Working Paper

HOW TO IDENTIFY DEGRADED LAND FOR SUSTAINABLE PALM OIL IN INDONESIA

BETH GINGOLD, ANNE ROSENBARGER, YOHANES I KETUT DEDDY MULIASTRA, FRED STOLLE, I MADE SUDANA, MASITA DWI MANDINI MANESSA, ARI MURDIMANTO, SEBASTIANUS BAGAS TIANGGA, CICILIA CICIK MADUSARI, PASCAL DOUARD

SUMMARY

Palm oil production in Indonesia has the potential to generate local benefits if oil palm cultivation expansion follows sustainable planning and management practices, including respect for local interests and rights. Potential benefits include increased incomes, profits, and government revenues, reduced poverty, and improved natural resource management. Whether this potential is achieved will depend on how new areas for oil palm cultivation are identified.

This working paper demonstrates how to implement a quick and cost-effective method for identifying potentially suitable areas for oil palm cultivation. The method is designed in accordance with established standards for sustainable palm oil production, such as those of the Roundtable on Sustainable Palm Oil (RSPO); incorporates relevant Indonesian laws and policies; and is consistent with proposed national REDD+ strategies to support palm oil production on low carbon degraded land. The method consists of a desktop analysis using readily available data and rapid field assessments. It is based on a set of indicators related to selected environmental, economic, social, and legal considerations.

This method can be used by companies as a first step in a site selection process for a certified sustainable plantation and can inform government officials and nongovernmental organizations (NGOs) in assessing land use policy options to support the expansion of sustainable palm oil production on degraded land. However, since it is designed primarily to rapidly identify the highest priority areas for further investigation, it should not be used to predetermine where oil palm cultivation expansion should occur.

CONTENTS

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Using this method as a first step in a site selection process can reduce the costs of implementing the additional due diligence activities required to confirm the suitability of a potential site for oil palm cultivation. These activities, which are outside the scope of this paper, include community mapping to document community claims and rights, conducting high conservation value (HCV) and social impact assessments, implementing a comprehensive free prior and informed consent (FPIC) process, and fulfilling legal requirements.

The World Resources Institute (WRI) and Sekala applied this method to identify nine potentially suitable areas in the Indonesian province of West Kalimantan for a pilot sustainable palm oil project under Project POTICO (http://www.wri.org/project/potico). These nine sites were identified through targeted field assessments of high priority sites identified through the desktop analysis using project-specific criteria and do not represent all potentially suitable areas in the province.

The desktop analysis, the first step in this method, classified a total of approximately 7 million hectares of land in the provinces of West Kalimantan and Central Kalimantan as potentially suitable, using the best publicly available data at the time of publication. This desktop analysis, associated data, and other supplemental materials are being made easily accessible on a public website (http://wri.org/publication/identifying-degraded-land-sustainable-palm-oil-indonesia). The website will also allow users to generate their own suitability maps—using parameters of their choice—to guide their own targeted field assessments.

INTRODUCTION

Palm oil production in Indonesia has the potential to generate local benefits if oil palm cultivation expansion follows sustainable planning and management practices, including respect for local interests and rights. Potential benefits include increased incomes, profits, and government revenues, reduced poverty, and improved natural resource management. Whether this potential is achieved will depend on how new areas for oil palm cultivation are identified.

In Indonesia, there is growing political and financial support for using "degraded land" for more "sustainable" palm oil production. In May 2010, Indonesian President Susilo Bambang Yudhoyono declared a policy to develop oil palm plantations on degraded land instead of forest or peatland.[1] As part of an ambitious national REDD+ strategy, this policy has the potential to allow the palm oil industry to continue to expand—generating profits, government revenues, and jobs—while reducing greenhouse gas emissions from deforestation and forest degradation.[2]

