block can be calculated through the following sub-steps:

Step 6.1. Identify/Calculate the centroid(s) of each peatland replanting area/block
This can be manually determined on a map or calculated in a GIS programme.

Step 6.2 Calculate the distance of the area/block to the final water outlet
By using centroid(s) found in sub step a,6.1, measure the distance between the centroid(s) to the final water outlet(s). This can be manually determined on a map or calculated in a GIS programme.

Step 6.3 Calculate the NDL
Calculate the NDL by using the following formula

$$Z_{NDL} = Z_{NWB} + 0.0002 \times \Delta X_{NWB}$$

Where

Z_{NDL} : NDL (m-msl)
Z_{NWB} : Annual mean water level elevation at the final water outlet at the boundary (step 4) (m-msl)
ΔX_{NWB} : Distance between the centroid of the replanting area and the final water outlet at the boundary (step 6.2) (meters)

Step 7. Calculate the depth to NDL of each peatland replanting area/block

The depth to the NDL is the vertical distance between the present land surface to the elevation of the NDL, as illustrated in Figure 10. For both approaches:

$$D_{NDL} = Z_S - Z_{NDL}$$

Where

D_{NDL} : Depth to NDL (cm)
Z_S : Land elevation, i.e., from site DEM (m-msl)
Z_{NDL} : NDL elevation, i.e., from NDL map

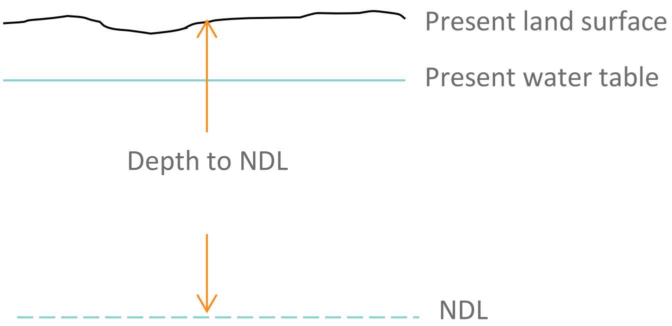

Figure 11: Illustration of positions of land surface, NDL, and depth to NDL

Step 8. Use the default subsidence rate or calculate the average subsidence rate of each peatland replanting area/block

For Tier 1, the calculation of the predicted future subsidence of ground level can be based on a default of 5 cm per year (using the same default estimate of peatland subsidence as used in the RSPO PalmGHG GHG emission calculator)

For Tier 2, the average subsidence rate is based on the observations from a subsidence pole.

Step 9. Project the future drainability of peatland replanting area

The Drainage Limit Time (DLT) is the time required, with continuing subsidence, for the peat surface to subside to the position of the NDL. DLT can be calculated, and can be mapped with raster arithmetic, by the following formula:

$$DLT = \frac{D_{NDL}}{S}$$

Where

DLT	:	Drainage Limit Time (year)
D_{NDL}	:	Depth to NDL (cm)
S	:	Subsidence rate (cm/year)

If the time before the site subsides to the NDL is > 40 years, the area may be replanted whereas if it is ≤ 40 years, replanting is not allowed.

The number of years in the drainage limit time needs to be reduced according to the timing of the Drainage Assessment procedure is undertaken prior to the proposed replanting year.

If the assessment is undertaken 8 years prior to the replanting year – the DLT needs to be reduced by 7 years;

If the assessment is undertaken 5 years prior to the replanting year – the DLT needs to be reduced by 4 years;

4.2 RESULT OF DRAINABILITY ASSESSMENT

4.2.1 Preparing DA Report

The results of the Drainability Assessment should be in the form of a report including details on the site, methodology and data sources used; results of the assessment (in table and map form) and management measures to be introduced based on the results.

The format and order of the Drainability Assessment is detailed in Section 6 of this Procedure.

4.2.2 Submission of the report

The report of the Drainability Assessment should be submitted to the RSPO Secretariat (ghg@rspo.org) as soon as possible after completion and prior to the time of any RSPO audit. The result of the Drainability Assessment may fall into different categories as in Table 2.

Table 2: Categories of assessed areas and implications on replanting

CATEGORY	DESCRIPTION	IMPLICATION
1	The proposed replanting area is in the category of more than 40 years to the NDL	Replanting can take place for one or more 20-year cycle.
2	Part of the proposed replanting area is in the category of 40 years or less to the NDL	The portion of the proposed replanting area with less than 40 years to the NDL should not be replanted. Depending on the size and configuration of this land – the company should decide to go ahead or not with the replanting on the remainder of the land.
3	The proposed replanting area is in the category of 40 years or less to the NDL	No replanting to take place. Decision should be taken on appropriate management strategy – i.e. planting with more water tolerant crops (paludiculture) or rehabilitation to natural peatland ecosystem).
4	When DLT calculation is not applicable because drainage base is below peat depth	The proposed replanting can take place while company commit to follow BMPs

The report will enable the RSPO Secretariat in association with the RSPO PLWG2 to review the experience of undertaking the assessment and make required adjustments (if any) to the Drainability Assessment Procedure. All reports submitted to the RSPO secretariat will be for internal use only and not be made publicly available.

4.2.3 Action to be taken based on results

In line with Indicator 7.7.5 P&C 2018,” *the assessment result is used to set the timeframe for future replanting, as well as for phasing out of oil palm cultivation at least 40 years, or two cycles, whichever is greater, before reaching the natural gravity drainability limit for peat*.”

4.2.4 Options for management of land not suitable for replanting

In line with Indicator 7.7.5 of the RSPO P&C 2018, when oil palm is to be phased out, it should be “replaced with crops suitable for a higher water table (paludiculture) or rehabilitated with natural vegetation”. These options are elaborated below:

a) Alternative Crops

Productive land use on rewetted peatland with crops that are adapted to the high-water levels in peatlands is called ‘paludiculture’. Species cultivated are normally indigenous peat swamp forest species adapted to growing in peat with naturally high-water levels. More than 400 Peat swamp forest (PSF) species have been identified to have productive use (Giesen, 2015). For centuries, local communities have used paludiculture techniques to cultivate crops that are native to peatlands, such as sago (starch for noodles and cookies), rattan (for furniture), gelam (for pole-wood and medicinal oil), jelutong (for latex), tengkawang (illipe nut, for vegetable oil) and purun grass (for thatching and basketry).

Some of these species have been planted at scale – eg Sago and jelutung and there are established markets for these. For other species further work is needed to develop and scale up production and develop markets. This is, however, a necessary investment to sustain productivity of the peatlands. Further information on paludiculture is provided in various references including the RSPO Manual on Best Management Practices for Management and Rehabilitation Of Natural Vegetation Associated With Oil Palm Cultivation On Peat (Parish et al, 2019), Giesen (2013 and 2015) and Giesen and Nirmala (2018).

b) Rehabilitation to natural ecosystem

Peatland which has been taken out of oil palm production can be rehabilitated to forest or other natural ecosystems. Such areas can be rewetted by blocking the drainage canals to bring the water near or at the surface. Indigenous peat swamp forest tree species can be planted in the shade of the remaining palms or directly in areas which have been cleared of palms. It is recommended that in open areas, fast growing secondary forest species such as Mahang (*Macaranga pruinosa*), Gelam (*Melaleuca cajiputi*), Parapat (*Combretocarpus rotundatus*) or Tenggek Burung (Melicope lunu-ankenda) are planted. Further details of appropriate species and techniques are given in the RSPO Manual on Best Management Practices (BMPs) for Management and Rehabilitation of Peatlands (Parish et al, 2019).

4.2.5 Socio-economic and operational considerations

The location and allocation on the land which may be removed from production may influence the strategy for future use of the land.

a) Scheme Smallholder land (Plasma)

For land allocated to Scheme Smallholders (plasma), which cannot be replanted according to the analysis through the DAP, there are several options which may be considered – allocating other land for smallholder (plasma) production; developing a viable paludiculture or alternative crop option for plasma farmers; or providing other forms of compensation.

b) Land adjacent to existing conservation areas versus small fragments

If the peatland which cannot be replanted is adjacent to existing conservation areas, then there would be a good argument for rehabilitating them to enable an expansion of the conservation areas. However, if they are small isolated fragments (less than 10-20 ha), it may not be viable to rehabilitate them to conservation areas and other productive use (e.g., paludiculture) should be considered.

4.2.6 Development of management plan or strategy for the areas not to be replanted

It is important that there is a clear management plan or strategy for all areas which are taken out of production. This could be done by having a separate plan or a section in a revised integrated management and monitoring plan for existing conservation areas. Such plans should specify the rehabilitation or wet production measures that will be undertaken at the site, including the removal of oil palms, blocking of drains, fire prevention and rehabilitation measures as appropriate.

5. Implementing the DAP

5.1 SELECTING TIER LEVEL

The DAP has two levels of detail: Tier 1 or Tier 2. The company must select which is the most appropriate.

The main differences between Tier 1 and Tier 2 are the recommended assessment area, data requirements and level of confidence of the outcome.

Tier 1 approach is recommended only for a contiguous assessment area of less than 250ha so that the assessment results will be more representative. For each separate peat areas delineated for replanting, only an average value is required for NDL, peat thickness and elevation.

For any contiguous assessment area covering more than 250ha, it is recommended to use the Tier 2 approach. For the Tier2 approach, for each sub unit (stratum) within each peatland area delineated for replanting (e.g., a block or group of blocks), an average value is required for NDL, peat thickness, and elevation. For Tier 2 approaches, a company's own data must be used for peat surface subsidence rate, except in cases where not enough data is available (at least 3 years of measurements taken at minimum quarterly basis at enough representative locations), or where data is not sufficiently reliable. In these cases, as well as for tier 1, a default value for peat surface subsidence of 5 cm/year should be used (based on Carlson *et al,* 2015).

Broadly, the degree of detail required for the data at each approach can be described as:

Tier 1 (See Annex 1): Assessment at replanting area level. One centroid data point per delineated discrete (single) peat replanting area/block is needed as input data for elevation and NDL, and a map for distance from the middle of the concession area to the nearest final water outlet is needed. The outcome can be presented in a simple Excel table. For each peatland replanting area, the distance to the NDL will be calculated, as well as the time that it will take to subside to the NDL. For each peatland replanting area, the Drainability Assessment will indicate whether the replanting can take place or not.

The size of the replanting area/block should take into account the topography of the ground. The NDL for the area/block is calculated based on the average ground elevation for the entire area/block. If there is a large difference within the block (e.g. there is a difference of 4 to 5 metres between the highest and the lowest ground elevation within the block) then the margin of error in the value of the NDL will be ± 2 to 2½ metres, which is not acceptable. Hence, the area/block should be further sub-divided until the ground elevation difference within a sub-area/sub-block is not more than 1 metre.

Tier 2 (See Annex 2): Assessment of subsidence stratum-level. A stratum is in this case a discrete unit of land (refer to Figure 12) that has a relatively homogeneous peat surface subsidence rate. This can be a zone (for example along a river), a management block or a group of management blocks. If the project area is not homogeneous in terms of peat surface subsidence, stratification based on soil subsidence measurements could be carried out to improve the accuracy and precision of the assessment. One centroid data point per separated stratum for each delineated replanting peatland is needed as input data for elevation and NDL, besides a map for distance from the middle of each stratum to the relevant water outlet. The outcome can be presented in an Excel table. For each stratum within each delineated replanting peatland, the Drainability Assessment provides a 'go' or 'no-go' for replanting.

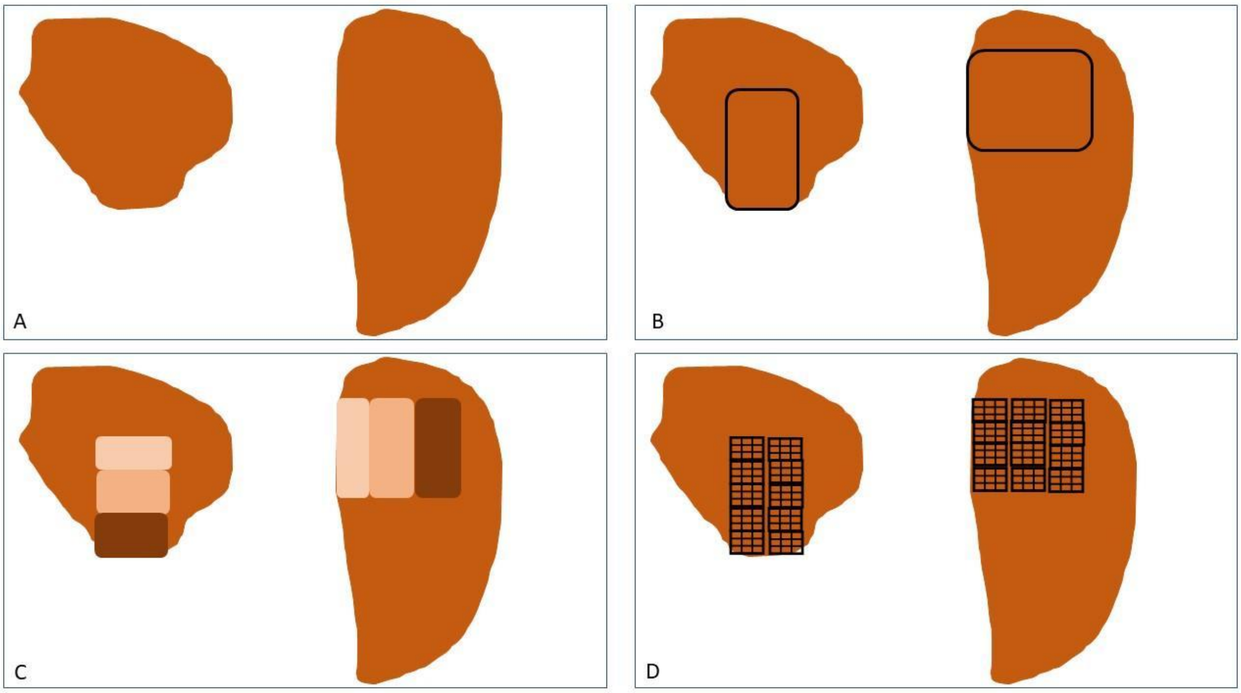

Figure 12: This figure illustrates the delineation of two separate peatlands (A) and the difference in Tier 1 (B), and Tier 2 (C) or (D).

Figure 12-A shows the peatland areas within the concession. Figure 12-B delineates individual replanting areas. If Tier 1 is used, one average value for peat depth, referenced elevation (e.g. above mean sea level), distance to the final water outlet at the plantation boundary and peat surface subsidence rate is required per individual replanting area for calculating the height that the peat surface lies above the NDL (Figure 14). If Tier 2 is used, average values are required to calculate the height of the peat surface above the NDL for each separated homogeneous stratum, e.g. based on peat surface subsidence rate and/or peat type (Figure 12-C) and/or planting blocks (Figure 12-D).

5.2 DISCRETE UNIT OF LAND FOR DRAINABILITY ASSESSMENT

In order to facilitate the maximum economic return of development on peatland area in a sustainable manner, companies are encouraged to adopt the Tier 2 assessment, subdividing the proposed replanting area into smaller land units. For practicality in implementation, the smallest land unit could be defined as the smallest field /block management units (for example, the Manuring or Harvesting Block, which has a smaller land size, approximately 20 to 40 ha).

Due to natural terrain variation, depth to NDL is not uniform and varies across the peatland area. Tier 2 assessment allows more detailed mapping and generates separate outcomes for each land unit. Figure 13 illustrates the benefit of Tier 2 assessments in a replanting area. In the example, the concession area is subdivided into 12 smaller management blocks with one centroid data point per individual block. Several blocks with lower NDL and DLT ≥ 40 years can proceed for replanting, while others cannot. In this example, 50% of the concession could be replanted for the next cycle. Due to the inherent limitation of Tier 1 assessment, where there is only 1 mapping point for the entire large concession on peatland, the company risks phasing out the entire concession from replanting.

Figure 13 Illustrates the results assessment of the Drainage Limit Time (DLT) of peatland areas within the concession.

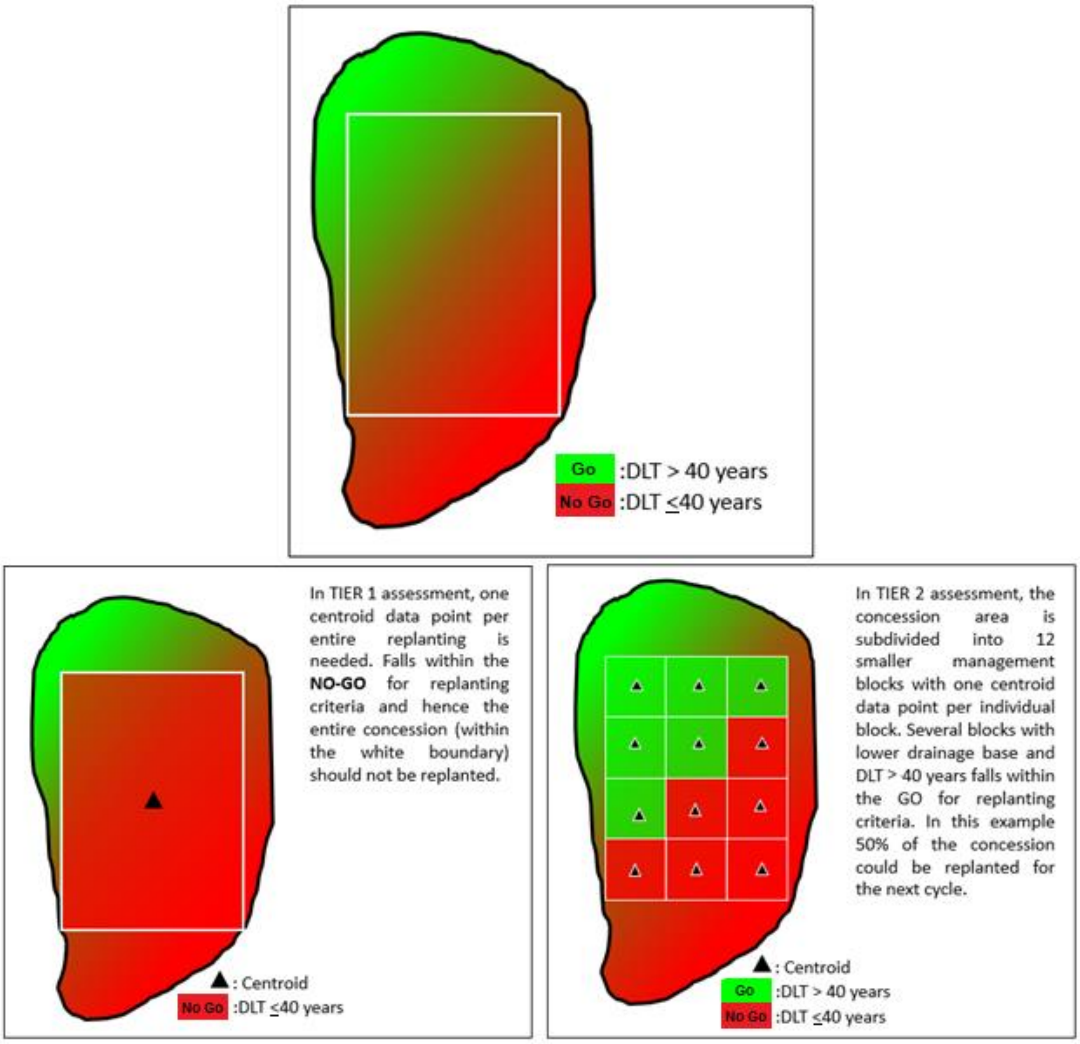

Figure 13: The difference of 'discrete land unit' and the resulting assessment implications between using Tier 1 & Tier 2 assessments.

5.3 BUNDLING OF AREA

In the case where the company has planted on relatively small areas of peat over a number of years, they have the option to bundle the assessments for several years. For example, if a company planted 50ha per year for 5 years in a row – giving a total of 250ha – they would have to undertake a Drainability Assessment in the year that the first plot reached 15 years old and then undertake assessments every year for each of the subsequent 50ha blocks. This repetitive assessment may involve a high cost and significant duplication.

It is therefore permitted that the company can undertake a combined assessment for all the planted areas older than 10 years, provided the assessment is undertaken when the first plot reaches 15 years old. The last year of the bundle replanting year should be no later than five years after the first year.

The company has the right to update the study prior to the actual replanting if there has been a change for example in the average subsidence rate of the site or the company has more accurate data on land elevation.

5.4 EXCEPTIONS TO THE DAP

As mentioned in the introduction, there are a few cases where the DAP does not apply - namely:

a) Where oil palm was originally planted on shallow peat and the peat layer has oxidised and no longer exists, then the area proposed for replanting is no longer classified as peat. In this case, the company needs to write to RSPO to inform them formally of the change in status/classification and provide evidence (such as a survey report by a qualified peat or soil specialist[3]).
b) Where the area proposed for replanting contains only a small contiguous peat area (including the re-planting area and adjacent planted and unplanted areas) which is smaller than 40ha and is surrounded by mineral soil. In this case the company needs to document this and make it available to auditors upon request.
c) Where the NDL as calculated is in the mineral soil layer below the peat layer, or, alternatively stated - if the base of the peat layer (basal contact) is above the NDL. In this case, the peat layer will be lost may disappear completely before reaching an undrainable situation. This can be checked by comparing the peat depth to the distance/depth to the NDL.

The elevation of the base of the peat layer can, for example, be calculated and mapped by overlaying a site Digital Elevation/Terrain Model (DEM) against a peat map, by using simple arithmetic:

$$\text{where } Z_{BC} \text{ is lower than } Z_S - D_P$$

Where

Z_{BC} : Basal contact elevation (m-msl)
Z_S : Land elevation, i.e., from site DEM (m-msl)
D_P : Peat thickness, i.e., from site peat map (m)

In locations with a basal contact above the NDL, drainage and subsidence may continue without the land ever reaching its NDL (i.e., becoming unable to drain by gravity). (Refer to Figure 10).

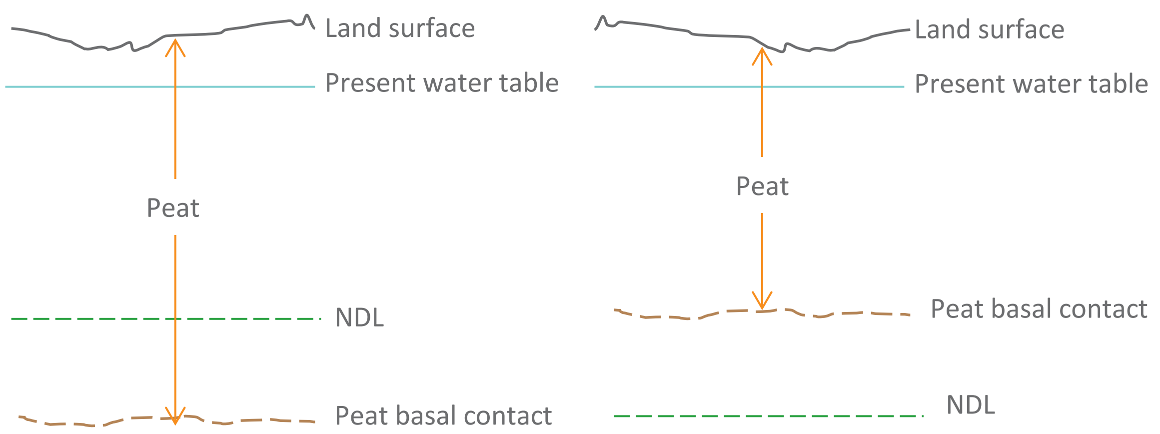

Figure 14: Illustration of vertical profile of peat soils showing relative positions of peat basal contacts against NDLs: basal contact below NDL (Drainability Assessment fully applies) (left) and basal contact above the NDL (phase-out of plantation following Drainability Assessment does not apply) (right).

However, it should be noted that some countries apply regulations related to peat basal contact drainage or exposure of the underlying mineral soil in certain conditions. For example, in Indonesia, wherever the mineral subsoil beneath the peat layer contains quartz sand or acidic clay (categorised as Potential Acid Sulphate Soil, PASS) basal contact exposure or drainage is prohibited. From the same perspective, other

[3] Someone with relevant credentials/recognised degree

regulations render drainage of acidic clay as damaging to the environment. In addition, if the NDL is just below (e.g., less than 50cm) the peat basal contact, then the future drainage of the land may be difficult.

6. Submission checklist for RSPO Drainability Assessment (DA)

Guidance:

- Users are required to indicate 'Yes' or 'NA' under the column labelled as 'Included in report' to confirm that respective information is made available in the report submitted or otherwise.
- This checklist must be submitted as part of the DA report during submission to the RSPO Secretariat.

1. Report descriptions	**Included in report (Yes or NA)**
Company name	
Plantation/Estate name	
Date of report	
Details of DA Assessor (for both in-house and external consultant) *Assessor's and company's name*	
Version of DAP referred (Version 1 or Version 2)	
Date of conducting the assessment	

2. Site descriptions	**Included in report (Yes or NA)**
Hectarage of OP plantation	
Hectarage of OP plantation on peat	
First year of planting *Please provide specific years if there are differences in the first year of planting*	
Current cycle of planting *Please provide specific cycle if there are differences in the current cycle of planting*	
Proposed replanting year	
Location of plantation with maps *Please include clear demarcation of where replanting is proposed*	
Descriptions of peatland/landscape *Please include soil type and extent of its presence in the area proposed for replanting.*	

3. Full description of assessment process	**Included in report (Yes or NA)**
Clearly state if RSPO (Tier1/Tier 2) approach was applied	
Average elevation (metres above sea level) of replanting sites *Please include details of methodology and related accuracy used to measure elevation. If elevation is referenced to a government benchmark or other survey marker, the location and details need to be included in the report including how the relative elevation of the plantation was measured*	
Average peat depth *Please ensure inclusion of details of methodology used to measure average peat depth*	
Distance from centroid to the discharge point to nearest water body (metres) *Please include method and explain rationale for the selection of nearest water body*	

Average water level elevation at the discharge point for the proposed replanting area (metres above mean sea level) *Please include the method carried out to determine this value and include data in annex*	
NDL elevation *Please include method used*	
Depth from peat surface to NDL or peat base *Please include the method used to obtain depth to NDL*	
Subsidence rate (default value of 5 cm/year for **Tier 1 only**) or (default value or actual value for **Tier 2 only**) *Please include the number of subsidence poles, frequency of measurement and period of subsidence monitoring and add annex with subsidence data*	
Table showing DLT (years) for each replanting area/block	

4. Maps (with coordinate) and photo evidence to be placed in the relevant section of report	Included in report (Yes or NA)
Location map of the estate showing the replanting area and the outlet with coordinates	
Map showing 'No Replanting Indicator (NRI)' (Go if DLT>40 years or two cycles, whichever is longer, or No-go if DL is less or equal to 40 years or two cycles, whichever is longer)	
Map showing replanting area and/or Non replanting area based on DA analysis	
Map showing main outlet/s from the estate and direction/route of water flow from the proposed replanting area (s) to the outlet	
Map showing drainage network and water outlet of the replanting area	
Map showing distance from centroid of each replanting block to nearest water bodies	
Map/table showing peat thickness	
Map showing location of subsidence poles	
Photo of subsidence pole (periodic ie annual reading if available)	
Photo of measurement pole at final discharge outlet	

5. Conclusion from Drainability Assessment	Included in report (Yes or NA)
Conclusion stating area proposed for replanting or non-replanting based on the assessment.	
(if needed) Proposed management measures for areas proposed not to be replanted.	

(Add company's name here) hereby confirms that all necessary information has been provided for the purpose of conducting a DA review:

Signed:
Name of Person-in-charge:
Date:
Contact details (email and number):

7. Changes to Approved DA report

The following describes the requirements related to any future changes to the approved DA report

1) Changes to the proposed replanting year

If the company later decides to change the proposed planting year, a notification should be submitted to RSPO Secretariat (refer Annex 10) prior to the proposed planting year. This notification will include the new adjusted DLT/NRI based on the new replanting year. The delay in the replanting should be not more than 5 years from date of the first replanting in the assessment report.

This report will be verified by the Secretariat.

2) Revision of the report

A company retains the right to revise and resubmit its DA report, up to 12 months prior to the proposed replanting year. This updated report could include new information on peat surface subsidence rate, DEM, water level at the outlet and peat thickness.

This report will go through a full review.

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ANNEX 1. TIER 1 APPROACH FOR DRAINABILITY LIMIT ASSESSMENT METHOD

This Annex is an integral part of the Drainability Assessment document, and is intended as a step-by-step guidance for Future Drainability Limit Assessment and reporting of oil palm plantations on peatland. The main principles of the assessment have been given in the main document and will not be repeated in this guidance.

Future Drainability Assessment under the Tier 1 approach follows the main principles of AARD & LAWOO (1992) drainability classification as presented by Ritzema (2002), with a few simplifications. The AARD & LAWOO classification is based on distance to the nearest water body, tidal range and water level fluctuation, and also the position of basal contact (peat base) relative to NDL. In RSPO Tier 1 DAP, the future drainability does not take into consideration the tidal range and water level fluctuation of the receiving water body but instead takes only the average water level at the water outlet of the plantation as the reference.

I. PROCEDURE SUMMARY

The Tier 1 approach can be summarised into 9 steps that are further described in the following sections:

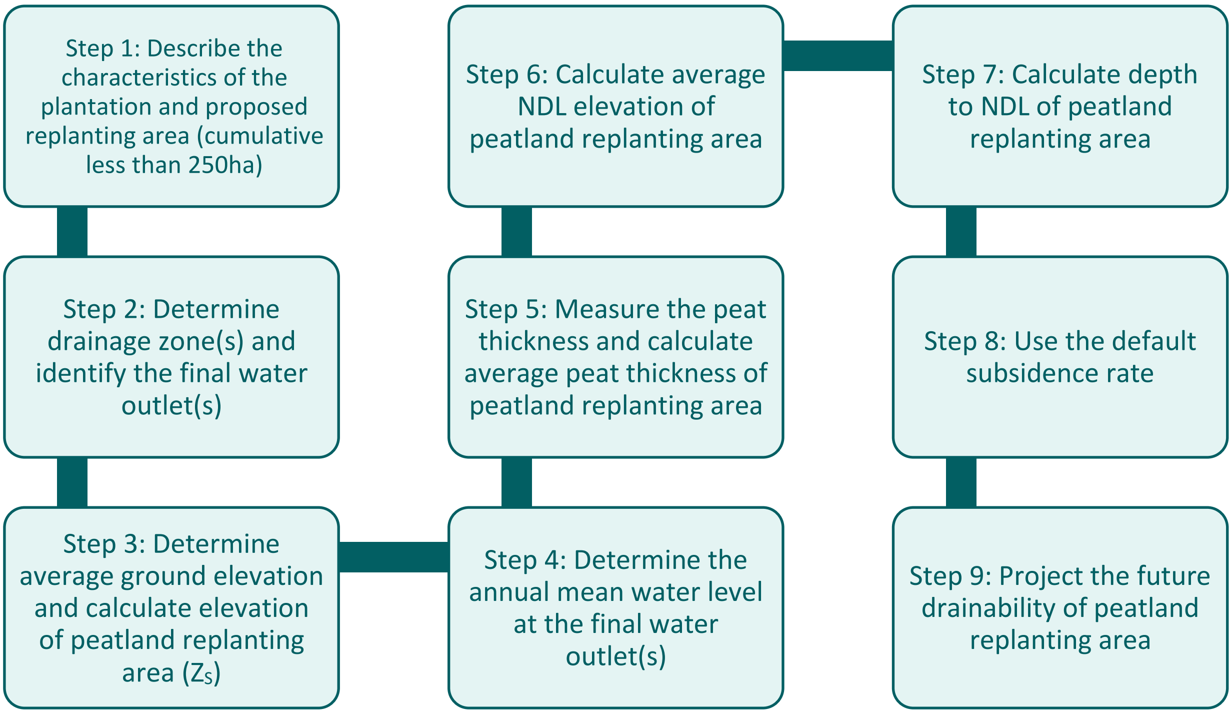

Figure A1.1: Future Drainability Assessment flow chart for Tier 1 approach

II. ASSESSMENT PROCEDURE

Step 1 Describe the characteristics of the plantation and proposed replanting area

It is important to describe the key characteristics of the area being assessed under the Drainability Assessment Procedure. This includes preparing a map of the plantation showing

i) the whole plantation showing rivers, road surrounding the plantation and central coordinates of the replanting area
ii) area proposed for replanting (can be combined with (iii) and (iv) with clear label on the map)
iii) areas planted and not planted with oil palm,
iv) areas with mineral soil and peat areas
v) the existing drainage system/layout

Some basic information on the history of planting should be collated as given in the following table:

PARAMETER	DATA
Total area of plantation, concession or management unit	
Area currently planted with oil palm	
Area not planted with oil palm (including conservation areas)	
Area of mineral soil in the planted area	
Area of peat in the planted area	
Year of first oil palm planting in the overall plantation*	
Central coordinate of the replanting area	
Area of proposed replanting on peat*	
Year of first oil palm planting in proposed replanting area**	
Year of planting of oil palm in current planting cycle in proposed replanting area**	

*Based on the most updated information available

***If there are more than one separate areas of replanting, add additional rows and label the area 1,2,3, etc. corresponding with the map.*

Step 2 Determine drainage zone(s) and identify the final water outlet(s)

The main function of a drainage system in a plantation is to manage the ground water table and hence to create the right environment to maximise crop production. The drainage system must be robust and effective during dry periods to maintain optimum water levels for the plant to produce high yields, and during wet periods to prevent waterlogging and flooding. Typically, in a plantation, the design of the drainage system needs to take into consideration the ground terrain and topography as well as the natural streams and water courses that crisscross the area.

Consider an oil palm plantation consisting of 3 separate replanting division A, B and C. Areas A and B are wholly on peat while area C is on both peat and mineral soil (Figure A1.2).

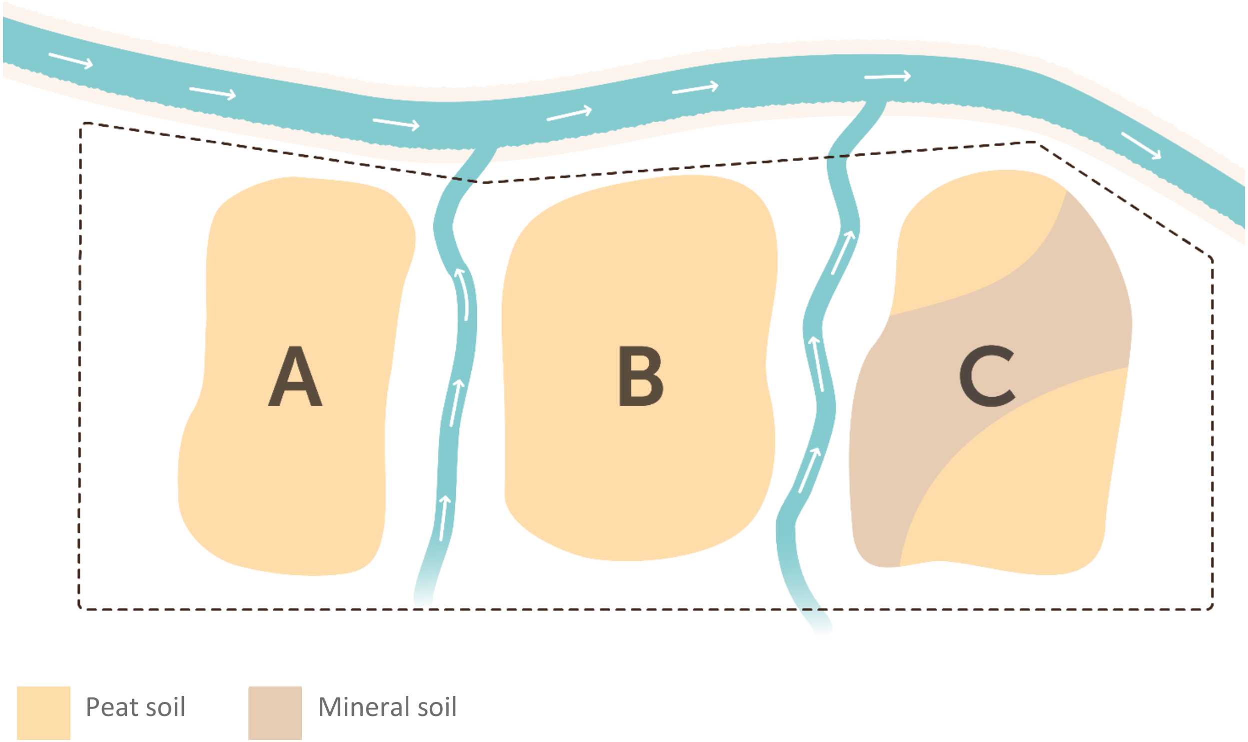

Figure A1.2: Illustration of an oil palm concession consisting of 3 separate replanting division A, B and C within a plantation. Area A and B are on peat while C is on both peat and mineral soil.

As the areas A, B and C are fairly large, each area is further demarcated into smaller drainage blocks (Figure A1.3).

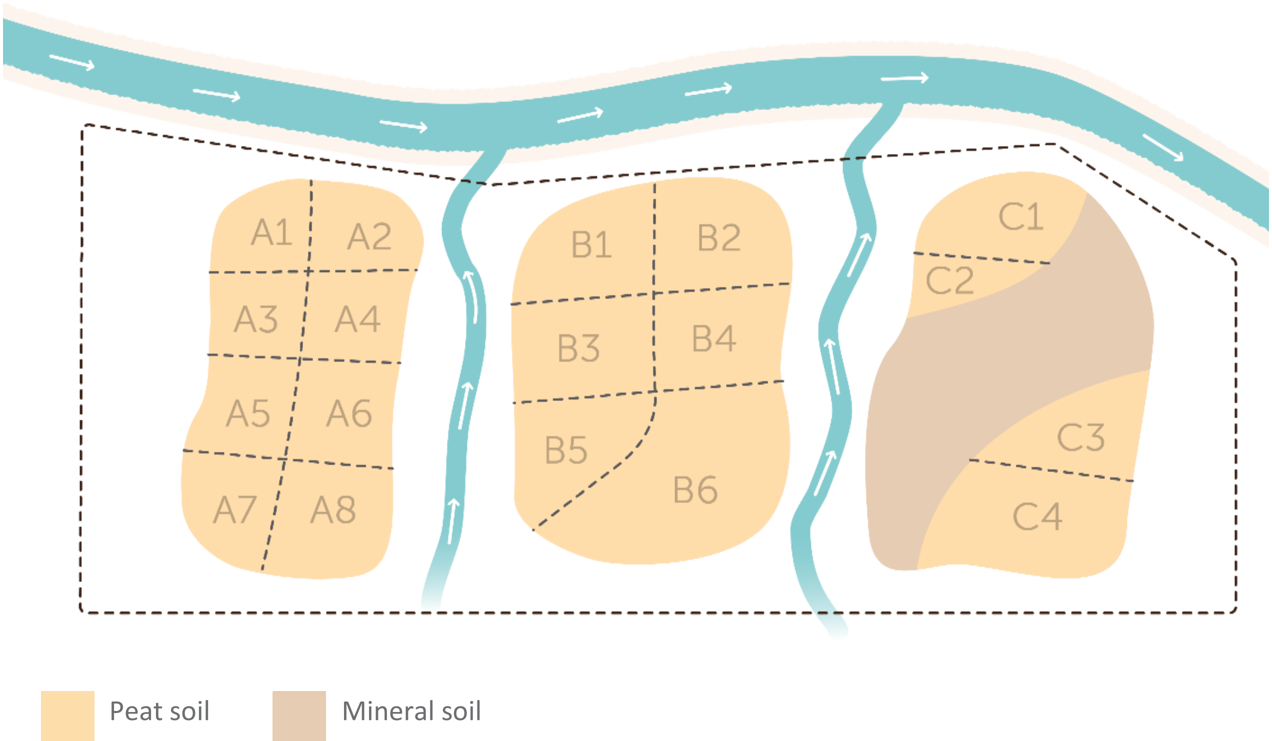

Figure A1.3: Illustration of oil palm concession showing demarcation of the area into different drainage blocks

Each block has its own internal drainage system which will ultimately discharge into the nearest river through a water gate (final water outlet). The drainage of any one block may be direct to the final water outlet or may have to pass through one or more adjoining blocks before reaching the final water outlet (Figure 1.4).

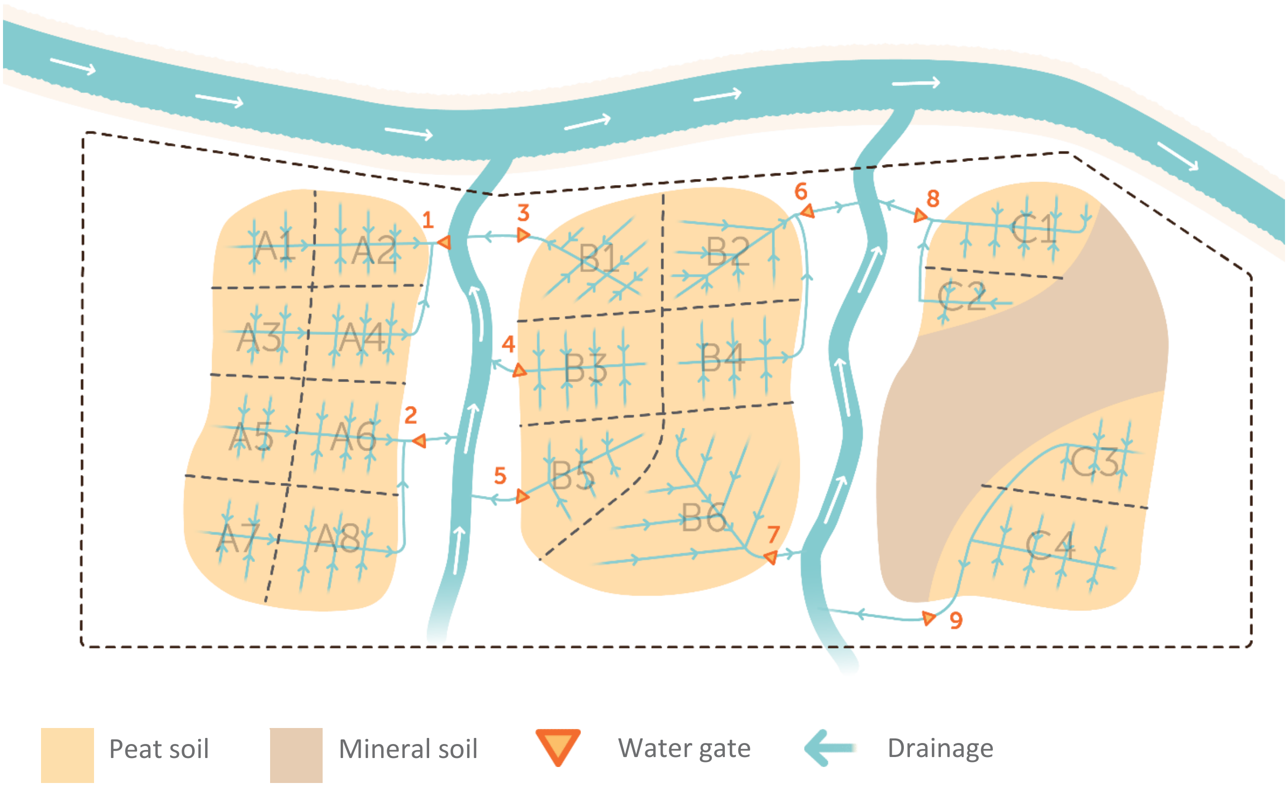

Figure A1.4: Illustration of an oil palm concession showing the internal drainage system into separate water gates (final water outlet)

The final water outlet is a gated/non-gated water structure located within or at the edge of the planted area to control the outflow of drainage water from the plantation to a receiving body. For gravity drainage, the final water outlet is generally located at the lowest part of the plantation.

Drainage map

A drainage map should be prepared showing

i) The drainage zone for the area proposed for replanting showing final water outlet at the plantation boundary that receives water from the proposed replanting area

ii) Direction and route of water flow from the proposed replanting area to the water outlet.