Support for the use of degraded land for palm oil production has also gained traction in the private sector. For example, the Roundtable on Sustainable Palm Oil's (RSPO) guidance for fulfilling voluntary sustainable certification requirements in Indonesia states that new plantations in Indonesia should use "previously cleared and/or degraded land."[3] In February 2011, Golden Agri Resources, one of Indonesia's largest palm oil producers, announced a "no deforestation" policy consistent with the government's proposed degraded land strategy.[4] Furthermore, in April 2011 the World Bank Group announced a new global strategy for investment in palm oil that would give priority to initiatives that "encourage production on degraded lands."[5]

There is no single definition of degraded land and no corresponding definition in Indonesian law or policy, leading to confusion regarding the extent, location, and legal status of these areas.[6] The term has been used in multiple contexts to describe land with a wide variety of characteristics, sometimes referring to biophysical characteristics such as tree cover, and sometimes to agricultural productivity, land use, or legal designation. Likewise, the term "sustainable" has been used in many contexts, further contributing to the confusion regarding the circumstances under which land should be legally available and used for oil palm expansion.

In the context of promoting more sustainable palm oil expansion, degraded land usually refers to areas with low carbon stocks and low biodiversity levels, rather than characteristics related to agricultural suitability or legal availability. For example, a draft Indonesia national REDD+ policy suggests that land is considered degraded if it contains less than 35 tons of carbon per hectare.[7]

This definition would include areas that were cleared of forests long ago and now contain low carbon stocks and low levels of biodiversity, such as alang alang (grasslands), and would exclude most areas with natural forest cover or peatland, which often contain greater than 200 tons of carbon per hectare.[8] However, this definition of degraded land would also include many areas that are currently under cultivation or are locally important for social or cultural reasons, and therefore may not be appropriate for oil palm cultivation expansion. Converting these areas to oil palm plantations can lead to social conflicts and increased

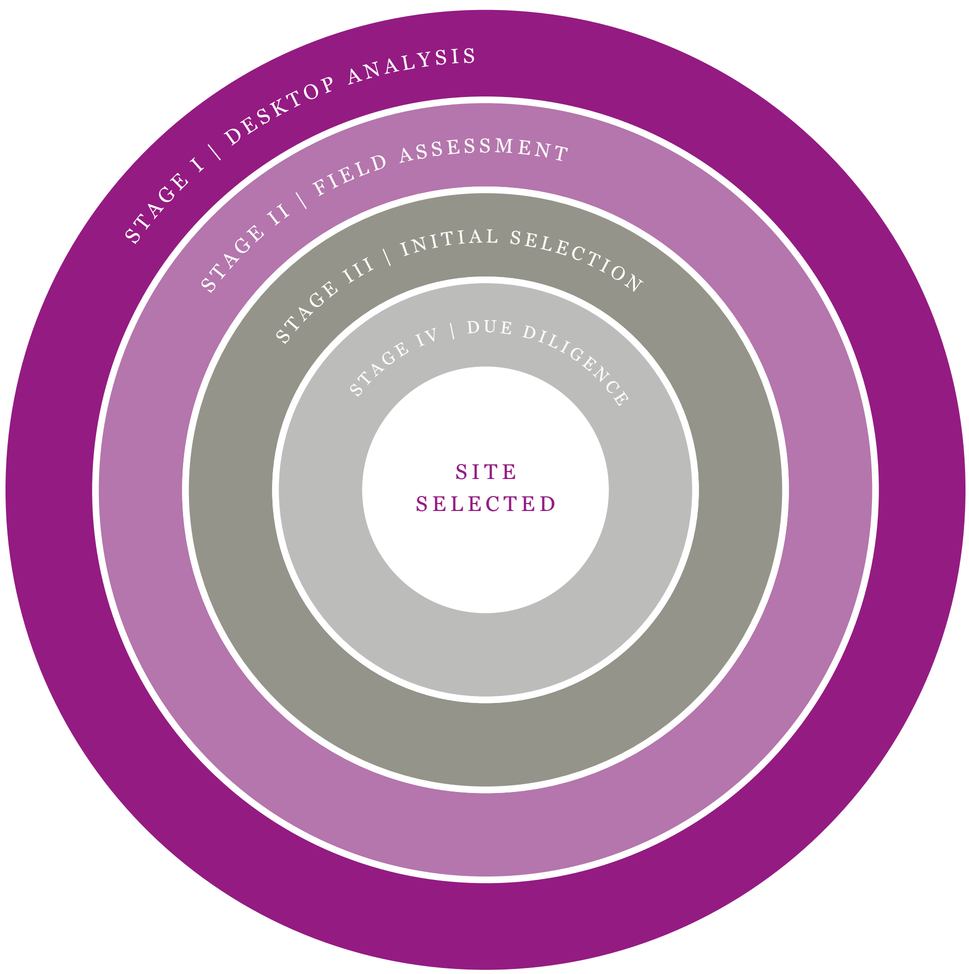
Figure 1 | **Site Selection Considerations**