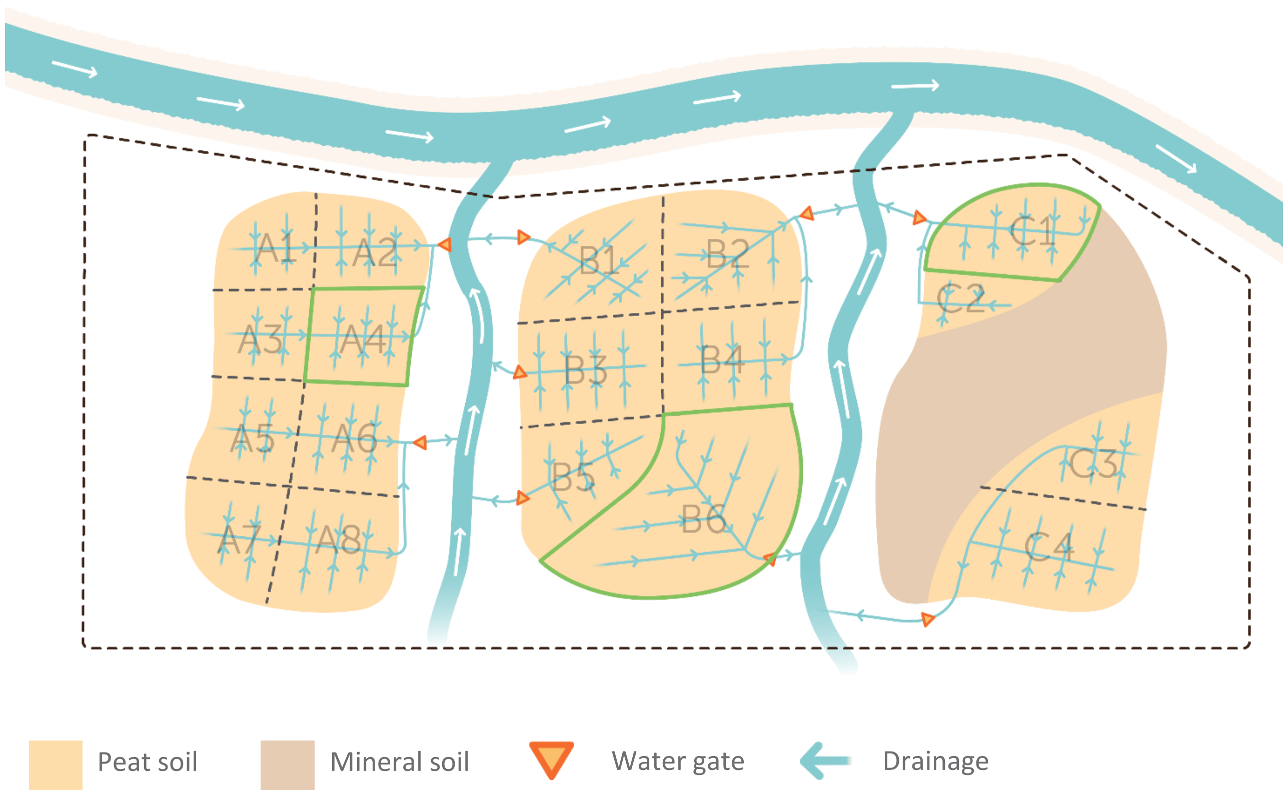

Figure A1.5: Illustration of an oil palm plantation consisting of 3 separate peatland areas. Replanting is planned to take place in red boundaries, but peatland replanting area consists only of areas in green boundaries.

Based on the mapping and any other information the final water outlet on the boundary of the plantation that receives water from the proposed replanting area should be identified. If there are more than one replanting area/block or the replanting area is large or on a peat dome, then there may be more than one final water outlet linked to the replanting area(s)/block(s).

A table should also be included in the report as follows:

Replanting area (RA)	Coordinates of centre of replanting area	Final water outlet linked to respective replanting area	Coordinates of final water outlet
RA A4		Final Water outlet 1	
RA B6		Final Water outlet 7	
RA C1		Final Water outlet 8	
etc		etc	

Step 3. Determine average ground elevation and calculate elevation of each peatland replanting area/block (Z_S)

Step 3.1 Undertake a survey to determine the elevation of the replanting area

The average ground elevation of the peatland replanting area and final water outlet needs to be determined to a significant degree of accuracy. This can be undertaken by a number of different methods which can measure elevation with a cumulative error of less than 50 centimetres (± 25 centimetres) accuracy, including:

a) auto levelling,
b) simple transparent U-hose,
c) optical water pass / Dumpy level / Builder's level
d) theodolite survey
e) Drone survey
f) LIDAR mapping
g) RTK (Real Time Kinetic) differential GPS
h) PP (Post Processed) differential GPS

Whatever method is used, a baseline reference point is required for the determination of the absolute elevation of the peat terrain elevation or development of digital terrain model[4]. Through these techniques, the average elevation of the replanting area of the sub-strata of the planting area can be determined.

Further details of these methods are described in Annex 5.

Unsuitable methods

A number of available methods for determining elevation have been determined as not suitable for use with the DAP as follows:

a) Elevation determined through freely available online global Digital Elevation Models (DEMs) such as ALOS World 3D-30 m (AW3D30), (2) the Shuttle Radar Topography Mission 1 Arc-Second C-Band Global DEM (SRTM 1)[5] and (3) the Advanced Spaceborne Thermal Emission and Reflection Global DEM Version 2 (ASTER GDEM 2) have errors in vertical accuracy of 5-15m[6,7]. In addition, many of these systems measure the elevation of the vegetation canopy and not of the soil surface – giving elevations which are significantly higher than the actual peat surface. Although some adjustments and corrections can be made – overall these tools don't generate the accuracy needed for the DAP.
b) Google Earth derives its data from some of the sources listed in a) as well as national data sets when available. These also will not be sufficiently accurate for the DAP.
c) Topographic maps are also unsuitable to determine the elevation as these normally only have contour intervals of 10-20 m which is too coarse for use with the DAP. In addition, they will normally have been prepared based on surveys in the past and will not take into account subsidence after clearance and development on peat.
d) Normal hand-held GPS devices have a vertical accuracy of ± 3-5m which is not sufficiently accurate for DAP.

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[4] In Tier 1 assessments it may be sufficient to determine the relative elevations of the replanting area and the final water outlet, but for Tier 2 the absolute elevations must be determined.

[5] Ref: https://www2.jpl.nasa.gov/srtm/

[6] Bayik Caglar, K. Becek, C. Mekik & M. Ozendi (2018) On the vertical accuracy of the ALOS world 3D-30m digital elevation model, Remote Sensing Letters, 9:6, 607-615, DOI: 10.1080/2150704X.2018.1453174

[7] Loudi Yap, Ludovic Houetchak Kandé, Robert Nouayou, Joseph Kamguia, Nasser Abdou Ngouh & Marie Brigitte Makuate (2019) Vertical accuracy evaluation of freely available latest high-resolution (30 m) global digital elevation models over Cameroon (Central Africa) with GPS/levelling ground control points., International Journal of Digital Earth, 12:5, 500-524, DOI: 10.1080/17538947.2018.1458163

Step 3.2. Develop or provide a Land Elevation Map or Digital Terrain Model

A Digital Elevation Model [8](DEM, raster) or Land Elevation Map (LEM, vector) of the peatland replanting area should be prepared based on the surveys in step 3.1. Alternatively, such maps may already be available from previous surveys. If the replanting area comprises several parts/individual peatlands, each part must be presented as a single entity. The Land Elevation Map or DEM should preferably be referenced to standard datum (mean sea level) and can be obtained and/or processed from various sources such as: LIDAR, photogrammetry, drones or (previous) direct land survey(s). The land elevation map needs to show the land elevation of the replanting area in relation to the elevation of the average water level at the final water outlet (step 4) If land survey(s) are conducted, the final drainage outlet to the nearest water body can be used as initial (starting point) for the elevation measurement.

The DEM or LEM must be up-to-date at the time of assessment. If the map date is more than a year old, the elevation values of the map must be updated by accounting for subsidence of the peatland over the same period.

For assessment areas smaller than 250ha a land levelling survey can be considered for determination of elevation of the replanting block and outlet water level.

Step 3.3. Calculate average elevation of peatland replanting area

If using DEM (raster format), the average value can be calculated based on individual pixel values. If using LEM (vector) the average land elevation of peatland replanting area can be calculated based on class (area)-weighted values of the LEM.

Step 4. Determine the annual mean water level at the final water outlet(s)

The water level elevation to be maintained at the final water outlet is subjected to the water level elevation of the receiving water body (i.e. a river, lake or sea). It is necessary to measure the mean water level elevation based on 12 months of water level measurements of the receiving water body adjacent to the final water outlet.

The average water level at the final water outlet should be determined through regular observation of a Pie-scale or staff gauge installed at the immediate downstream side of the outlet. Such data collection should be carried out for at least 12 months so as to cover the minimum and maximum water level at the outlet. The water level at the outlet will vary seasonally between the wet season and the dry season for inland location and on an hourly basis linked to tidal fluctuations for coastal plantations. For inland plantations, it may be sufficient to measure the water level on a daily basis to determine the monthly average water level, whereas for plantations where the outlet is affected by tidal movements continuous measurements (such as by a data logger) are needed to determine the average level. In addition to the average, it is useful to determine the range of water level fluctuations.

Where credible official records are available, the company may make reference to water elevation measurements from such sources. Such data may be available from flood measuring stations, tide tables or other official records. For such cases, the water level data may be based on a different datum from the datum used to measure the elevation of the plantation and it would be necessary to adjust all the data to a common datum, e.g. mean sea level or to an elevation reference point used for the plantation. The source of data for water elevation must be credible, such as official record, based on river gauging measurements, land survey, etc.

Details of the methodologies for water level measurement are given in Annex 4.

[8] It is essential that the maps show the elevation of the surface of the peat (i.e., Digital Terrain Model). It should be noted that many available maps which may have been prepared by remote sensing may show the elevation of the top of the vegetation (i.e., oil palm or forest in earlier times) rather than the soil.

Step 5. Measure the peat thickness and calculate average peat thickness of peatland replanting area/block

Step 5.1. Measure or collate data on peat thickness
Collate existing peat depth measurements or undertake a peat depth survey to gather existing data on the peat thickness. Methodologies for measuring the peat thickness are given in Annex 5.

Step 5.2 Develop peat thickness map
Provide a peat thickness map of the peatland replanting area. If the replanting area comprises several parts/individual peatlands, each part must be delineated as a single entity. The map must be as accurate as possible, with 10 cm vertical resolution or finer. If a peat thickness map is available in raster format, its horizontal resolution must be 100 metres or finer.

The peat thickness must be up to date at the time of assessment and created from peat thickness samples that meet the following requirements: at least 30 percent of the samples are obtained not more than 1 year prior to the time of assessment and the oldest samples are not more than 3 years (calculated from the year the Drainability Assessment is done). If the above requirements cannot be met, the peat thickness values of the map must be updated by accounting for subsidence taking place between the map date (year) and the assessment date (year).

Step 5.3 Calculate average peat thickness
If the peat thickness map is in raster format, the average value can be calculated based on individual pixel values. If the peat thickness map is in vector format, average peat thickness can be calculated based on class(area)-weighted values.

Step 6. Calculation of the average NDL elevation of each peatland replanting area/block

The average NDL of a peatland replanting area/block can be calculated through the following sub-steps:

Step 6.1. Identify or Calculate centroid(s) of peatland replanting area

This can be manually determined on a map or calculated in a GIS programme. The boundary of the peatland replanting area must be clearly defined (delineated). If the peatland replanting area comprises several parts/individual peatlands, each part must be delineated as a single entity. The delineation MUST ONLY COVER THE REPLANTING AREA ON PEATLAND (see also illustration on Figure A1.6). The centroid coordinate(s) of the peatland replanting area(s) is calculated as average Longitude (X) and Latitude (Y) of boundary(s) vertices.

When using ArcGIS, the centroid coordinate can be calculated by using Calculate Geometry in Attribute Table Contextual Operation (Right Click).

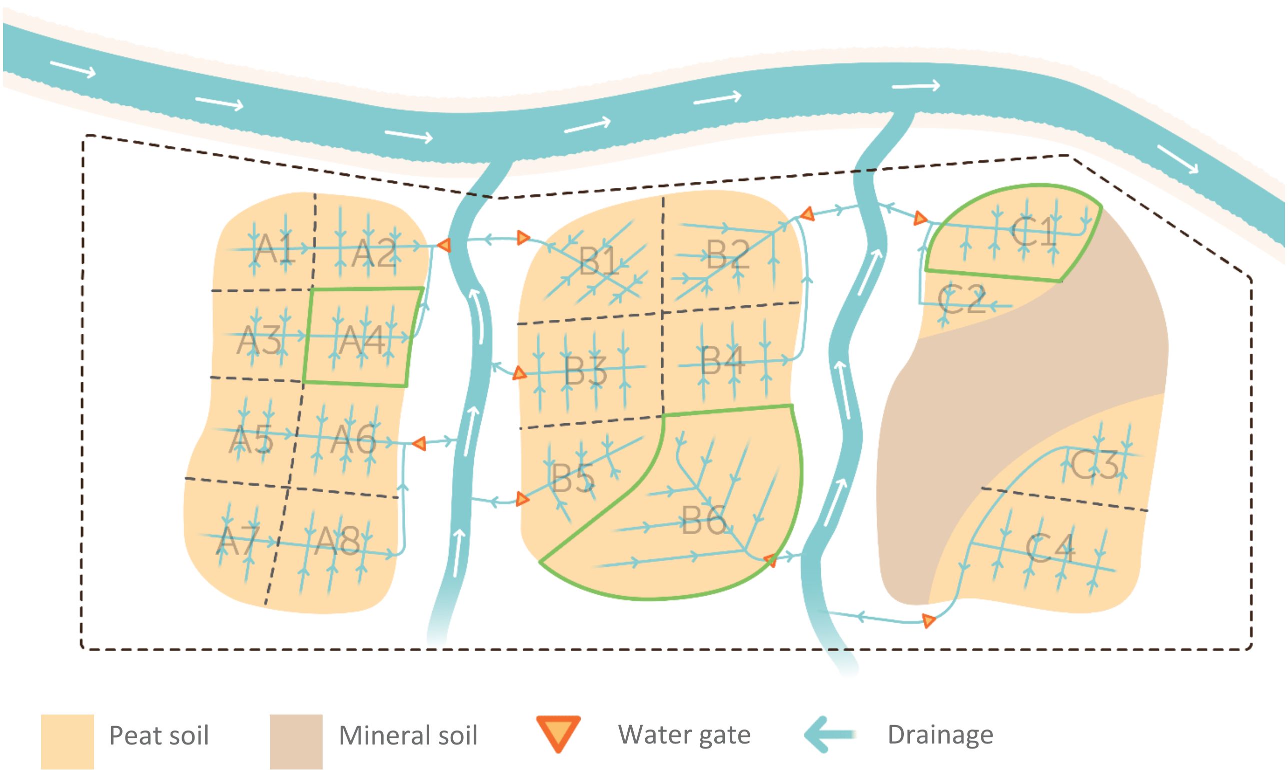


Figure A1.6: Illustration of an oil palm concession consisting of 3 separate peatland areas. Replanting is planned to take place in green boundaries.

Step 6.2 Calculate distance to the final water outlet

By using centroid(s) found in sub step 6.1, measure the distance between the centroid(s) to the final water outlet(s). This can be manually determined on a map or calculated in a GIS programme

Step 6.3 Calculate the NDL

Calculate the NDL by using the following formula:

$$Z_{NDL} = Z_{NWB} + 0.0002 \times \Delta X_{NWB}$$

Where

Z_{NDL} : NDL (m-msl)

Z_{NWB} : Annual mean water level elevation (step 4) (m-msl)

ΔX_{NWB} : Distance between the centroid of the replanting area and the final water outlet at the boundary (step 6.2) (metres)

Step 7: Calculate the depth to NDL of the peatland replanting area/block

Step 7.1. Provide NDL(s) of the peatland replanting area(s) (results from Step 6 above)

Step 7.2. Provide average land elevation(s) of the peatland replanting area(s) (results from Section 3 above)

Step 7.3. Calculate depth to NDL of the peatland replanting area(s) by using the following formula:

$$D_{NDL} = Z_s - Z_{NDL}$$

Where

D_{NDL} : Depth to NDL (m)

Z_s : Average land elevation, from Step 3 (m-msl)

Z_{NDL} : NDL, found in from step 6 (m-msl)

Step 8. Use the default subsidence rate

For Tier 1 approach, the default subsidence rate of 5 cm/y must be used as the average subsidence rate of the peatland replanting area.

Step 9. Project the future drainability of the peatland replanting area

A. Calculate DLT

Step 9.1. Provide average Peat Thickness as obtained in Step 5.

Step 9.2. Provide Depth to NDL (D_{NDL}) as obtained in Step 6.

Step 9.3. Use Default subsidence rate value (S) as defined in Step 8.

Step 9.4. Compare average peat thickness found in Step 9.1 against the representative depth to NDL found in Step 9.2.

If the depth of the peat is greater or equal to the depth to NDL, proceed to step 9.5.

If the depth of the peat is less than the depth to NDL – then the NDL is in the mineral soil below the peat – the DLT does not need to be calculated.

Step 9.5. Calculate DLT by using the following formula:

$$DLT = \frac{D_{NDL}}{S}$$

Where

DLT : Drainage Limit Time (year)

D_{NDL} : Depth to NDL, found in Step 9.2 (cm)

D_p : Peat Thickness, found in Step 9.3 (cm)

S : Annual subsidence rate (Default value = 5 cm/year)

The number of years in the DLT needs to be reduced according to timing when the assessment procedure is undertaken prior to the proposed replanting year:

- If the assessment is undertaken 8 years prior to the replanting year – the DLT needs to be reduced by 7 years;
- If the assessment is undertaken 5 years prior to the replanting year – the DLT needs to be reduced by 4 years;
- If the assessment is **repeated** 1 year prior to the replanting year – then DLT is as calculated (no changes).

Example:

In Figure A1.5 and Table A1.1, DLTs of three peatland areas were calculated

Table A1.1: Table of illustrative data for Figure A1.5 containing basic information on average peat thickness, representative depth to NDL, average subsidence and calculated DLT of concessions consisting of 3 separate peatland areas.

Peatland replanting area	Proposed replanting year	Average peat thickness (D_P) (meters)	Depth to NDL (D_{NDL}) (meters)	Average subsidence rate (S) (cm/year)	Initial DLT (years)	Adjustments (Projected replanting year - assessment year*. Exclude the replanting year)	Final DLT (Initial DLT - Adjustments)	NRI (Final DLT - 40) (years)
A	2025	4.5	2.7	5	54	3	51	11
B	2027	5.2	3.34	5	66.8	5	61.8	21.8
C	2030	3.8	1.3	5	26	8	18	-22

*Assuming assessment year is 2021for this example

B. No Replanting (no-go) Indicator (NRI)

For Tier 1 approach, a No Replanting Indicator (NRI) map is not required, since a single value (for a single unit of peatland) or a table (for multi-unit peatland) is sufficient. The NRI value can be evaluated by simply subtracting DLT value(s) by 2 crop cycle periods (40 years).

NRI = DLT - 2 x crop cycle period (2 x 20 = 40 years)

If NRI > 0, threshold has not yet been reached. If NRI is zero or a negative number, that means the two-crop cycle threshold has been reached and **NO** replanting is allowed on the corresponding peatland.

From Table A1.1, it is apparent that NRI has been reached in peatland areas C, because the calculated DLT is less than 40 years.

In the case that a plantation on peat has been using planting cycles of longer than 20 years in the past or plans to do so in the future – then the NRI should be calculated using 2x the average crop cycle length. If the crop cycle is 25 years, then:

NRI = DLT - 2 x crop cycle period (2 x 25 = 50 years)

This Annex is an integral part of the Drainability Assessment Procedure, and is intended as a step-by-step guidance for future Drainability Limit Assessment with regards to the replanting of oil palm plantations on peatland. The main principles of the assessment have been given in the main document and will not be repeated in this Annex.

Future Drainability Assessment under the Tier 2 approach follows the main principles of AARD & LAWOO (1992) drainability classification as presented by Ritzema (2002), with a few simplifications. The AARD & LAWOO classification is based on distance to nearest water body, tidal range and water level fluctuation, and also the position of basal contact (peat base) relative to NDL. In RSPO Tier 2 DAP, the future drainability does not take into consideration the tidal range and water level fluctuation of the receiving water body but instead takes only the average water level at the water outlet of the plantation as the reference.