poverty when local interests are not respected and local people are not effectively involved in decision making.[9] This definition of degraded land would also include some areas that are legally designated as part of the Forest Estate and therefore are currently unavailable for oil palm cultivation.[10]

Several established standards provide guidelines for sustainable palm oil production. These guidelines include economic, environmental, social, and legal considerations to be taken into account when identifying new areas for oil palm cultivation—including but not limited to carbon and biodiversity considerations.[11] For example, fulfilling voluntary market sustainable certification requirements includes avoiding negative impacts on "high conservation value" (HCV)[12] areas and obtaining the "free prior and informed consent" (FPIC) of local people.[13] The time and cost of fulfilling these requirements can be reduced when sustainability considerations are used to guide the earliest stages of identifying new areas for palm oil production.

This paper presents a quick and cost-effective method for identifying potentially suitable areas for oil palm cultivation. The World Resources Institute (WRI) and Sekala developed this method as part of Project POTICO.[14] The method is designed in accordance with established standards for sustainable palm oil production. It incorporates relevant Indonesian laws and policies, and is

Figure 2 | **Overview of a Comprehensive Site Selection Process**



consistent with the proposed national REDD+ strategy to support palm oil production on degraded land. The development of this method was informed by interviews with private companies and complementary work conducted by organizations such as WWF, Conservation International (CI), The Nature Conservancy (TNC), PanEco Foundation, and Fauna & Flora International (FFI).[15]

The output of the method is a set of sites identified as potentially suitable for oil palm cultivation based on a selected set of eight considerations, which are grouped into environmental, economic, legal, and social categories. As described in Figure 1, these considerations are: (1) carbon and biodiversity; (2) soil and water protection; (3) crop productivity; (4) financial viability; (5) zoning; (6) rights; (7) land use; and (8) local interests.

Specific indicators are used to assess each of these considerations. These indicators are designed to provide sufficient information to quickly identify potentially suitable areas to be further investigated in the field, rather than to exhaustively address each of these considerations. The carbon and biodiversity consideration contains indicators relevant to identifying "degraded land" as defined in national REDD+ strategies. This consideration is only a part of a more comprehensive definition of potentially suitable land for sustainable oil palm cultivation, which includes all of the considerations described in this method.

As Figure 2 illustrates, the method consists of a province-wide desktop analysis (Stage I) and rapid field assessments of priority sites (Stage II). Field assessments are imperative to confidently identify potentially suitable areas, due to the limitations regarding data availability, accuracy and resolution at the provincial level, as well as inherent limitations of any desktop analysis to assess qualitative and site-specific social issues.

This method can be used by companies as a first step in a site selection process for a certified sustainable plantation and can inform government officials and NGOs in assessing land use policy options to support the expansion of sustainable palm oil production on degraded land. However, since it is designed to rapidly identify the highest priority areas for further investigation, it should not be used to conclusively determine where oil palm cultivation expansion should occur.

Using this method as a first step in a site selection process can reduce the costs of implementing the additional due diligence activities required to confirm the potential suitability of an area. Such activities, which are outside the scope of this paper, include community mapping to document community claims and rights, conducting HCV and social impact assessments, implementing a comprehensive FPIC process, and implementing required legal procedures (Figure 2).[16]

This paper also presents results of the application of the method to identify potential field sites for a pilot project under Project POTICO and the potential suitability maps of West Kalimantan and Central Kalimantan generated in the desktop analysis. Data associated with the desktop analysis, which varies in quality for different indicators, will be made available for viewing and download on a website along with other supplemental materials (http://wri.org/publication/identifying-degraded-land-sustainable-palm-oil-indonesia). The website will also allow users to generate their own suitability maps—using parameters of their choice—to guide their own targeted field assessments.[17]

METHOD

This section describes the method for identifying potentially suitable sites for oil palm cultivation developed under Project POTICO. It consists of two stages:

- **STAGE I. DESKTOP ANALYSIS.** Areas are classified as "high potential," "potential," or "not suitable" for oil palm cultivation on a province-wide potential suitability map (Step 1). Priority field sites are identified for field surveys (Step 2).

- **STAGE II. FIELD ASSESSMENTS.** Sites are classified using the same categories based on the results of field surveys.

"Potentially suitable" areas and "potentially suitable" sites are those classified as either high potential or potential.

Each stage includes indicators for the selected environmental, economic, social, and legal suitability considerations. Table 1 summarizes the considerations and indicators assessed in each stage.

Table 1 | **Considerations, Indicators, and Stages**

CONSIDERATION		INDICATOR	STAGE I. DESKTOP ANALYSIS		STAGE II. FIELD ASSESSMENTS
			STEP 1. SUITABILITY MAPPING	STEP 2. FIELD SURVEY SITE SELECTION	
ENVIRONMENTAL	Carbon and biodiversity	Land cover	X		X
		Peat	X		X
		Conservation areas with buffer zones	X		
	Soil and water protection	Erosion risk	X		X
		Groundwater recharge potential	X		
		Water resource buffers	X		
ECONOMIC	Crop productivity	Topography (elevation; slope)	X		X
		Climate (rainfall)	X		
		Soil (depth; type; drainage; acidity; color)	X		X
	Financial viability	Size		X	X
		Accessibility		X	X
LEGAL	Zoning	Legal classification		X	X
	Rights	Concessions		X	X
		Active plantations			X
		Community claims/rights	This critically important consideration is outside the scope of this method and must be addressed through additional activities before the suitability of a site is confirmed (see Figure 2).		
SOCIAL	Land use	Land use dependence	X*		X
		Manmade drainage			X
		Land history			X
	Local interests	Community perception of oil palm			X
		Community interest in planting oil palm			X
		Political interests			X

* Land cover is used as a proxy for land use during desktop analysis. Land use is assessed directly during field assessments.

STAGE I: DESKTOP ANALYSIS

The desktop analysis consists of two steps:

- **STEP 1. SUITABILITY MAPPING.** A province-wide potential suitability map is created that classifies areas according to their potential suitability for sustainable palm oil production based on indicators related to the carbon and biodiversity, soil and water protection, and crop productivity considerations.

- **STEP 2. FIELD SURVEY SITE SELECTION.** Priority sites are chosen from potentially suitable areas identified in Step 1, taking into account indicators related to the financial viability, zoning, and rights considerations.

The results of the desktop analysis are designed to provide preliminary guidance to direct field assessments of priority sites (Stage II.). Limitations in the accuracy and availability of provincial-level data necessitate verification in the field. Furthermore, some considerations, particularly those relating to social issues, cannot be assessed using a desktop analysis.

The following describes each of these steps. The associated datasets used under Project POTICO are described in the application section. These datasets, which vary in quality and resolution for different indicators, were the best available, provincial-level GIS data at the time of the analysis.[18]

Step 1. Suitability Mapping

The output of Step 1 is a province-wide potential suitability map, which assigns all land to one of three suitability classes for sustainable palm expansion: high potential, potential, or not suitable.[19] This combined suitability map is the combination of three thematic layers, each corresponding to one of the following considerations: carbon and biodiversity, soil and water protection, and crop productivity. Each layer is created using a subset of 13 individual indicators associated with these considerations. This section describes the indicators, suitability classes, and data used to create the combined suitability map, organized by thematic layer.