I. PROCEDURE SUMMARY

The Tier 2 approach can be summarised into 9 steps that are further described in the following sections:

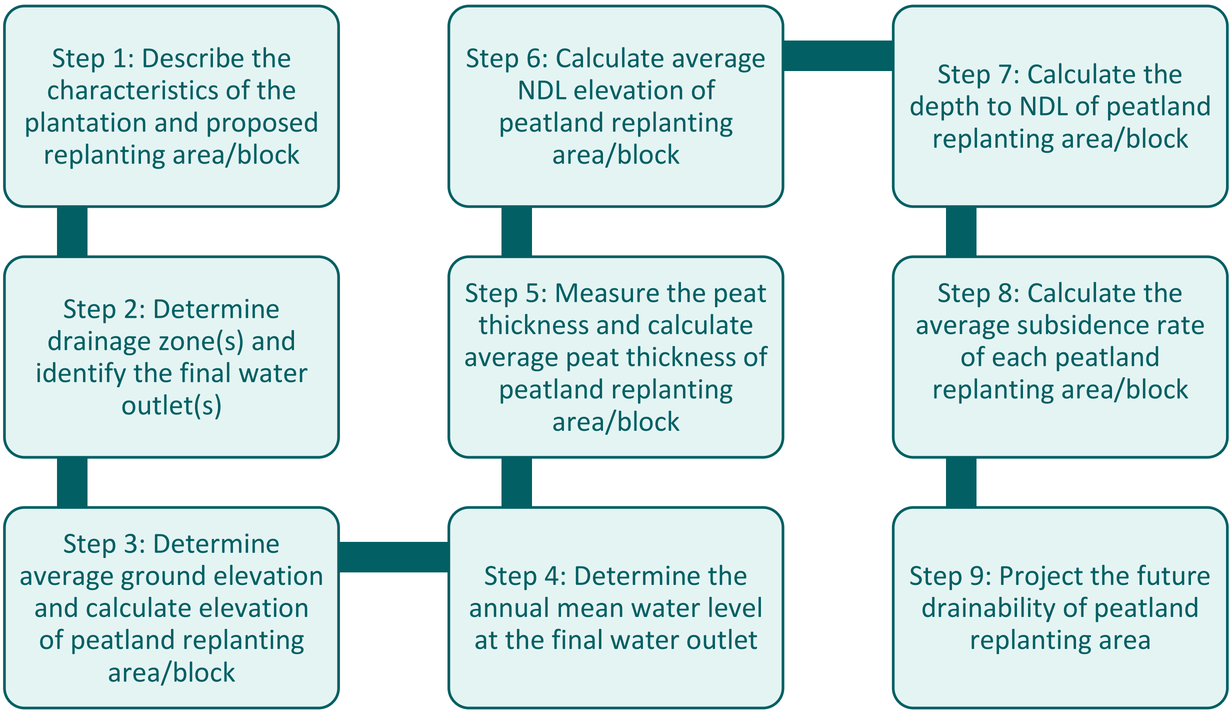


Figure A2.1: Future Drainability Assessment flow chart for Tier 2 approach

II. ASSESSMENT PROCEDURE

Step 1. Describe the characteristics of the plantation and proposed replanting area

It is important to describe the key characteristics of the area being assessed under the Drainability Assessment Procedure. This includes preparing a map of the plantation showing:

i) the whole plantation showing rivers, road surrounding the plantation and central coordinates of the replanting area
ii) area proposed for replanting (can be combined with (iii) and (iv)with clear label on the map)

iii) areas planted and not planted with oil palm,
iv) areas with mineral soil and peat areas
v) the existing drainage system/layout

Some basic information on the history of planting should be collated as given in the following table:

PARAMETER	DATA
Total area of plantation, concession or management unit	
Area currently planted with oil palm	
Area not planted with oil palm (including conservation areas)	
Area of mineral soil in the planted area	
Area of peat in the planted area	
Year of first oil palm planting in the overall plantation*	
Central coordinate of the replanting area	
Area of proposed replanting on peat*	
Year of first oil palm planting in proposed replanting area**	
Year of planting of oil palm in current planting cycle in proposed replanting area**	

*Based on the most updated information available

***If there are more than one separate areas of replanting, add additional rows and label the area 1,2,3, etc. corresponding with the map.*

Step 2 Determine drainage zone(s) and identify the final water outlet(s)

The main function of a drainage system in a plantation is to manage the ground water table and hence to create the right environment to maximize crop production. The drainage system must be robust and effective during dry periods to maintain optimum water levels for the plant to produce high yields, and during wet periods to prevent waterlogging and flooding. Typically, in a plantation, the design of the drainage system needs to take into consideration the ground terrain and topography as well as the natural streams and water courses that crisscross the area.

Consider an oil palm plantation consisting of 3 separate replanting division A, B and C. Areas A and B are wholly on peat while area C is on both peat and mineral soil (Figure A2.2).

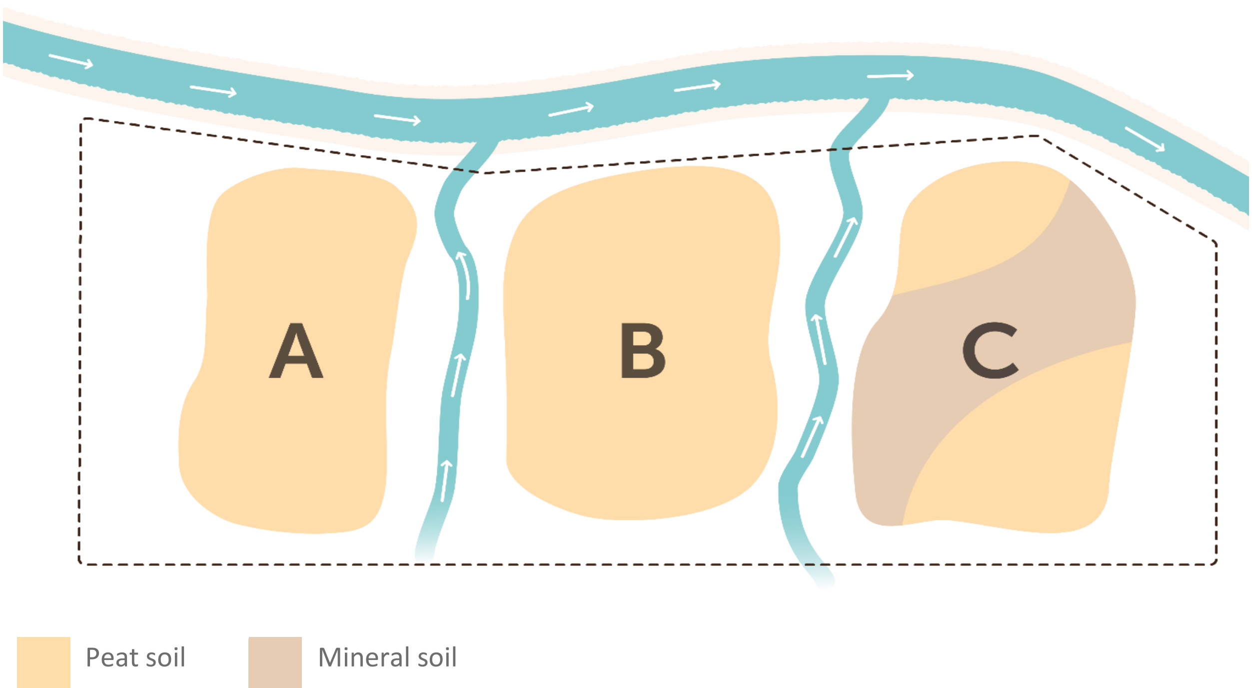


Figure A2.2: Illustration of an oil palm concession consisting of 3 separate replanting divisions A, B and C within a plantation. Area A and B are on peat while C is on both peat and mineral soil.

As the areas A, B and C are fairly large, each area is further demarcated into smaller drainage blocks (Figure A2.3).

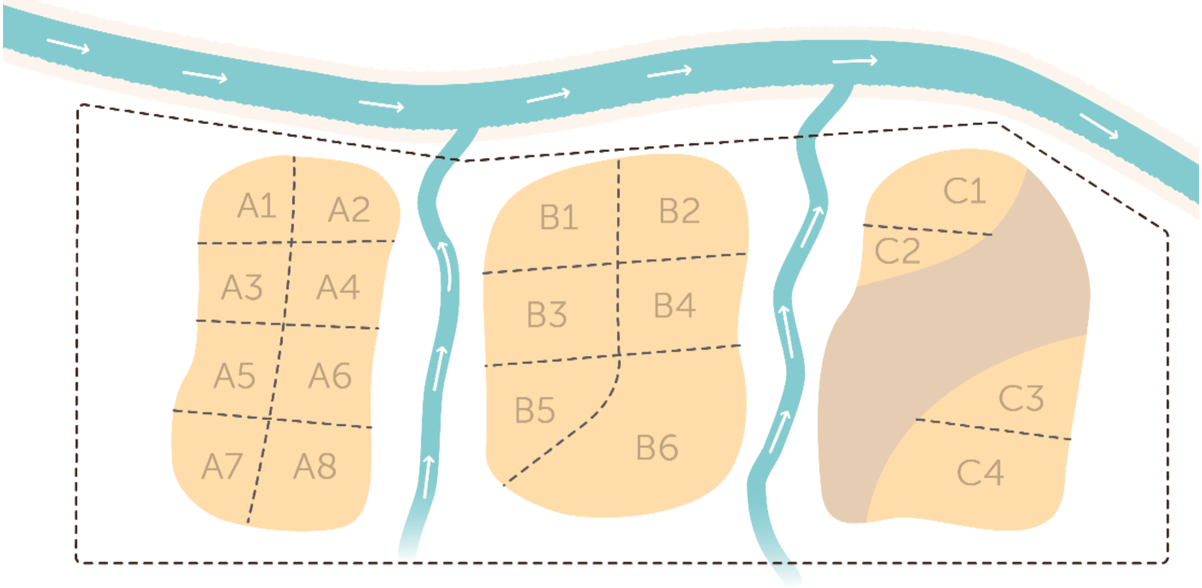


Figure A2.3: Illustration of oil palm concession showing demarcation of the area into different drainage blocks

Each block has its own internal drainage system which will ultimately discharge into the nearest river through a water gate (final water outlet). The drainage of any one block may be direct to the final water outlet or may have to pass through one or more adjoining blocks before reaching the final water outlet (Figure A2.4).

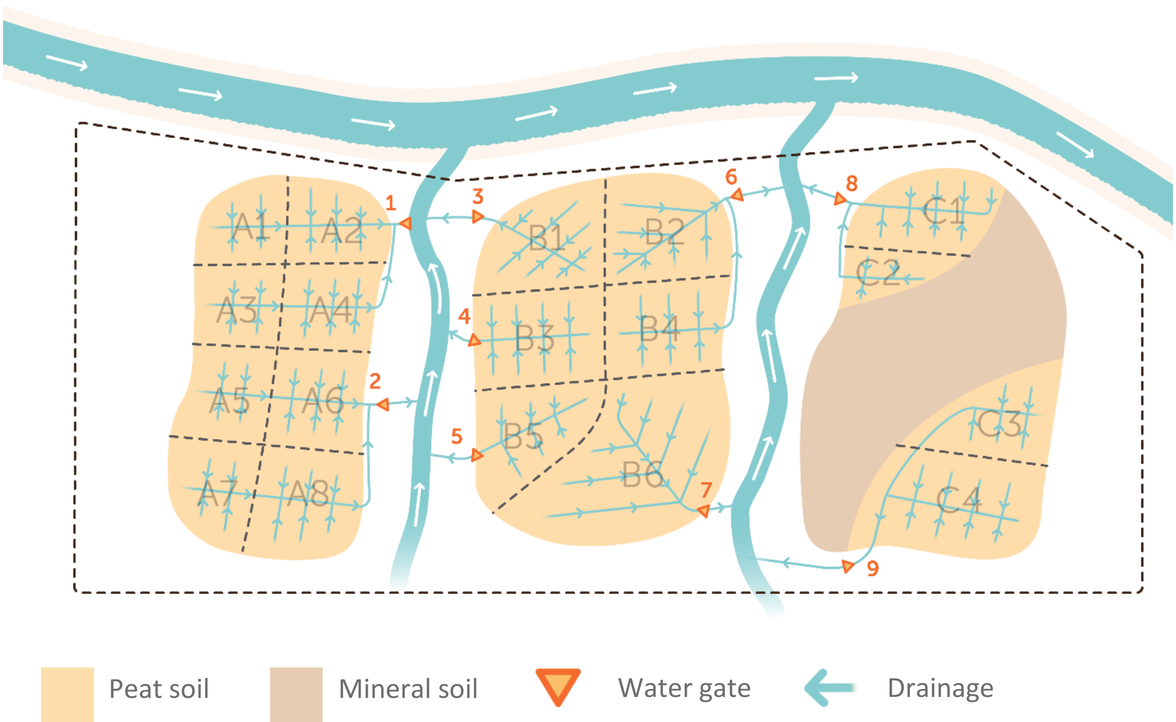


Figure A2.4: Illustration of an oil palm concession showing the internal drainage system into separate water gates (final water outlet)

The final water outlet is a gated/non-gated water structure located within or at the edge of the planted area to control the outflow of drainage water from the plantation to a receiving body. For gravity drainage, the final water outlet is generally located at the lowest part of the plantation.

Drainage map

A drainage map should be prepared showing

i) The drainage zone for the area proposed for replanting showing final water outlet at the plantation boundary that receives water from the proposed replanting area.

ii) Direction and route of water flow from the proposed replanting area to the water outlet.

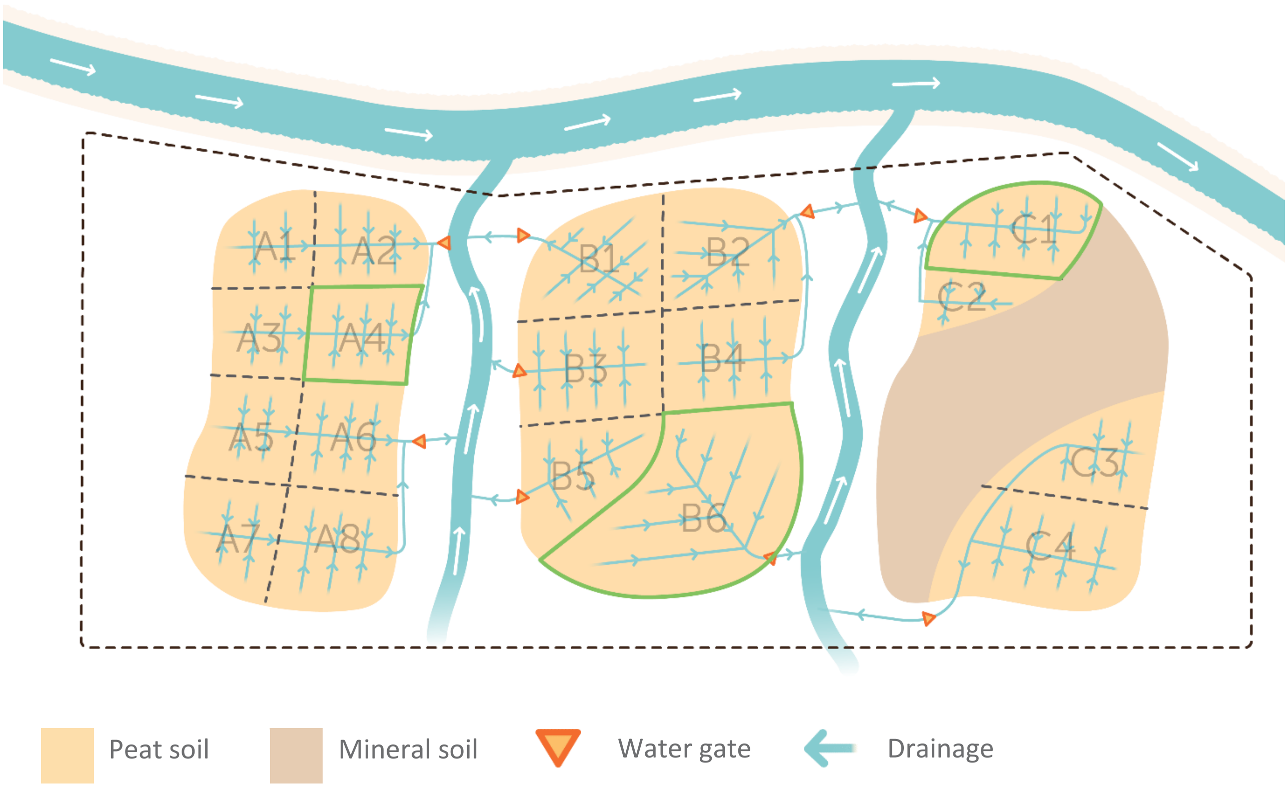


Figure A2.5: Illustration of an oil palm plantation consisting of 3 separate peatland areas. Replanting is planned to take place in green boundaries.

Based on the mapping and any other information the final water outlet on the boundary of the plantation that receives water from the proposed replanting area should be identified. If there are more than one replanting areas or if the replanting area is large or on a peat dome, then there may be more than one final water outlet linked to the replanting area(s).

A table should also be included in the report as follows:

REPLANTING AREA (RA)	COORDINATES OF CENTRE OF REPLANTING AREA	FINAL WATER OUTLET LINKED TO RESPECTIVE REPLANTING AREA	COORDINATES OF FINAL WATER OUTLET
RA A4		Final Water outlet 1	
RA B6		Final Water outlet 7	
RA C1		Final Water outlet 8	
etc		etc	

Step 3. Determine average ground elevation and calculate elevation of peatland replanting area (Z_S)

Step 3.1 Undertake a survey to determine the elevation of the replanting area

The average ground elevation of the peatland replanting area and final water outlet needs to be determined to a significant degree of accuracy. This can be undertaken by a number of different methods which can measure elevation with a cumulative error of less than 50 centimetres (± 25 centimetres) accuracy, including:

a) auto levelling,
b) simple transparent U-hose,
c) optical water pass
d) theodolite survey
e) Drone survey
f) LIDAR mapping
g) RTK (Real Time Kinetic) differential GPS
h) PP (Post Processed) differential GPS

Whatever method is used, a baseline reference point is required for the determination of the absolute elevation of the peat terrain elevation or development of digital terrain model[9]. Through these techniques, the average elevation of the replanting area of the sub-strata of the planting area can be determined.

Further details of these methods are described in Annex 5.

Unsuitable methods

A number of available methods for determining elevation have been determined as not suitable for use with the DAP as follows:

a) Elevation determined through freely available online global Digital Elevation Models (DEMs) such as ALOS World 3D-30 m (AW3D30), (2) the Shuttle Radar Topography Mission 1 Arc-Second C-Band Global DEM (SRTM 1)[10] and (3) the Advanced Spaceborne Thermal Emission and Reflection Global DEM Version 2 (ASTER GDEM 2) have errors in vertical accuracy of 5-15 m[11],[12]. In addition, many of these systems measure the elevation of the vegetation canopy and not of the soil surface – giving elevations which are significantly higher than the actual peat surface. Although some adjustments and corrections can be made – overall these tools don't generate the accuracy needed for the DAP.
b) Google Earth derives its data from some of the sources listed in a) as well as national data sets when available. These also will not be sufficiently accurate for the DAP.
c) Topographic maps are also unsuitable to determine the elevation as these normally only have contour intervals of 10-20 m which is too coarse for use with the DAP. In addition, they will normally have been prepared based on surveys in the past and will not take into account subsidence after clearance and development on peat.
d) Normal hand-held GPS devices have a vertical accuracy of ± 3-5 m which is not sufficiently accurate for DAP.

[9] In Tier 1 assessments, it may be sufficient to determine the relative elevations of the replanting area and the final water outlet, but for Tier 2 the absolute elevations must be determined.

[10] Ref: https://www2.jpl.nasa.gov/srtm/

[11] Bayik Caglar, K. Becek, C. Mekik & M. Ozendi (2018) On the vertical accuracy of the ALOS world 3D-30m digital elevation model, Remote Sensing Letters, 9:6, 607-615, DOI: 10.1080/2150704X.2018.1453174

[12] Loudi Yap, Ludovic Houetchak Kandé, Robert Nouayou, Joseph Kamguia, Nasser Abdou Ngouh & Marie Brigitte Makuate (2019) Vertical accuracy evaluation of freely available latest high-resolution (30 m) global digital elevation models over Cameroon (Central Africa) with GPS/leveling ground control points., International Journal of Digital Earth, 12:5, 500-524, DOI: 10.1080/17538947.2018.1458163

Step 3.2. Develop or provide a Land Elevation Map or Digital Terrain Model

A Digital Elevation Model[13] (DEM, raster) or Land Elevation Map (LEM, vector) of the peatland replanting area should be prepared based on the surveys in Step 3.1. Alternatively, such maps may already be available from previous surveys. If the replanting area comprises several parts/individual peatlands, each part must be presented as a single entity. The Land Elevation Map or DEM should preferably be referenced to standard datum (mean sea level) and can be obtained and/or processed from various sources such as: LIDAR, photogrammetry, drones or (previous) direct land survey(s). The land elevation map needs to show the land elevation of the replanting area in relation to the elevation of the average water level at the final water outlet (step 4). If land survey(s) are conducted, the final drainage outlet to the nearest water body can be used as the initial (starting point) for the elevation measurement.

The DEM or LEM must be up to date at the time of assessment. If the map date is more than a year old, the elevation values of the map must be updated by accounting for subsidence of the peatland over the same period.

Step 3.3. Calculate average elevation of peatland replanting area

If DEM (raster format) is used, average value can be calculated based on individual pixel values. If LEM (vector) is used, average land elevation of peatland replanting area can be calculated based on class (area)-weighted values of the LEM.

Step 4: Determine the annual mean water level at the final water outlet(s)

The water level elevation to be maintained at the final water outlet is subjected to the water level elevation of the receiving water body (i.e. a river, lake or sea). It is necessary to measure the mean water level elevation, based on 12 months of water level measurements of the receiving water body adjacent to the final water outlet.

The average water level at the final water outlet should be determined through regular observation of a Pie-scale or staff gauge installed at the immediate downstream side of the outlet. Such data collection should be carried out for at least 12 months so as to cover the minimum and maximum water level at the outlet. The water level at the outlet will vary seasonally between the wet season and the dry season for inland location and on an hourly basis linked to tidal fluctuations for coastal plantations. For inland plantations, it may be sufficient to measure the water level on a daily basis to determine the monthly average water level, whereas for plantations where the outlet is affected by tidal movements continuous measurements (such as by a data logger) are needed to determine the average level. In addition to the average, it is useful to determine the range of water level fluctuations.

Where credible official records are available, the company may make reference to water elevation measurements from such sources. Such data may be available from flood measuring stations, tide tables or other official records. For such cases, the water level data may be based on a different datum from the datum used to measure the elevation of the plantation and it would be necessary to adjust all the data to a common datum, e.g. mean sea level or to an elevation reference point used for the plantation. The source of data for water elevation must be credible, such as official record, based on river gauging measurements, land survey, etc.

Details of the methodologies for water level measurement are given in Annex 4.

[13] It is essential that the maps show the elevation of the surface of the peat (i.e., Digital Terrain Model). It should be noted that many available maps which may have been prepared by remote sensing may show the elevation of the top of the vegetation (i.e., oil palm or forest in earlier times) rather than the soil.

Step 5 Measure the peat thickness and calculate average peat thickness of peatland replanting area

Step 5.1. Measure or collate data on peat thickness

Collate existing peat depth measurements or undertake a peat depth survey to gather existing data on the peat thickness. Methodologies for measuring the peat thickness are given in Annex 5.

Step 5.2 Develop peat thickness map

Develop a peat thickness map of the peatland replanting area based on the survey data in Step 5.1. If the replanting area comprises several parts/individual peatlands, each part must be delineated as a single entity. The map must be as accurate as possible, with 10 cm vertical resolution or finer. If a peat thickness map is available in raster format, its horizontal resolution must be 100 metres or finer.

The peat thickness must be up-to-date at the time of assessment and created from peat thickness samples that meet the following requirements: at least 30 percent of the samples are obtained not more than 1 year prior to time of assessment and the oldest samples are not more than 3 years (calculated from the year the Drainability Assessment is done). If the above requirements cannot be met, the peat thickness values of the map must be updated by accounting for subsidence taking place between the map date (year) and the assessment date (year).

Step 5.3. Calculate average peat thickness

If the peat thickness map from Step 5.2 is in a GIS format then the average value can be calculated based on individual pixel values.

Step 6. Calculation of the average NDL of the peatland replanting area

The average NDL of a peatland replanting area/block can be calculated through the following sub-steps:

Step 6.1. Identify or calculate centroid(s) of peatland replanting area

This can be manually determined on a map or calculated in a GIS programme. The boundary of the peatland replanting area must be clearly defined (delineated). If the peatland replanting area comprises several parts/individual peatlands, each part must be delineated as a single entity. The delineation MUST ONLY COVER REPLANTING AREA ON PEATLAND (see also illustration in Figure A2.6). The centroid coordinate(s) of the peatland replanting area(s) is calculated as average Longitude (X) and Latitude (Y) of boundary (ies) vertices.

When using ArcGIS, the centroid coordinate can be calculated by using Calculate Geometry in Attribute Table Contextual Operation (Right Click).

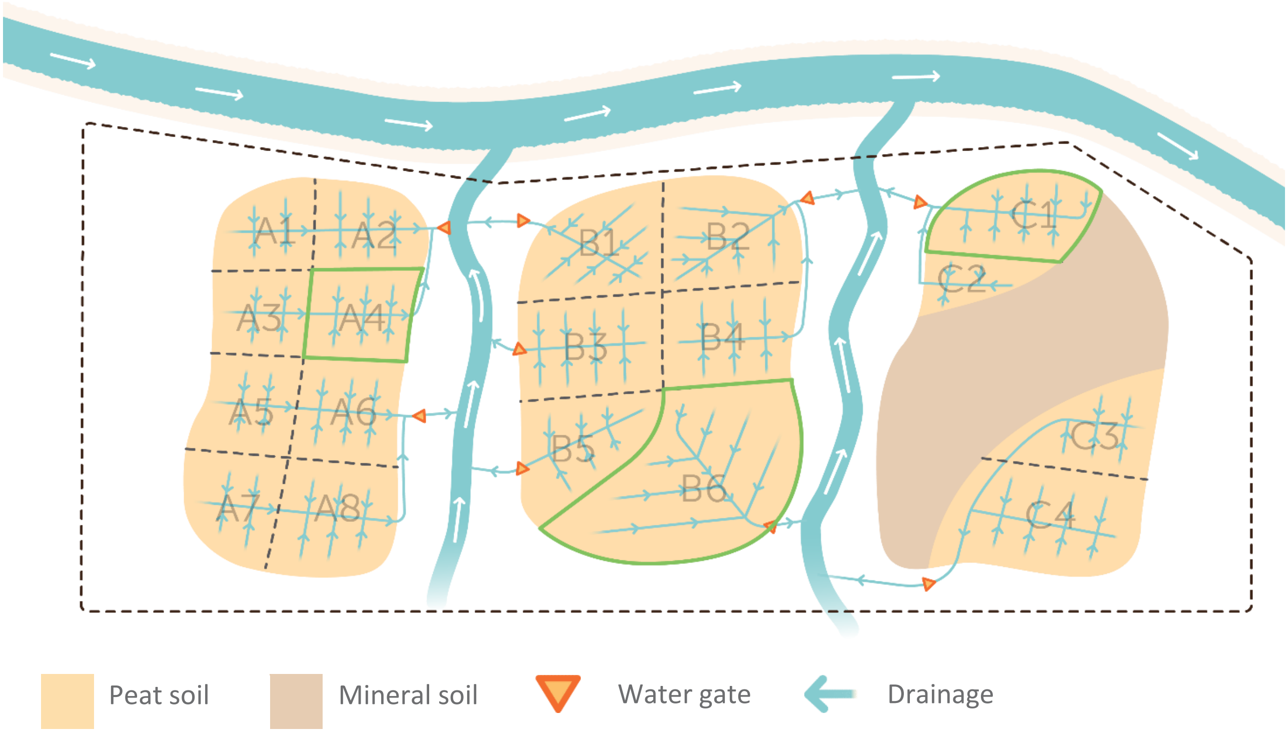


Figure A2.6: Illustration of an oil palm plantation consisting of 3 separate peatland areas. Replanting is planned to take place in green boundaries.

Step 6.2. Stratify replanting peatland area

Every part of replanting peatland area that shows variability, which can result in variations to the subsidence rate, must be stratified. This stratification should mainly be based on the planting blocks – i.e., each separate planting blocks or cluster of similar planting blocks becomes a separate stratum. In terms of selecting a strata of blocks to cluster – this may be done by considering adjacent blocks with similar peat depth or subsidence rates.

Company (ies) must justify and describe any stratification factor(s) chosen in the assessment.

Step 6.3. Calculate centroid of each spatial unit in the strata of the replanting peatland area

Centroid coordinate(s) of each spatial unit in the strata of the replanting peatland area(s) is calculated as average longitude (X) and latitude (Y) of boundary(ies) vertices.

Step 6.4. Identify and calculate distance to the final water outlet

Select the final water outlet of the replanting block as in the Table in Step 2, and measure the distance between the centroid of the replanting block to the respective outlet.

Step 6.5. Calculate the NDL

Calculate the NDL by using the following formula:

$$Z_{NDL} = Z_{NWB} + 0.0002 \times \Delta X_{NWB}$$

Where

Z_{NDL} : NDL (m-msl)

Z_{NWB} : Annual mean water level elevation (step 4) (m-msl)

ΔX_{NWB} : Distance between the centroid of the replanting area and the final water outlet at the boundary (step 6.5) (metres)

Step 7 Calculate the depth to NDL of the peatland replanting area/block

Step 7.1. Provide NDL(s) of the peatland replanting area(s) (results from Step 6 above)

Step 7.2. Provide average land elevation(s) of the peatland replanting area(s) (results from Section 3 above)

Step 7.3. Calculate depth to NDL of the peatland replanting area(s) by using the following formula:

$$D_{NDL} = Z_s - Z_{NDL}$$

Where

D_{NDL} : Depth to NDL (m)

Z_s : Average land elevation, from Step 3 (m-msl)

Z_{NDL} : NDL, found in from step 6 (m-msl)

Step 8. Calculate subsidence rate for each stratum of the peatland replanting area

Step 8.1. Provide table of stratified time-series averaged subsidence as shown in Table A2.1. Note that in case the site consists of multiple peatland areas, there must be a separate Table for each area (or part of area).

Step 8.2. For each stratum, calculate weighted subsidence, i.e., the product of each averaged subsidence (S_i) and its representative peatland area of the block where the subsidence pole is installed (A_i) where *i* denotes index number.

Step 8.3. For each stratum, calculate total peatland area of the blocks where subsidence poles were installed, and the sum of weighted subsidence.

Table A2.1: Table of illustrative data containing information of Subsidence Pole code, Block area of the subsidence pole, time-series averaged subsidence and weighted subsidence (subsidence x area) for Stratum A (Deep)

BLOCK NUMBER	BLOCK AREA (ha)	SUBSIDENCE POLE NUMBER	AVERAGED SUBSIDENCE (cm/y)	WEIGHTED SUBSIDENCE cm-ha/yr
1	4	1	4.6	18.4
2	4	1	4.1	16.4
3	4	2	3.8	15.2
4	4.2	2	3.8	15.96
5	3	2	4.1	12.3
Total	19.2			78.26

Table A2.2: Table of illustrative data containing information of Subsidence Pole code, Block area of the subsidence pole, time-series averaged subsidence and weighted subsidence (subsidence x area) for Stratum B (Moderate)

BLOCK NUMBER	BLOCK AREA (ha)	SUBSIDENCE POLE NUMBER	AVERAGED SUBSIDENCE (cm/y)	WEIGHTED SUBSIDENCE cm-ha/yr
21	4	1	3.4	13.6
22	4	1	3.4	13.6
23	3.3	2	3.3	10.89
24	4.1	2	3.6	14.76
Total	15.4			52.85

Step 8.4 Calculate average subsidence representative of the stratum by using the following formula:

$$S = \frac{\sum_{i=1}^{n}(A_i \times S_i)}{\sum_{i=1}^{n} A_i}$$

Where
A : Area of the stratum/Spatial Unit
S : Subsidence rate of the stratum/Spatial Unit
i : Stratum index
n : Total stratum number

For example, based on Table A2.1 and A2.2, average subsidence for stratum A:

$$S = \frac{78.26}{19.2} = 4.1\ cm/y$$

And for stratum B:

$$S = \frac{52.85}{15.4} = 3.4\ cm/y$$

Example:

In Figure A2.6 and Table A2.2, *DLT*s of several spatial units of stratified replanting peatland areas were calculated.

Table A2.3: Table of illustrative data for Figure A2.6 containing information on average peat thickness, representative depth to NDL, average subsidence and calculated DLT of a concession consisting of 2 separate peatland areas stratified further by using parameters planting block and peat depth.

Management block	**Average peat thickness (D_P)** **(metres)**	**Depth to NDL (D_{DNL})** **(metres)**	**Average subsidence rate (*S*)** **(cm/year)**	**DLT** **(years)**
A22 Shallow	1.5	1.6	3	not applicable (D_{NDL} >D_P)
…	…	…	…	…
B21 Shallow	1.6	1.2	4	30
…	…	…	…	…
C14 Shallow	2.4	2.1	3	70
C14 Deep	5.2	1.8	5	36
…	…	…	…	…
J12 Deep	6.2	2.5	5	50
J12 Moderate	3.8	2.5	4	62.5
…	…	…	…	…
So forth..	So forth..	So forth..	So forth..	So forth..

Step 9. Project the future drainability of the Peatland Replanting Area

A. Calculate Drainage Limit Time (DLT)

Step 9.1. Provide average Peat Thickness as obtained in Step 5.

Step 9.2. Provide Depth to NDL (D_{NDL}) as obtained in Step 6.

Step 9.3. Use subsidence rate value (*S*) as determined in Step 8.

Step 9.4. Compare average peat thickness found in Step 9.1 against the representative depth to NDL found in Step 9.2.

If the depth of the peat is greater or equal to the depth to NDL, proceed to Step 9.5

If the depth of the peat is less than the depth to NDL – then the NDL is in the mineral soil below the peat – in which case, the DLT does not need to be calculated for such stratum.

Step 9.5. Calculate DLT by using the following formula:

$$DLT = \frac{D_{NDL}}{S}$$

Where

DLT : Drainage Limit Time (year)
DNDL : Depth to NDL, found in Step 9.2 (cm)
D_p : Peat Thickness, found in Step 9.3 (cm)
S : Subsidence Rate (Actual value, cm/year)

The number of years in the DLT needs to be reduced according to timing when the assessment procedure is undertaken prior to the proposed replanting year:

- If the assessment is undertaken 8 years prior to the replanting year – the DLT needs to be reduced by 7 years;
- If the assessment is undertaken 5 years prior to the replanting year – the DLT needs to be reduced by 4 years;
- If the assessment is **repeated** 1 year prior to the replanting year – then DLT is as calculated (no changes).

Example:

In Figure A2.5 and Table A2.1, DLTs of three peatland areas were calculated

Table A2.1: Table of illustrative data for Figure A2.5 containing basic information on average peat thickness, representative depth to NDL, average subsidence and calculated DLT of concessions consisting of 3 separate peatland areas.

Peatland replanting block	Proposed replanting year	Average peat thickness (D_P) (meters)	Depth to NDL (D_{NDL}) (meters)	Average subsidence rate (*S*) (cm/year)	Initial DLT (years)	Adjustments (Projected replanting year - assessment year*. Exclude the replanting year)	Final DLT (Initial DLT - Adjustments)	NRI (Final DLT - 40) (years)
1	2025	4.5	2.7	3.4	79	3	76	36
2	2027	5.2	3.34	4.1	81	5	76	36
3	2030	3.8	1.3	3.4	38	8	30	-10

*Assuming assessment year is 2021for this example

B. No replanting (no-go) indicator (NRI)

For Tier 2 approach, a No Replanting Indicator (NRI) Map is required (ie a map showing the proposed replanting blocks where replanting is allowed or not allowed) . The NRI value can be evaluated by simply subtracting from the adjusted DLT value(s) the 2 crop cycle period (40 years).

NRI = DLT - 2 x crop cycle period (2 x 20 = 40 years)

If NRI > 0, threshold has not yet been reached. If NRI is zero or a negative number, that means the two-crop cycle threshold has been reached and **NO** replanting is allowed on the corresponding peatland

From Table A2.1, it is apparent that NRI has been reached in peatland areas 3, because the calculated DLT is less than 40 years.

In the case that a plantation on peat has been using planting cycles of longer than 20 years in the past or plans to do so in the future – then the NRI should be calculated using 2x the average crop cycle length. If the crop cycle is 25 years, then:

NRI = DLT - 2 x crop cycle period (2 x 25 = 50 years)

Annex 3: Subsidence Measurement

Soil Subsidence

Subsidence results from consolidation, oxidation and shrinkage of the organic materials because of drainage. Subsidence cannot be stopped as long as the water table is below the peat surface. Deeper drainage results in higher subsidence rates. To decrease subsidence, high water tables must be maintained the entire year, sufficient ground cover and fire is avoided. RSPO requires growers to monitor soil subsidence as part of Indicator 7.7.3(C): Subsidence of peat is monitored, documented and minimised.

Measurement of peat subsidence

Peat subsidence can be measured by installing a vertical pole made of durable material into the peat. It is important to ensure that the subsidence pole is installed firmly until the mineral substratum (minimum of 50 cm) for anchorage. A layer of concrete, or other permanent marker (eg welded metal plate or crossbar) can act as a marker of the initial soil surface height.

An area of 2 m by 2 m around the subsidence pole should be securely fenced up to prevent disturbance that will lead to inaccurate readings. A subsidence pole should be installed at a minimum rate of at least one and preferably two (for control) in every 240 ha of an estate provided that the peat is of uniform nature.

However, more subsidence poles are required to measure subsidence in plantations with varying peat qualities, depths and drainage circumstances. Where peat occurs in small blocks, one subsidence pole is required in each separate block larger than 10 ha. Each year, the subsidence of the peat can be marked on the subsidence pole or recorded elsewhere. For the purpose of making decisions on replanting using the Drainability Assessment Procedure (DAP), one subsidence pole per maximum 100ha should be considered to give more accurate calculations. It is good practice to record the soil subsidence at minimum every quarter as the peat level may rise in the wet season and fall in the dry season. A data table (with all the subsidence measurements taken over a minimum period of three years) should be included as an annex in the DA Report.

Regular measurements can determine the trend. At least three years of measurements are required to provide a reliable estimate of the soils subsidence rate. There may be obstructions when installing the subsidence pole due to existing logs within the peat profile. Therefore, the exact position and depth for installing a subsidence pole has to be ascertained by using an auger to define the depth to the underlying mineral soil.

Figure A3.1: Example of subsidence pole installed

Photograph on the right was taken in 2011 and on the left was taken in 2018 of the same poles.

Figure A3.2: Photo of a subsidence pole installed 10 years after initial drainage.

Figure A3.3: Photo showing measurement rule to read subsidence level.

It is advisable for the subsidence pole to be marked with non-erodible material to indicate the initial peat surface height.

Example: Shown below is an example of subsidence recording table.

Estate Name: Estate 1
Field No: 95D
Subsidence Pole No: P2
Subsidence pole Installed on 10th Sept 2018

SAMPLE RECORD OF SUBSIDENCE POLE

Date of Measurement	3-month Subsidence in (cm)	Cumulative subsidence in (cm)	Annual subsidence in (cm)
10th September 2018	0.0	0	
8 December 2018	1.3	1.3	
10th March 2019	1.5	2.8	
10th June 2019	0.9	3.7	
8th September 2019	1.1	4.8	4.8
10th December 2019	1.0	5.8	
15th March 2020	1.1	6.9	
8th June 2020	1.3	8.2	
9th September 2020	1.1	9.3	4.5
10th December	0.8	10.1	
5th March 2021	1.1	11.2	
8th June 2021	1.0	12.2	
10th September 2021	1.2	13.4	4.1
3-year Average			**4.5**

The final water outlet in a plantation is normally a gated water structure located at the lowest point along the plantation boundary to control the outflow of drainage water from the plantation to a receiving water body (a river, lake or the sea). The water elevation of the water body at this final outlet is therefore an important parameter in determining the drainability of the peat area in the plantation.

Measuring Water Elevation

Water elevation can be measured manually or automatically. Manual methods are simple and inexpensive, but they have to be read on a daily basis. Automatic water level recorders overcome this requirement, but require a higher initial cost.

Manual observations are made by reading the water surface in contact with a fixed graduated staff gauge. The markings on the staff gauge will show the different elevations with respect to a Government Benchmark or a common datum used in the plantation and the markings can be of different designs (see Figure A4.1). The staff gauge is made of a durable material and is fixed rigidly to a structure such as an abutment, pier, wall, or is planted on the bank of the river. Sometimes it may not be possible to read the entire variation of water surface elevations of the river by a single staff gauge and additional staff gauges may be needed at different heights (see Figure A4.2).

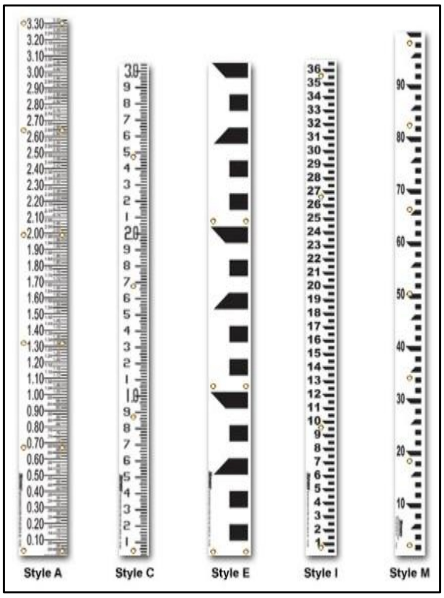


Figure A4.2: Different types of markings used in staff gauge

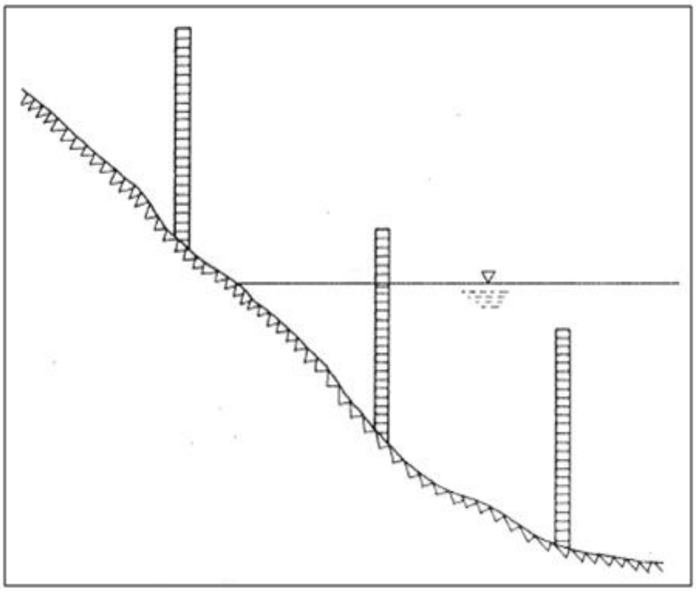


Figure A4.1: Sectional staff gauges

Figure A4.3: shows a water elevation staff gauge installed along Sg. Pahang at Pekan Town in the state of Pahang, Malaysia.

Figure A4.3: A staff gauge installed at Sg. Pahang (DID Malaysia)

Another method of manually measuring the water elevation is to lower a weight on a wire/cable suspended from a bridge until it touches the water surface. For this method, it is necessary to first obtain the elevation of the bridge and then derive the water elevation by deducting the length of wire lowered from the bridge elevation. A modern version of this method uses an echo sounder to record the distance to the water surface (see Figure A4.4).

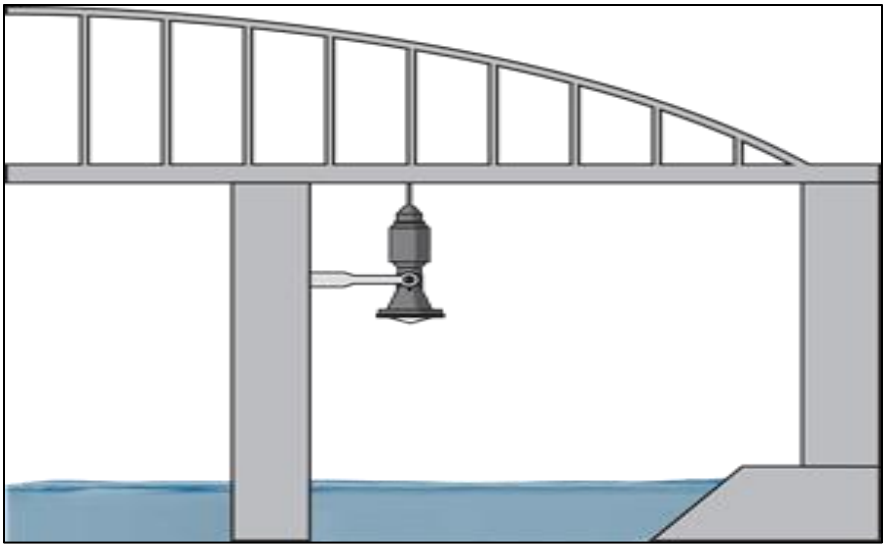


Figure A4.4: Measuring the water elevation of a river using an echo sounder.

The float-operated water level recorder is the most common type of automatic water level recorder in use. A float operating in a stilling well is balanced by means of a counterweight over the pulley of a recorder (see Figure A4.5). The movement of the float due to the rising or lowering of the water surface will cause an angular movement of the pulley which is converted to a linear movement of a pen to record over a drum driven by clockwork (see Figure A4.6). The output will be a chart showing the water elevation (stage) over time (Figure A4.7). Modern automatic water level recorders consist of models that give digital signals recorded on a storage device or transmitted directly (via telemetric or satellite) to a central data-processing centre.