To create the combined suitability map, the three suitability classes are each assigned a number code, in which high potential = 1, potential = 2, and not suitable = 3. Each of these codes is assigned to a specific range of values for each indicator in the analysis. For example, for the indicator of elevation, a value of less than 500 meters is high potential (1), a value of 500–1,000 meters is potential (2), and a value of greater than 1,000 meters is not suitable (3). A simple binary technique is used to determine the overall suitability of an area, such that if the value of any single indicator for an area is not suitable, the end result for that area is not suitable.[20] Conversely, for an area to be classified as high potential, values for all 13 indicators in that area must be high potential. All other areas are classified as potential.

Suitability classes for each indicator, as described below, are designed based on several established suitability standards and methods, including the High Conservation Value (HCV) Toolkit for Indonesia, and Indonesian policies and regulations.[21]

a. Carbon and Biodiversity Layer

The carbon and biodiversity layer is designed to reflect whether the conversion of an area to an oil palm plantation is likely to result in negative impacts on carbon stocks and biodiversity high conservation values (HCV 1–3).[22] This layer has three suitability indicators: (1) land cover, (2) peat, and (3) conservation areas with buffer zones (Table 2). Suitability classes for these indicators were chosen as follows:

- **LAND COVER** refers to whatever is covering the earth's surface, whether the cover is a class of vegetation or a type of manmade infrastructure. It serves as an indicator for aboveground carbon stocks and biodiversity. Land cover also serves as a preliminary indicator for the land use consideration to be further explored in subsequent fieldwork, as well as for the soil and water protection consideration, as described by the HCV Toolkit.

  Consistent with the 35 tons of carbon per hectare threshold provided in the draft Indonesia National REDD+ strategy, any natural forest land cover type was classified as not suitable, including both primary and secondary forests. These areas are also most likely to contain HCV 1–3. However, other land cover types—such as grasslands or savannah—may also contain high conservation values, which could result in some areas that are classified as potentially suitable in the desktop study later being determined to be not suitable during field assessments.

Table 2 | **Carbon and Biodiversity Indicators and Suitability Classes**

INDICATOR	SUITABILITY CLASSES		
	HIGH POTENTIAL (1)	POTENTIAL (2)	NOT SUITABLE (3)
Land cover*	Shrub/bush; savannah; open	Dry-land farming; dry-land farming/ mixed shrub; shrub swamp; timber plantation; estate crop; rice field; mining area	All natural primary and secondary forest; mangrove forest, dry-land forest, swamp forest; airport; settlement; transmigration area; swamp; fish pond
Peat	No peat soil (0 cm)	-	Peat soil of any depth (>0 cm)
Conservation areas with buffer zones	All areas outside of conservation areas with buffer zones	-	All areas within conservation areas with buffer zones Conservation areas: Hutan Lindung (Protection Forest); Hutan Konservasi (Conservation Forest) Buffer of 500 meters around areas with set boundaries; 1,000 meters around areas without set boundaries

* Land cover also serves as a preliminary social indicator for land use and for soil and water protection. These land cover codes correspond with data provided by the Ministry of Forestry. Other datasets may have different land cover codes which can similarly be classified as high potential (no forest cover, little/no active land use); potential (no forest cover, active land use); not suitable (forest cover and/or very active land use).

For land cover types other than natural forests, those indicating a high degree of active land use—for example, settlements—are classified as not suitable; those indicating possible active land use—such as dry-land farming—are classified as potential; and areas with land cover types without indications of active land use—such as open land—are classified as high potential.