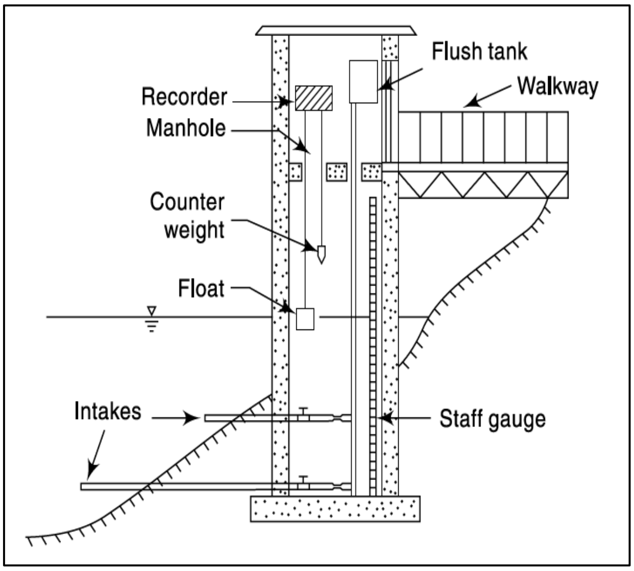


Figure A4.5: A float-operated water level recorder

Figure A4.6: Clockwork mechanism

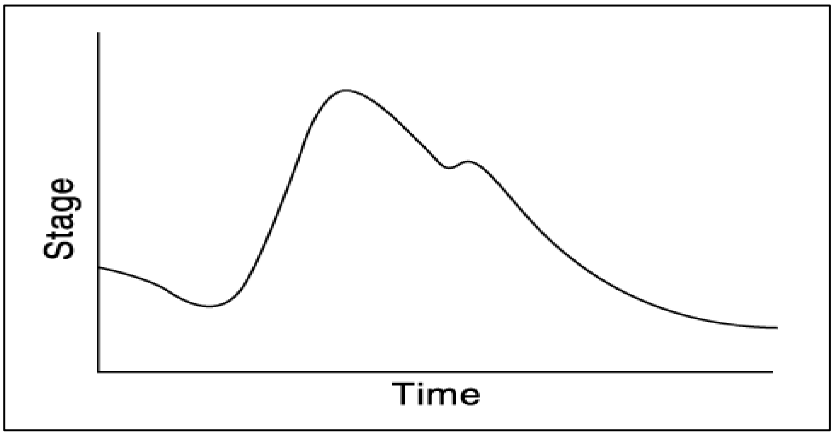


Figure A4.7: An output chart showing the river water elevation over time

Figure A4.8: A Water Elevation Telemetry Station installed at Sg Kuantan (DID Malaysia)

Water Elevation at the Final Water Outlet

To allow for gravity drainage of the plantation, the water elevation to be maintained at the final water outlet must be equal to or higher than the water elevation of the receiving water body. It is thus necessary to obtain from credible official records, or where such records are not available, to measure or estimate the mean water elevation of the receiving water body at the final water outlet.

The water elevation at the final water outlet should be determined through regular observation of a staff gauge installed at the immediate downstream side of the outlet. The water level at the outlet will vary seasonally between the wet season and the dry season for inland location and on an hourly basis linked to tidal fluctuations for coastal plantations. For inland plantations, the water elevation of the receiving water body may be measured on a daily basis to determine the average monthly water level, whereas for plantations where the outlet is affected by tidal movements continuous measurements with a data logger are needed to determine the monthly average level. In addition to the average, it is useful to determine the range of water level fluctuations. Such data collection should be carried out for at least 12 months so as to cover the different seasons in a year. Where there is less than 12 months' data available, the company may still proceed with an initial drainability assessment and prepare a provisional report, provided the available data covers the entire period of the wet or rainy season. The company will need to continue with the water level elevation measurements and update the provisional report once 12 months' data is available.

Where water elevation at the outlet is available from official records or from tide tables, it is necessary to first check whether the water elevation data is based on a different datum from the datum used to measure the elevation of the plantation. If the datum is different, it would be necessary to adjust all the data to a common datum, e.g. mean sea level or to an elevation reference point used for the plantation. The source of data for water elevation must be credible, such as official records based on river gauging measurements, land survey, etc.

Calculating the annual mean based on monthly mean water level elevation at the final water outlet

Both Tier 1 and Tier 2 requires companies to measure the annual mean water level elevation at the final water outlet.

The companies, should measure the water level on at least 20 days per month to calculate the mean monthly water level at the outlet. This should then be averaged to calculate the mean of mean of 12 months water level at the receiving water body. This water level can be calculated using a 3 steps approach as follows:

Step 1: Carry out data collection for at least 12 months so as to cover the different seasons in a year.

Step 2: Tabulate the collected data as shown in the table below. Calculate the mean water level for each month.

The table below shows a typical water elevation data collected over a period of 12 months for a river.

River water level data (in meters above sea level, masl)

Date	2019		2020									
	Nov	Dec	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sept	Oct
1	5.62			1.90		4.95			3.20	4.10	4.95	4.00
2	5.37	3.37	3.47		2.30	4.90	4.10	4.00	3.40		4.80	3.60
3		3.57	3.52	1.85	2.35	4.80		4.95	3.30	4.00	4.50	3.20
4	3.67	3.67	3.62	1.80	2.30	4.90	3.10	4.80	3.35	4.20	4.20	
5	2.92	3.77		1.85	2.40		3.60	4.75		4.10		3.00
6	2.77	3.77	3.57	1,90	2.50		2.70	4.60	3.15	4.00		3.40
7	3.37	3.72	3.62	1.85	2.45	5.40			3.00	3.95	4.30	4.20
8	2.77		3.47	2.00			4.50	4.50	2.90	3.80	5.35	4.30
9		3.77	2.12		2.40	5.30	4.80	4.60	2.75		5.90	4.00
10		5.42	3.57	1.95	2.55			4.55	2.50	3.70	5.30	3.85
11	4.12	3.77	3.17	1.80	2.45	2.00	3.90	4.40	2.30	3.65	5.20	
12	3.77	3.97		1.85	2.40		3.20	4.35		3.50	4.85	3.60
13	2.77	4.02	3.07	1.90	2.50	1.95	2.80	4.30	2.00	3.45		3.40
14	2.87	3.37	2.37	1.70	2.60	2.00	2.70		1.65	3.35	3.40	3.25
15	2.77		2.62	1.75		2.50	2.90	4.00	1.25	3.30	3.30	3.15
16	2.97	5.32	2.62		2.55	4.20	4.20	3.85	1.30		3.35	3.05
17		5.42	2.17	1.70	2.60	5.20		3.80	3.50		3.20	3.00
18	3.27	4.27	3.37	1.75	2.45	4.00	3.90	3.70	5.40	4.10	3.20	
19	3.42	3.37		1.80	2.40		3.80	3.65		4.00	3.00	2.90
20	3.47	5.67	2.67	1.90	3.90	3.25	2.90	3.60	5.35			2.75
21	3.37	3.87	2.67	1.85	3.95	3.20			3.40	3.90	3.00	2.60
22	5.37		2.72	1.95		3.10	2.50	3.55	4.90	3.85	3.20	2.55
23	6.02	6.72	2.57		4.30	4.20	2.20	3.40	4.70		3.00	2.45
24		6.67	2.67	1.95	4.60	4.00		3.45	5.60	4.00	3.40	2.35
25	6.37			1.90		4.60		3.40	4.45	4.10	3.85	
26	5.37	5.52		1.90	4.80		2.40	3.35		4.00	4.50	2.70
27	4.97	5.27	2.62	1.85	4.95	4.20	2.60	3.45	4.40	3.90		2.60
28	5.77	5.52	2.72	1.95	4.80	4.10	2.50		4.50	4.20	4.20	2.90
29	3.77		2.72	2.00		4.00	2.55	3.35	4.10	4.10	4.40	
30	3.37	5.72	2.72		4.75	4.10	4.10	3.30	4.20		4.50	2.80
31		4.87	2.62		4.65							3.10
Σ	100.3	114.4	73.05	44.70	79.90	90.85	71.95	99.65	90.55	89.25	102.8	82.70
η	25	25	25	25	25	23	21	25	26	23	25	26
WE	4.01	4.58	2.92	1.79	3.20	3.95	3.43	3.99	3.48	3.88	4.11	3.18

Step 3: Calculate the annual mean water level elevation

From the data collected, calculate the annual mean from means of the 12 months water level elevation of the receiving water body at the final water outlet using the following equation:

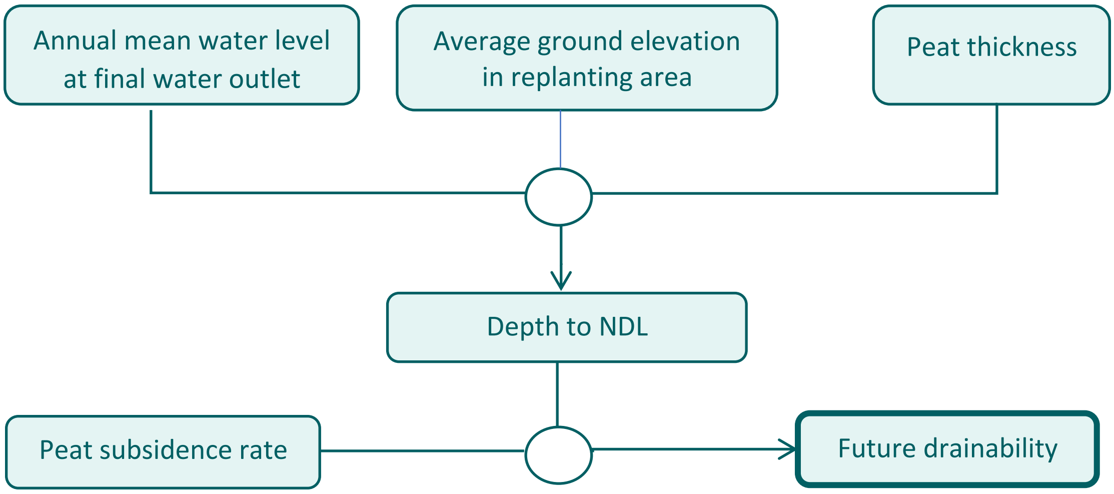
$$\text{Annual Mean Water Elevation, AMWE} = \Sigma\ (\eta \text{ months mean water level}) \div \eta$$

Where

Σ : is the sum of mean monthly water level elevation for the year

η : is the number of months where the water elevation is measured (ie, 12)

The diagram including annual mean water level at final water outlet as shown in Figure 1 page 2 of the DAP is reproduced below for easy reference.



ELEVATION AND PEAT THICKNESS SURVEY

Digital Elevation Model, Digital Surface Model & Digital Terrain Model[14]

Elevation Mapping systems
There are three commonly used descriptors for elevation mapping system as listed below: • A DEM (Digital Elevation Model) provides the bare-Earth surface, removing all natural and built features, • A DTM (Digital Terrain Model) is an augmented DEM, which includes features of the natural terrain, such as rivers and ridges. • A DSM (Digital Surface Model) captures both the natural and built/artificial features of the environment, including surface vegetation and structures

The DAP requires companies to measure elevation using DTM or DEM (bare earth surface). Care must be taken to avoid using any DSM or system that includes the vegetation (palm) layer in the elevation measurement.

Auto level method and similar methods

Elevation of terrain or Digital Terrain Model (DTM)[15] can be measured by auto levelling, simple transparent U-hose, optical water pass and theodolite instrument methods.

Levelling is a conventional method that has been used for many years to determine highly accurate vertical ground to ground terrain height values of elevations. Methods mentioned above give accurate measurement, but are time consuming and require high manpower. High rainfall and rough terrain could cause delay in survey work. Besides, in auto level the methods have to be together with GPS equipment to collect the coordinate points (X and Y values) for data processing as auto level only can provide levelling of Z value. In all methods GPS derived terrain height measurement requires a baseline reference point to start the survey work.

[14] DEM, DSM & DTM: Digital Elevation Model – Why It's Important. Retrieved from https://geodetics.com/dem-dsm-dtm-digital-elevation-models/
[15] Digital Terrain Models (DTM) sometimes called Digital Elevation Models (DEM) is a topographic model of the bare Earth that can be manipulated by computer programs. Retrieved from https://www.eea.europa.eu/help/glossary/eea-glossary/digital-terrain-model

Peat Elevation using Real Time Kinematic (RTK) Global Positioning System (GPS)

The use of the Real Time Kinematic (RTK) GPS has been a popular method among surveyors to obtain highly accurate positions and elevations. RTK survey method provides much faster speed in a survey to measure the height with a feature above mean sea level or an elevation. Terrain information can be directly obtained and the accuracy of the data collection can reach up to centimetre level.

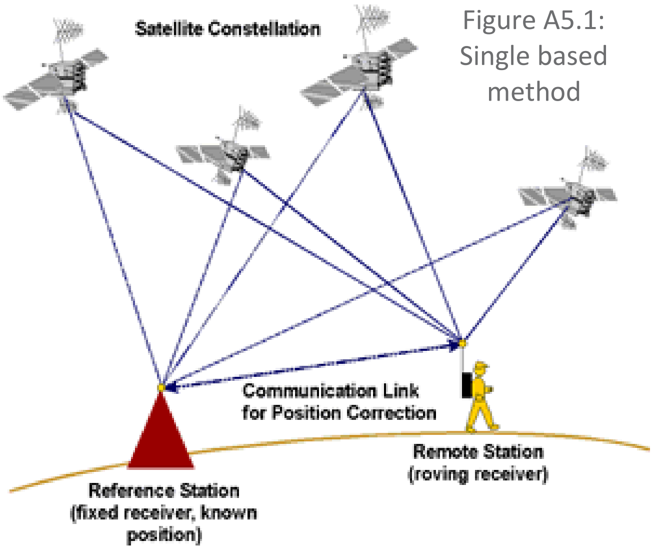


Figure A5.1: Single based method

RTK methods can be used and classified into two, namely single-based method (Figure A5.1) and network-based method (Figure A5.2). The single-based observation only requires one known GPS station to send the correction to the rover station as shown in Figure A5.1.

The network-based observation requires multi network known as GPS station to send the data correction to the rover station (JUPEM MyRTKnet services in case of Malaysia) via internet connection as shown in Figure A4.2. However, with the MyRTKnet method, it is limited for some estates depending on the power of internet coverage and its connection.

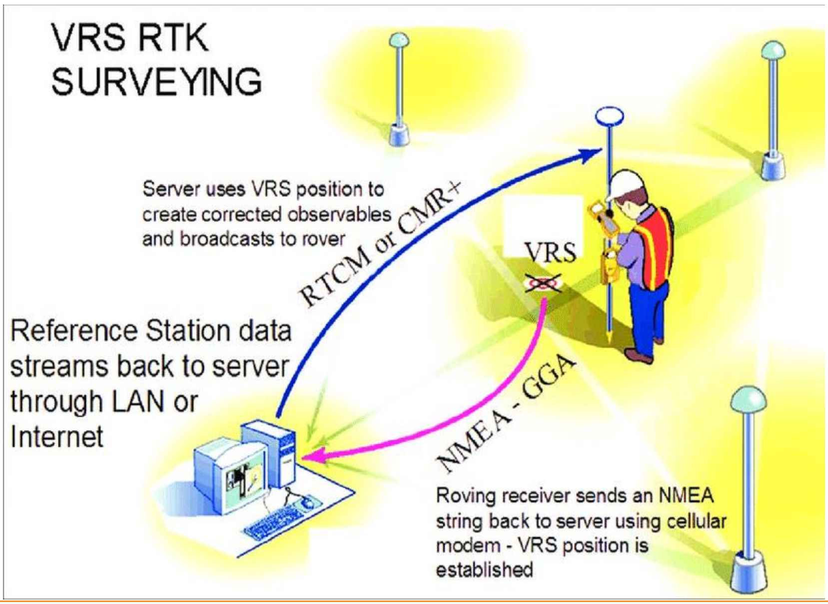


Figure A5.2: Network-based method

Single-Based Method (Figure A5.1)

The single-based observation requires GPS observation at a benchmark (BM) or baseline reference points, basically located near or within permanent structures such as milestones, telecommunication poles and government buildings such as police station, petrol pump, school etc. Usually, the static method or fixed position method needs about an hour or more of observation time to get accurate data of X, Y and Z positions through satellites. Two verification benchmarks or baseline reference points to be located and measured to ensure the accuracy of the predetermined elevations of the two benchmarks (Figure A5.3 and Figure A5.4). The tolerance error between the two benchmarks must be less than 6 cm[16] as recommended by the Land Survey Department of Malaysia.

[16] The tolerance errors of the two benchmarks were referred for cross-checking the benchmark height value as provided by Department of Surveying and Mapping, Malaysia (JUPEM). According to JUPEM, the height difference (z) to compare with known point is to be less than 6 centimeters.

Figure A5.3: Observation of benchmark

Figure A5.4: Observation of Temporary Benchmark

After the main benchmark verification, a temporary bench mark (TBM) has to be established close to the survey land for the measurement of level control point during surveys work. The TBM will become a permanent reference point using concretion. The mean sea level (MSL) height of the temporary bench mark (TBM) is acquired from the benchmark (BM) using the static method (Figure A5.4). The static method is highly accurate with error expected in millimetres. TBM will be become a permanent ground reference point for ground work etc. topography survey and mapping, etc., verifying levelling at peat area.

Figure A5.5: Spot height measurement using GPS Rover

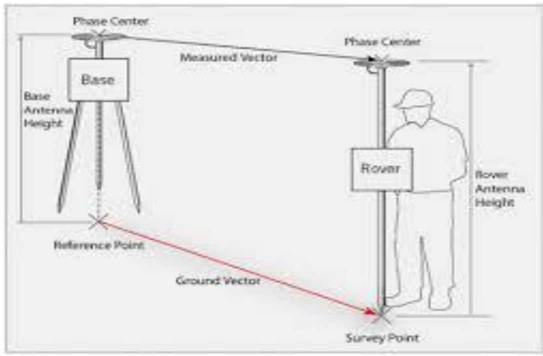


Figure A5.6: RTK Rover concept

Method of data collection on the ground using the RTK system in single-based method

a. The data collection of the topographic data would be conducted by collecting all existing topographic features in the survey area. The spot heights of X, Y and Z values are measured in Figure 5.6. The method of data collection using RTK using rover antennae is shown in Figure 5.6.
b. RTK fix positioning can be achieved quickly, where data is collected from mostly more than six satellites were available.
c. The collected terrain heights would be interpolated and produce Digital Terrain Model (DTM) ground to ground basis by using Raster Interpolation Tool in ArcGIS or others GIS software.
d. From the derived DTM, the contour lines can be generated according to the acquired preference interval; i.e. 1-metre or 0.5-metre interval.

Meanwhile, for the determination of horizontal position (x, y), the tolerance errors were limited to 2 centimeters. (Reference taken from KPUP Circular Vol: 6/2009 on page 129)

Network-Based Method (e.g. MyRTKnet service under Malaysian situation) (Figure A5.2)

MyRTK net has been developed by the land survey department with 78 GPS reference stations throughout Malaysia. The stations track GPS signals and send the signals to dedicated data lines of the central network server at the Geodesy section of the land department. In RTK, it requires only about two minutes of observation time to get all three X Y and Z values. The Geodesy section manages and distributes the GPS correction data to subscribers to get positioning of the terrain (X and Y values and elevation by Z value) in real time. Geoid models equipped with GPS are activated to get actual elevation height from mean sea level. However, to do the work needed strong internet connections at the location are to be surveyed.

Peat Elevation using Drone

Unmanned Aerial Vehicle (UAV) or drones are commonly utilised to solve problems in various applications across different fields due to its low cost, safety, and low flying altitude. With photogrammetric techniques and latest available aerial technology, it is possible to utilise UAV for generation of Digital Elevation Model (DEM) and subsequently, determination of elevation on various geomorphology. Studies have shown that vertical accuracy can range between 5-15cm[17]. However, it is critical that the data collected by the UAV or drone is interpreted in such a way that the vegetation layer is "removed" to ensure that the elevation model represents only the soil surface (bare earth).

Peat Elevation using LIDAR

Light Detection and Ranging (LIDAR) is a technology similar to RADAR that can be used to create high-resolution Digital Elevation Models (DEMs) with vertical accuracy as good as 10 cm. The distance between the laser scanner and the ground is then calculated based on the speed of light. A bare earth DEM should be created removing any vegetation layer.

For LIDAR-based DEM generation, standard practices have been developed elsewhere (for example: http://desktop.arcgis.com/en/arcmap/10.3/manage-data/las-dataset/using-lidar-in-arcgis.htm).

U-hose water levelling

As an alternative to the theodolite and optical water pass, traditional U-hose water levelling can be used instead. The basic principle of the U-hose method is to make use of nouveau plane (the flatness property of the water surface) across any U-pipe (or U-hose in this case), as depicted in Figure A5.7. The land elevation difference between point A and point B ($\Delta H_{A\text{-}B}$) is obtained as:

$$\Delta H_{A\text{-}B} = a - b$$

As the survey advances along a transect, the measurements proceed from point B to point C, from C to D, and so forth, until sufficient transect length has been covered and the ups and downs of the points across the line are fully presented. It is not necessary to record coordinates at every step, because it may be laborious; therefore, only points intended (planned) as sample points require coordinate-recording. An illustration is given in Figure A4.7 and the levelling calculation template (MS Excel), which can be downloaded from the RSPO website (resources → supplementary materials).

[17] F Arif et al 2018. Generation of digital elevation model through aerial technique IOP Conf. Ser.: Earth Environ. Sci. 169 012093

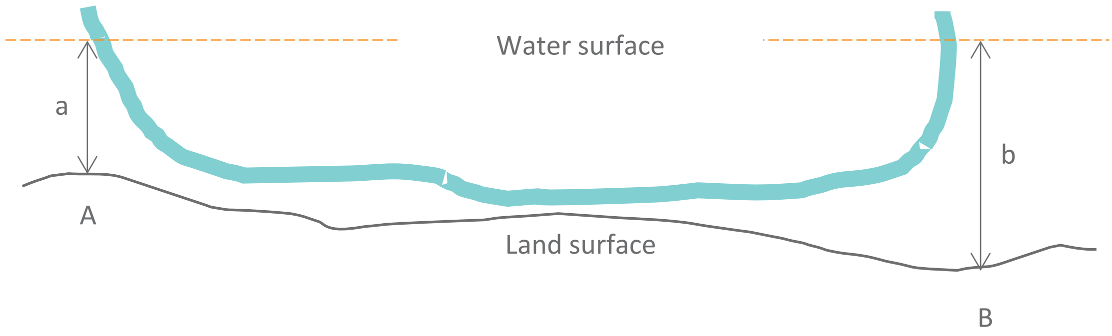


Figure A5.7: Illustration of U-hose water levelling survey

At least one of the measurement points must be referenced to standard datum (m-msl). Connect (measure elevation difference between) any known measurement point of any transect to the nearest elevation benchmark (known official elevation point). Retrieve the benchmark elevation to be used later in referencing to standard datum.

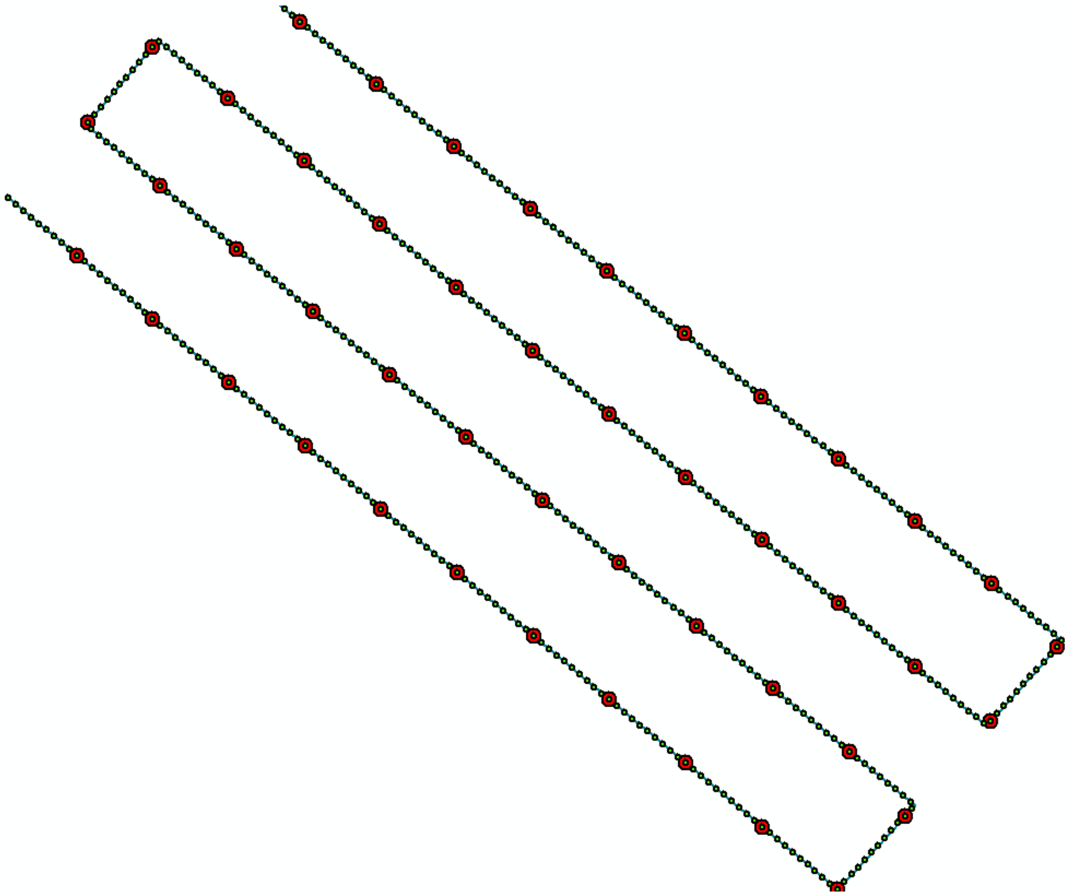


Figure A5.8: Illustration of 4 transects connected to each other through continuous U-hose levelling survey with 40 metres measurement interval (green dots). Coordinates are only recorded at planned 400 meters interval measurement points (red dots).

Elevation Data analysis

In principle, the calculation of elevation is based on chained/sequential elevation differences along transect lines. Elevation at point B equals elevation at point A plus height difference value between point A and B. Formally, in sequential formula it reads:

$$h_{i+1} = h_i + \Delta h$$

Where

h : Relative elevation (cm), i.e., measured elevation when not yet referenced to standard datum.

Δh : Elevation difference between sequential position (cm), calculated as subtraction of back-sight readings and fore-sight readings measured in levelling survey. See also Calculation Template file.

i : Sequence indices 1, 2, 3,… so forth

To get a clearer picture, please examine the Calculation Template file accompanying this document.

Reference elevation data to standard datum can be done by offsetting relative elevation by using the following formula:

$$H_i = h_i + \alpha$$

Where

H : Elevation, referenced to standard datum (cm-msl)

α : Elevation offset (cm)

while

$$\alpha = Z_b - Z_m$$

Where

Z_b : Actual elevation at benchmark or reference position (cm-msl)

Z_m : Measured relative elevation at benchmark or reference position (cm)

As shown in Figure A5.9, relative elevation at a benchmark or a reference position can be measured by measuring its height difference from one (or more) sampling point (along red line).

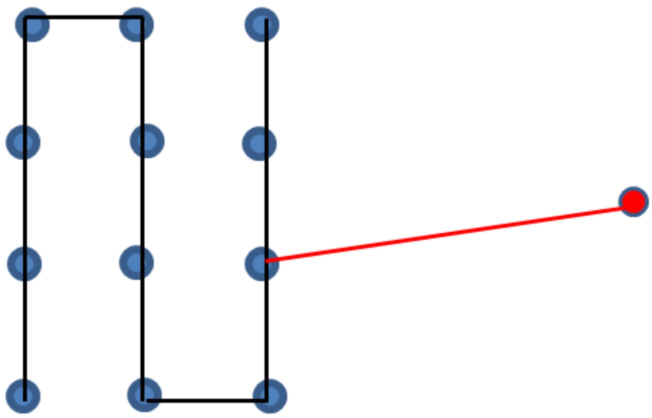


Figure A5.9: Illustration of 12 elevation sampling points (blue dots) arranged along 3 transects (black lines), a benchmark (red dots)

Peat Thickness Assessment

A peat thickness map is needed to create the site drainability map. Peat thickness measurements can be done by using a peat auger. It is recommended to place peat thickness measurements at the same location as the levelling sample points, to increase work efficiency.

Step by Step Procedure

Step 1. Define minimum sample size

It is recommended to base the minimum number of sample points on Slovin's formula (Guilford and Fruchter, 1973; Yamane, 1967):

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

Where
n : Minimum number of required sample points
N : Number of populations, i.e., total number of cells of the output DEM or peat map raster covering the actual area
e : Planned margin of error = 100% – Confidence level

Example:
Plantation area = 5,000 hectares
Planned mapping unit (DEM or peat map resolution) = 1 hectare (100 m cell-size)
Planned confidence level = 90%

Solution:

$$N = \frac{5{,}000\ ha}{1\ ha} = 5{,}000$$

$$e = 100\% - 90\% = 10\% = 0.1$$

$$n = \frac{5,000}{1+5,000 \times 0.1^2} = 98$$

Step 2. Plan measurement transects

Having determined the minimum number of sample (points), the next step is to arrange the sample points over the survey (concession) area. For this purpose, the area is partitioned into *n* sub-areas (grids), each for a sample point. Make sure the entire peatland area(s) of the site is covered. For the above example, the concession is partitioned into 98 sampling points. Centre points of the grids are assigned a sample point location.

For concession areas that have been set up with planting blocks, the block can be used as partition grids if preferred so, as long as the number of blocks is sufficient to meet the minimum required sample points. If not, more than one sample point per block needs to be assigned while maintaining 'as evenly spatial distribution' as possible.

Plotting the points on a map, a visual inspection can be made to determine the most efficient way (based on proximity to roads, other access, distance between points, etc.) of converting (connecting) the points into transects (trajectories). Additional sampling points may be added along transects, when required, especially in cases where the micro-topography of the land has been altered into mini-domes.

Step 3. Measure peat thickness along transects for peat map generation

Peat thickness measurement can be done by using a peat auger or similar device. More advanced methods such as Ground Penetrating Radar (GPR), Geoelectric, Low-Energy Seismic Imaging or other methods can also be used as long as it is validated by a sufficient number of correlation boreholes. Details of this advanced method can be found in various standard references on Geophysics.

The most commonly used corer for peat soils in SE Asia usually features a half-cylinder core chamber and a flip-cover. Other types of corers may feature different core chambers. For fibrous, woody, peat soils, the smaller the corer/auger diameter, the more efficient it is to operate. Measuring peat thickness by using a manual corer or auger is done in a series of attempts. At each attempt the corer/auger is inserted/pushed into the peat soil in a vertical direction. A peat sample is taken in the chamber or groove at a certain depth before the corer/auger is pulled out and the sample in the chamber/groove is inspected for the presence of underlying mineral substratum (usually sand or clay). As long as the mineral substratum is absent, the attempt is repeated by gradually increasing its insertion depth. Once the substratum is found, the insertion depth to the substratum uppermost position is measured. An illustration is given in Figure A5.10.

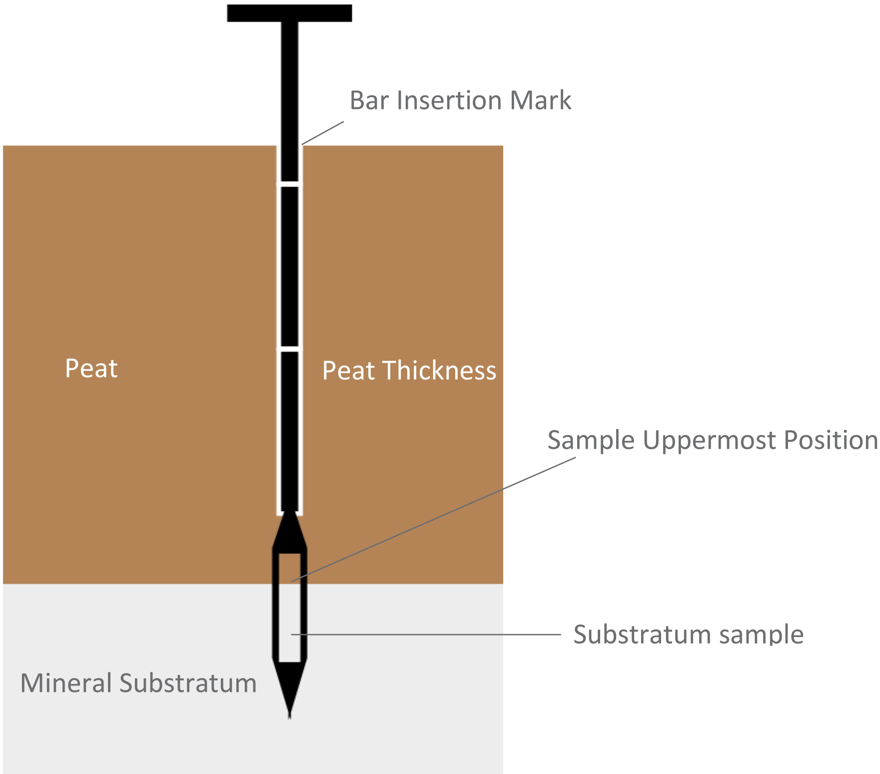


Figure A5.10: Illustration of the use of a peat corer or auger

Step 4. Peat thickness data digitisation and processing

Processing peat thickness data is simple. Data is presented as XYZ, where X, Y columns denote coordinates while Z represents peat thickness.

Procedure A. DEM and Peat Thickness Map Generation

Approach

Elevations and peat thickness data (on the sample points) gathered in the survey as explained in section 3.1 are used to generate the site Digital Elevation Model and peat thickness map in raster format by using a standard geostatistical method (Kriging). More information about geostatistical analysis can be found in the ESRI documentation web page 2.

The quality of the resultant site DEM and peat map can be assessed by using a standard cross correlation method in geostatistical procedure (see also ESRI documentation web page 1).

Step by Step Procedure

Step 1. Prepare interpolation points

The source of interpolation points is elevation data or measured peat thickness data resulting from Procedure A Step 4. The data must be in XYZ format shapefile, where XY is the coordinate value, while Z is the peat thickness (m or cm) or elevation value (m or cm-msl).

Step 2. Set interpolation parameters

Standard/best practice of geostatistical procedure must be followed, for example, ESRI documentations on Geostatistical Analysis. For the purpose of this Guidance, the following parameters are to be set as follows:

PARAMETERS	VALUE	DESCRIPTION
Optimise Model	Do It	This makes sure that correct semi variogram model is chosen
Nugget	Zero	This makes sure that predicted values are as close as possible to the actual values at sampled locations
De-clustering	Yes	This helps remove spatial bias from unrepresentative sampling whenever clustered data are present

Step 3. Perform geostatistical analysis (Kriging)

A best practice Kriging procedure is available at ESRI website
http://desktop.arcgis.com/en/arcmap/10.3/tools/3d-analyst-toolbox/how-kriging-works.htm

Basically, once a geostatistics tool is made available, a user is required to supply interpolation input data and set several interpolation parameters. The interpolation result is named as a GA Layer by default. The user needs to export this GA Layer into Raster by specifying raster resolution.

Step 4. Data Quality Control

In the quality control process, the raster interpolation is checked against artefacts such as bull's eyes, unrealistic values, and extreme outliers. Bull's eyes and unrealistic values are the result of individual or clustered outliers and should have been prevented by the de-clustering process. But they may appear anyway, and if so, they can be removed by masking and removing the outlier points and re-doing the geo-statistical process using the corrected point source.

ANNEX 6: TRANSITION ARRANGEMENTS FOR DRAINABILITY ASSESSMENT PROCEDURE

INTENT OF 5-YEAR TRANSITION PERIOD

In the Indicator 7.7.5 related to Drainability Assessment approved in 2018 there is a requirement that Drainability Assessments are conducted using the RSPO Drainability Assessment Procedure at least five (5) years prior to replanting.

The intention of this provision was to ensure that Companies did not wait till the last moment prior to replanting to undertake the Drainability Assessment. The period of 5 years was used for alignment with another requirement in P&C 2018 (Indicator 3.1.2) that states, *"an annual replanting programme projected for a minimum of five years (but longer where necessary to reflect the management of fragile soils) with yearly review be available"*.

The intent of 7.7.5 was that at the early stage of identification of any peat area for replanting (through 3.1.2), that the process to prepare a Drainability Assessment would also be initiated. Undertaking a Drainability Assessment at an early stage will give the company an understanding on what information is needed for the Drainability Assessment (especially for data on subsidence rate for the plantation concerned as well as accurate information on the elevation of the replanting area versus the drainage outlet) as well as obtaining a provisional result based on existing or default data.

Undertaking the initial assessment of five years prior to the planned replanting could highlight the need to:

a) Gather additional subsidence data from the site concerned (failing which a conservative default of 5cm/year would be used
b) Introduce enhanced management measures, e.g., water management, to slow the rate of subsidence; and
c) Gather more accurate elevation data for the plantation and the outlet.

If such additional information was gathered, the assessment could be repeated at a later date, prior to the replanting, when a more accurate assessment of future drainability could be made. It was concluded that this would make the Drainability Assessment more accurate and give better predictions.

However, if this is strictly to be followed, the earliest that replanting could be undertaken after the adoption of this requirement in 2018 would be in 2024 (assuming the initial assessment was undertaken in 2019). Therefore, no planting could be undertaken during the period of effectiveness of the RSPO P&C 2018. This was not the intention of this provision.

Concerns with this provision were highlighted by companies prior to the adoption of the P&C 2018 and, as a result, it was agreed that the matter would be reviewed by the Peatland Working Group and a solution would be found by developing a transition arrangement where the five-year requirement could be phased starting in 2019.

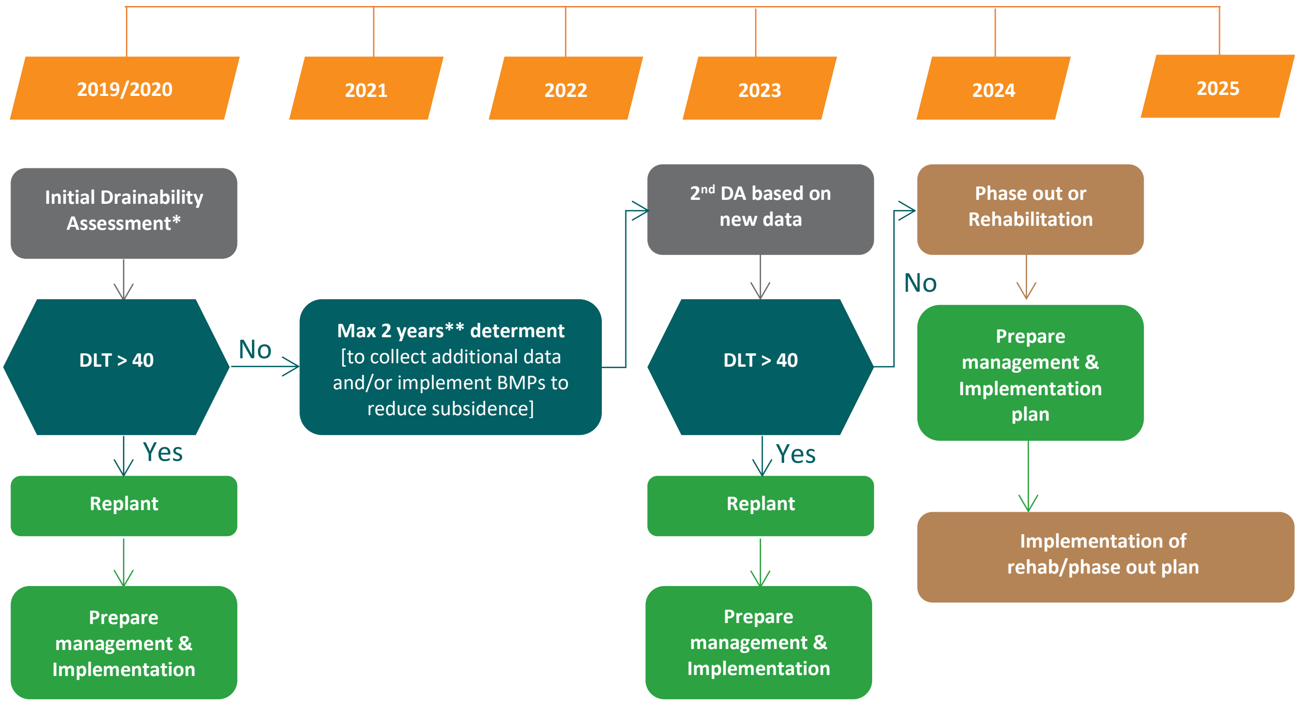
A related problem is that companies highlighted the difficulty to know exactly when a particular area would be replanted – given some variability in the age of replanting in peatland areas (between 15-25 years) with an average of 20 years. This may cause challenges during implementation and auditing where there could be differences of opinion on the appropriate replanting date and hence required timing of the Drainability Assessment. It has therefore been agreed that it would be best to restate the requirement in the following way: "Drainability Assessments would need to be initiated 15 years after first planting on peat". The actual replanting date may be determined based on the status and productivity of the plantation as well as the results of the Drainability Assessment.

Transition arrangement

In order to have a smooth initiation of the Drainability Assessment and avoid any misunderstanding during auditing, the following transition arrangements have been agreed for the period 2019/2020-2024/2025. Starting 2019, all relevant RSPO member companies shall conduct an initial Drainability Assessment for all areas of oil palm on peat that are older than 15 years (and may therefore be expected to be due for re-planting between 2019-2024. Companies may decide on whether to replant based on this initial assessment (refer to Figure A 6.1).

For areas scheduled for replanting in 2019 - 2021, companies have the option to defer the final decision on replanting by up to **two years** to enable more information, especially subsidence data from the sites concerned, to be collected. With regard to areas scheduled for replanting in 2022 -2024, companies have the option to repeat the assessments prior to the scheduled time for replanting, based on additional data gathered between 2019 until the scheduled time for replanting.

The results of the initial assessments in 2019 should be documented in prescribed reporting format and provided to the RSPO Secretariat within one month of completion as input to the review of initial implementation – so that experience can be a basis for refinement of the DAP as appropriate.



** for replanting planned for 2019-2025*
*** from year of planned replanting (for replanting planned in 2019-2023 only)*

Figure A6.1: Drainability Assessment transition period for planted peat areas older than 15 years, i.e., may be considered for replanting in 2019-2024

In 2020, companies should prepare initial Drainability Assessments for areas planted in 2005, i.e., anticipated to be replanted in 2025. Companies could either decide based on the initial assessment or gather additional information and repeat the assessment at the latest by 2024 to make a final decision.

Other issues

Prior Drainability Assessments

For companies that have completed Drainability Assessments using alternative methodologies for the period of 11 June 2019 - 15 November 2019, they are required to submit their assessments to RSPO for review prior to any replanting being undertaken. Starting 15 November 2019 onwards, all alternative methodologies require confirmation by RSPO prior to use.

Drainability Assessments which have been completed and have commenced replanting activities before 11 June 2019 may continue replanting as planned, based on the results of the completed assessment(s).

Table A6.1: Requirements for submission of prior DA assessments and replanting of peat areas

SCENARIO	REQUIREMENT
DA conducted before 11 June 2019	**Areas replanting started before 11 June 2019** Replanting may proceed as planned
DA conducted before 11 June 2019 covering multiple years (e.g., DA conducted in 2018 for replanting through 2019-2025)	**Areas replanting started before 11 June 2019** Replanting may proceed as planned **Remaining areas** Send DA report (other method) to PLWG2 for review. Planting to start after passing the review **OR** Conduct DA based on RSPO methodology and submit to RSPO (for DA procedure revision purposes only)
DA conducted between 11 June -15 Nov 2019	Send DA report (other method) to PLWG2 for review. Planting to start after passing the review; **OR** Conduct DA based on RSPO methodology and submit to RSPO (for DA procedure revision purposes only)
DA conducted 15 November onwards	Send DA methodology to PLWG2 for review. Once approved, DA can be conducted using the approved methodology; **OR** Conduct DA based on RSPO methodology and submit to RSPO (for DA procedure revision purposes only)

Submissions and proposals may be sent through email at ghg@rspo.org.

Acquisitions

Companies which have been acquired by RSPO members that contain planted areas on peat and have been replanted after November 2013 or Nov 2018 without having undertaken a prior Drainability Assessment are required to conduct one for all said areas planted for more than 15 years by the acquiring company.

Results of the Drainability Assessment shall determine whether the replanted areas shall be maintained or rehabilitated as per Indicator 7.7.5 of the P&C 2018.

Planting cycle on peat

Based on information from RSPO member companies, the normal time period for replanting on peat is 20 years (shorter than the normal 25 years for plantations on mineral soil) as a result of generally reduced yields due to serious leaning, disease etc.

In order to avoid a possible loophole being created by companies artificially extending the "life" of the plantations on peat in order to avoid undertaking a Drainability Assessment or complying with its requirements, companies are required to start conducting the Drainability Assessments starting 15 years after prior planting on peat (Figure A6.2).

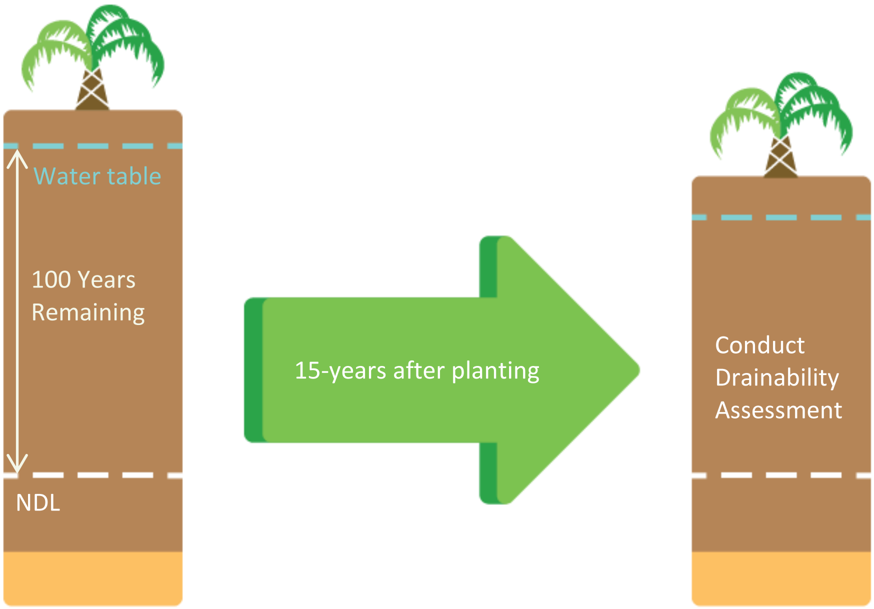


Figure A6.2: Initial Drainability Assessments conducted 15 years after planting (equals 5 years prior to replanting assuming 20-year crop cycle) for plantations with crop cycles >20 years

A company which has undertaken best management practices on peat and has, as a result, minimised leaning of palms and was still achieving high yields at the age of 20 years may make a justification to extend the current cycle (i.e. delay the replanting), provided that a Drainability Assessment had been completed and the assessment shows that the plantation is not within 40 years of subsiding to the NDL.

TIDAL INFLUENCE

Drainability problems mostly exist when excess rainwater cannot be drained from plantations to discharge into rivers/sea during wet periods. Tidal influences may play a role in drainage problems, and may extend up to 30 km up river from the coast. For this Drainability Assessment, the assumption is made those tidal influences are captured in the 'two-crop cycle-threshold', i.e., it is assumed that the 1-2 metres-distance-to-drainage-base (2 crop cycles) threshold is enough to cover tidal influences (see also paragraph 2.3 for more explanation) and therefore tidal influences [18] are not included in the calculations separately. However, it is important to determine the mean annual water level at the outlet of the plantation.

For the Drainability Assessment, the assumption is made that Mean Water Level (MWL) shall be used as reference water level. There are several landmark water levels in the tidal system: Highest Astronomical Tide (HAT), Mean High Water Springs (MHWS), Mean High Water Neaps (MHWN), Mean Sea Level (MSL), Mean Low Water Neaps (MLWN), Mean Low Water Springs (MLWS), and Lowest Astronomical Tide (LAT). Any of these landmark water levels can be used in defining the reference water level for calculation of Drainability Limit, and the choice will depend on perspective and purpose, which adds complications to the calculation. Even after simplifying landmark water levels into just three: High Water Level (HWL), Mean Water Level (MWL) and Low Water Level (LWL), there is still a need to define and justify which level should be used.

From an agronomic point of view the LWL can be chosen, since by installing flap-gate(s), or similar structures, the tidal influence can (partly) be prevented. However, where flap-gates are installed, there is no longer any free-flowing water in the system and whenever flap-gates fail the land may be flooded. From an environmental point of view the HWL can best be used as reference water level, since this provides a far better safeguard against peatland subsidence. For this Drainability Assessment the MWL is used as the reference water level, as a compromise between HWL and LWL. (See Annex 8 for a more in-depth discussion on Future Drainability Assessment of Tidal Peatlands).

SUBSIDENCE

The current RSPO P&C requires that subsidence of peat soils shall be minimised and monitored. Therefore, it is assumed that plantation will measure soil subsidence at reliable spatial and temporal intervals. In the case that less than 3 years of data is available (the minimum required), or the approach to data collection to determine the peat soil subsidence rate does not reflect the requirements, a scientifically robust default value can be assumed for peat soil subsidence in SE Asia.

For this default value, a peat surface subsidence rate is assumed based on science. **Carlson *et al* (2015)** performed an independent study commissioned by the RSPO Emission Reduction Working Group. They studied 66 peer reviewed papers that were available in 2015 and selected 24 site studies based on accuracy criteria that were suitable for the meta-analysis. The average peat surface subsidence rate in these 24 sites (Riau, Johor and Sabah) was **4.7 cm per year with an average confidence interval of 1.8cm** which provides a **range of 2.9 cm/yr to 6.5 cm/yr**.

Based on this study, a **default value for the rate of peat surface subsidence of 5 cm/yr** is assumed and shall be used in the calculations if a company's own data is not available or is not sufficient. It is always better and encouraged to use your own data.

[18] ie the difference between mean tide and high tide

CONSERVATIVENESS

The Tier 1 method is a simplified method. This means automatically that the Tier 1 method should also be the most conservative. The simplification includes that it is a **Lumped method**: The replanting area is not partitioned spatially, instead it is treated as a single lumped area, or group of areas. Secondly, it is a **Static method**: Peat surface subsidence rate, for example, is assumed to not vary from year to year, but is instead assumed to be constant by using site-specific, historical subsidence rates or a conservative default value of 5 cm/yr. **A certain conservativeness** is built in, because simplification always comes with a loss of accuracy.

ANNEX 8: REFERENCE WATER LEVELS FOR FUTURE DRAINABILITY ASSESSMENT OF TIDAL PEATLANDS

SELECTION OF REFERENCE WATER LEVELS

Drainability determines how easy a land can be drained or to drain naturally. The degree and classification of drainability depends on perspective. With gravity drainage in tidal areas, the degree of drainability is only determined by topography and tidal range. Meanwhile, in natural conditions, natural drainability of coastal peatland is mostly determined by topography and high-water level. This means, in tidal areas, peatlands can only survive when their elevations are above high tidal water levels. This is because peat soils cannot sustain under constant or periodic backflow of salt or brackish water. Therefore, choosing the correct reference water level for calculating NDL elevation becomes crucial.

There are several landmark water levels in the tidal system: Highest Astronomical Tide (HAT), Mean High Water Springs (MHWS), Mean High Water Neaps (MHWN), Mean Sea Level (MSL), Mean Low Water Neaps (MLWN), Mean Low Water Springs (MLWS), and Lowest Astronomical Tide (LAT). Basically, any of these landmark water levels can be used in defining reference water level for Drainability Limit calculation, and the choice actually depends on perspective and purpose, which adds complication to the calculation. For practical reasons, we can simplify landmark water levels into just three: High Water Level (HWL), Mean Water Level (MWL) and Low Water Level (LWL).

Future drainability under agricultural schemes can be assessed by considering the implementation of tidal drainage where flap-gate(s), or similar structures, are operated. In this scenario, LWL can be chosen as a reference water level. Long term implication of this choice is that the calculated NDL will end up below MWL, and the headroom level of 40 years away from the NDL may end up below HWL or MWL. In this situation, if future land elevation is below HWL or MWL, it is impossible to do a “Return To Nature” after abandonment, because the land is likely to be flooded by salt or brackish-water permanently or periodically.

If mean water level is chosen as a reference in calculating future drainability, the calculated NDL is going to be higher than MWL. However, depending on the subsidence rate, the headroom level of 40 years away from the NDL may be above or below HWL. In this scenario, if the future land elevation is below HWL, “Return To Nature” after abandonment in the future, becomes impossible since the land will be flooded by salt or brackish water periodically (during high tide).

Only by choosing HWL as a reference water level can the “Return To Nature” scenario be assured with greater certainty. Nevertheless, in certain situations, choosing MWL can also provide some degree of assurance. Therefore, MWL can be regarded as a compromise, and be applicable.

Examples (simulation) of two uses of reference water level choices are given in the following paragraphs. Figure A7.1 illustrates the two examples.

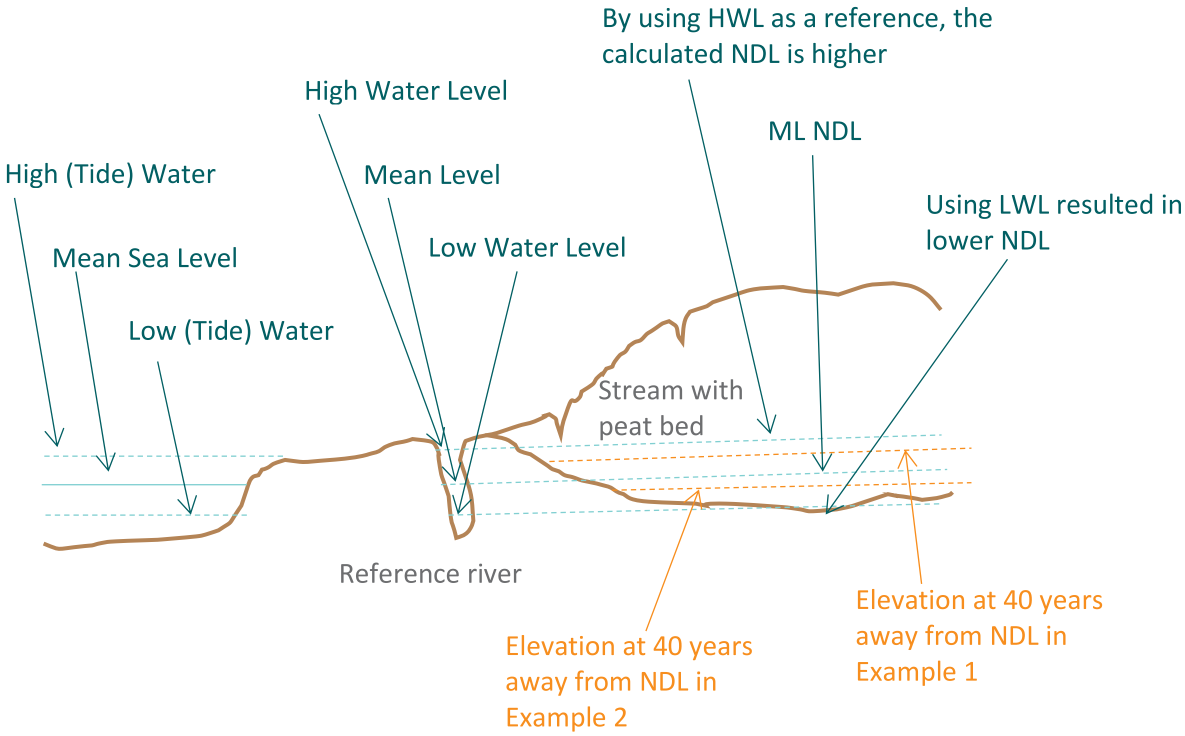


Figure 8.1: Illustration of NDL elevations that are referenced to high, mean, and low water levels respectively

Example 1: Choosing Mean Water Level as a reference level

With 3 metres tidal range, the highest water level elevation would be about 1.5 metres above sea level. If we use mean water level (0 m-msl) as a reference level, the drainability limit elevation would be so close to 0 m-msl. And with 3 cm/year subsidence, land elevation at 40 years away from drainability limit (time of abandonment or return to nature) would be at 1.4 m-msl. The land is still going to be flooded during high tide, and it is likely that the areas close to the sea will become more suitable for mangrove. It can be seen that choosing mean water level as a reference level may not guarantee a possibility of "Return To Nature" after abandonment.

Example 2: Choosing Low Water Level as a reference level

In many places in Indonesia tidal ranges are so big that it may reach 4-5 metres in amplitude. In this scenario, a tidal system with 3 metres amplitude is taken as an example. If we would take LWL as a reference, it would be -1.5 m-msl (1.5 m below mean sea level). That means NDL elevation would be so close to 1.5 m below mean sea level. With a subsidence rate of about 3 cm/year, the elevation above the NDL (time of abandonment or Return to Nature) at 40 years would be 10 cm below mean sea level. If the land is not restored and subsidence continues until this level is reached, the land would be flooded during high tide, and even extending for some time during low tide period. The tides usually affect peatlands through open channel system only. But with this, it will also affect the land with salt or brackish-water overland flow. Over time, this may eventually change the ecosystem from peatland to salt water. Therefore, using LWL as the reference is not an option in this assessment. Using HWL as the reference is recommended, while using MWL is acceptable as a compromise.

VARIABILITY OF TIDAL RANGE

Around the SE Asian coasts, spring tide ranges (Figure A8.2) are a metre or less on the south west coast of Sumatra, but they increase to more than 3 metres in the narrows of the Straits of Malacca. They are up to 1 metre on the south-west coast of Kalimantan, and somewhat larger (up to 2.8 metres) on the east coast. North-east of the Arafura Sea tide ranges of more than 5 metres occur in estuarine inlets along the southern coast of Irian Jaya, where tidal bores are generated, moving upstream as steep waves as the tide rises. Tidal oscillations are also complicated by wind action. Northeast winds over the China Sea build up the water level south of Singapore by as much as 0.5 metres between January and March, while south-east winds raise winter sea levels a similar amount along the southern coasts between Timor and Java."

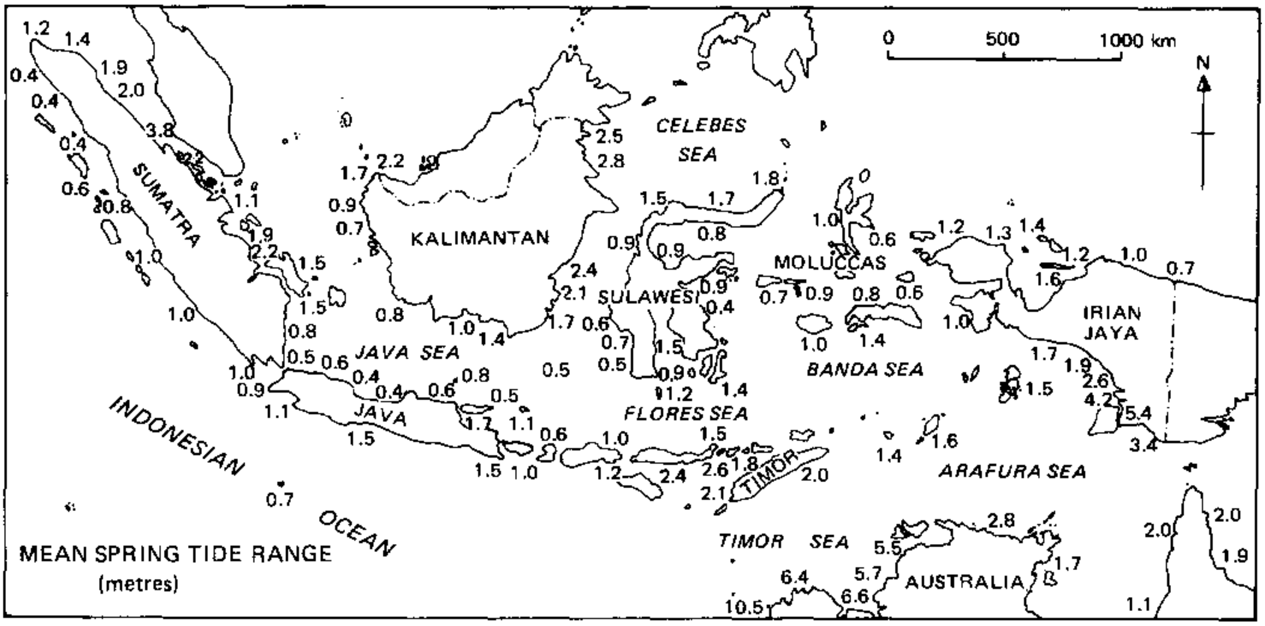


Figure 8.2: SE Asia's tides[19]

On the basis of this information and bearing in mind the location of coastal peatlands in SE Asia, it would appear that phasing out plantation operations once the peat surface is within 1 to 2 metres height above the NDL should be sufficient to prevent flooding at high tide, but, as is recommended in Annex 5, this assumption should be checked against local conditions.

[19] Source: http://archive.unu.edu/unupress/unupbooks/80197e/80197E02.htm)

ANNEX 9: DA Report Review Process and Transition from DAP Version 1 To Version 2

Companies are given a transition period until 31st March 2022 during which either Version 1 or Version 2 can be used, although using Version 2 is recommended. Starting 1st April 2022, the DAP Version 2 comes into full effect where all DA reports that was initiated after this date shall follow the report format in DAP Version 2.

As for DA reports conducted using DAP Version 2 which is submitted to RSPO for the first time, kindly include 'Submission Checklist for RSPO Drainability Assessment (DA)' (refer Section 6)

Overview of the review process

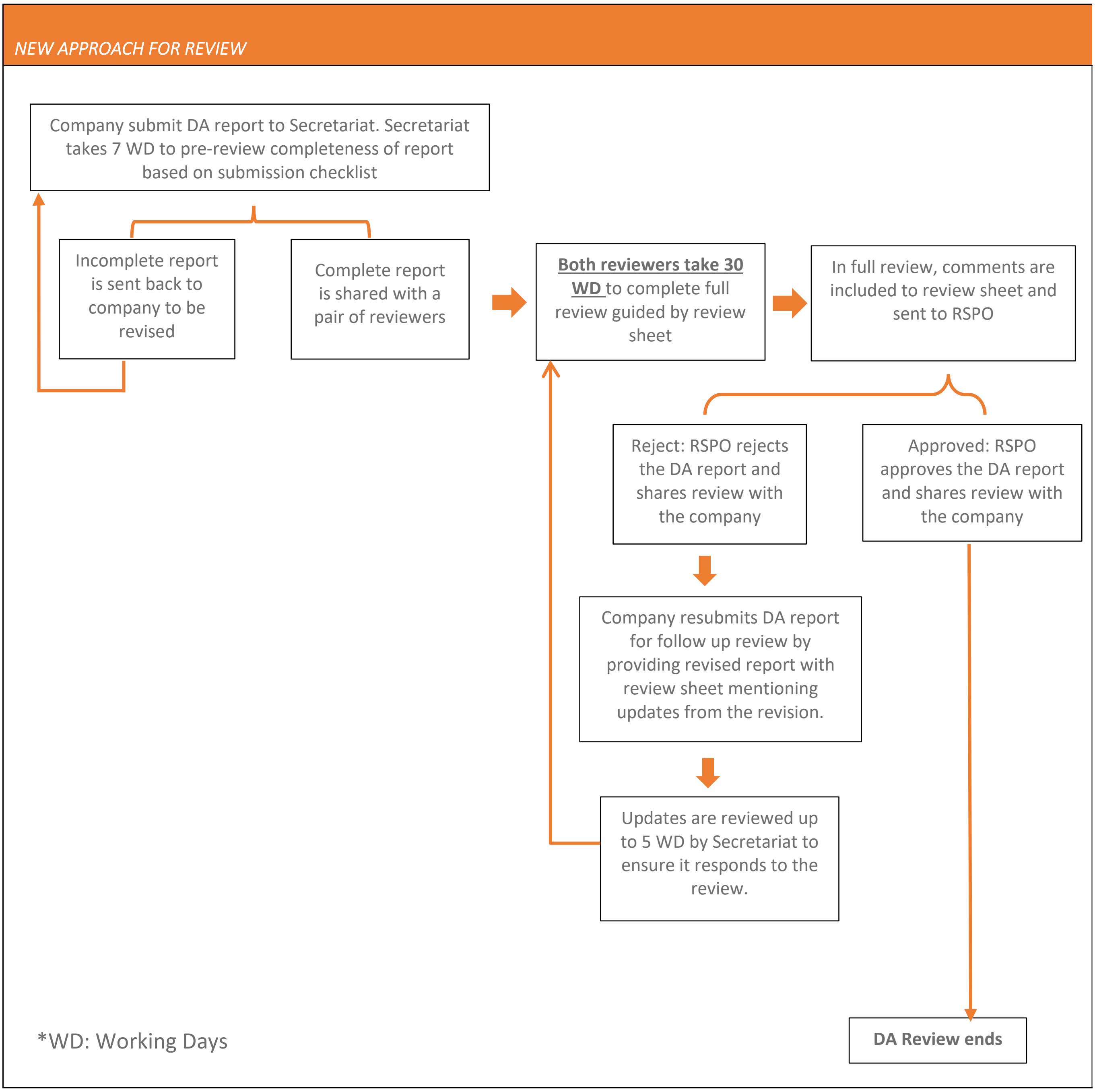


Figure A8.1: Flowchart showing DA review process

ANNEX 10: CHANGES TO APPROVED DA REPORT

For companies that decide to change the proposed replanting year as specified in a previously approved DA Report, the information below needs to be submitted to RSPO Secretariat.

Details	
Name of company	
Name of the plantation	
Initial DA report approval (date)	
Initial approved replanting year	
Initial approved area for replanting (ha)	
New proposed replanting year	
New proposed area for replanting (ha)	
Reason for change in replanting year	

Revised DLT/NRI Calculation

Peatland replanting block	**Original Proposed replanting year**	**Final approved DLT**	Proposed revised Replanting year	No of year of delayed replanting	Revised DLT **(Approved DLT – delay)**	**NRI (Final DLT - 40) (years)**	**Go/No-Go**
1	2025	76	2030	5	71	31	Go
2	2026	80	2030	4	76	36	Go
3	2027	42	2030	3	39	-1	No-Go

Note: The initial proposed replanting area and new proposed replanting area must be of the same area and hectarage. Changes will require a full review to be carried out for the new hectarage.

Note: As stated in section 5.3, it is permitted that the company can bundle assessments for proposed replanting less or equal to five years apart in one DA Report. In case a company wishes to adjust the planting year within a bundled assessment, the revised planting year should not be later than the permitted five year spread of the bundle (ie no more than 5 years after the date of the first proposed planting year).

RSPO is an international non-profit organisation formed in 2004 with the objective to promote the growth and use of sustainable oil palm products through credible global standards and engagement of stakeholders.

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