The specific land cover codes chosen for each suitability class depend on the data used. The land cover codes in Table 2 correspond with land cover data provided by the Ministry of Forestry.[23] Exact definitions and descriptions of methodologies used to produce this data are not available. Other datasets may have different land cover codes which can similarly be classified as high potential (no forest cover, little/no active land use); potential (no forest cover, active land use); or not suitable (forest cover and/or very active land use).

- **PEAT** refers to the presence of peat soil. Peat soils of all depths and composites are considered not suitable for several reasons. Due to their high carbon content, peat soils are not considered suitable for oil palm plantations according to the draft Indonesia National REDD+ Strategy and according to Presidential Instruction No. 10/2011 regarding a two-year moratorium on new permits on primary natural forest and peatland.[24] Peat soils are also associated with wetlands with critical hydrological functions for soil and water protection. In addition, development on peat soils has been associated with high development costs and low yields, which can result in lower financial viability.[25]

- **CONSERVATION AREAS WITH BUFFER ZONES** are likely to contain biodiversity high conservation values (HCV 1–3) and are defined by legal classifications from the Ministry of Forestry, with buffer zones created in accordance with Indonesian regulations, namely Government Regulation No. 47/1997 and Presidential Decree No. 32/1990. Legal classifications that are considered conservation areas are Hutan Lindung (Protection Forest) and Hutan Konservasi (Conservation Forest). Buffer zones are created to include areas within 500 meters of conservation areas with set boundaries and within 1,000 meters of areas without set boundaries.

b. Soil and Water Protection Layer

The soil and water protection layer is created using additional environmental indicators that reflect ecosystem services provided by an area that influence both long-term agricultural productivity and environmental impacts directly related to human health and livelihoods. While fully addressing this consideration during plantation development will require in-depth HCV and social impact assessments outside the scope of this paper, including these preliminary indicators at the outset can help avoid selecting the most vulnerable areas during the site selection process.

Indicators for soil and water protection are modeled based on Indonesian policies[26] and the HCV Toolkit's "environmental services" (HCV 4).[27] The forest ecosystems identified as water protection areas by the HCV Toolkit are already classified as not suitable based on the land cover indicator described above, and are therefore not included in this section. Slope is also closely linked to soil and water protection, and is indirectly included in this section as an input factor for two indicators (erosion risk and groundwater recharge potential). However, as a direct indicator, slope is included in the crop productivity layer rather than in this layer.

The soil and water protection layer has three suitability indicators: (1) erosion risk, (2) groundwater recharge potential, and (3) water resource buffers (Table 3). Suitability classes for these indicators were chosen as follows:

- **EROSION RISK** is calculated in this method based on a modified version of the Universal Soil Loss Equation (USLE), suggested by the HCV Toolkit for Indonesia.[28] Areas with high or very high erosion risk are associated with high levels of soil loss and sedimentation, and therefore are classified as not suitable.

- **GROUNDWATER RECHARGE POTENTIAL** reflects the likelihood of surface water reaching groundwater. Areas with high recharge potential values are critical for groundwater replenishment and are vulnerable to contamination from heavy pesticide, herbicide or fertilizer use, and therefore are classified as not suitable. When sufficient data is available, this can be calculated based on an adaptation of the model developed by Yeh et al. (2009).[29] This model requires data on five input factors: drainage, lithology, land cover, slope, and lineaments. When this data is not available, this indicator can be excluded from the desktop analysis but should be considered in a comprehensive site selection process.

- **WATER RESOURCE BUFFERS** are areas surrounding water resources—including lakes, streams, rivers, springs, and coastlines—that are critical for maintaining healthy water supply. These areas are classified as not suitable, which is consistent with Indonesian Government Regulation No. 47/1997 and Presidential Decree No. 32/1990.

Table 3 | **Soil and Water Protection Indicators and Suitability Classes**

INDICATOR	SUITABILITY CLASSES		
	HIGH POTENTIAL (1)	POTENTIAL (2)	NOT SUITABLE (3)
Erosion risk	Very low; low	Medium	High; very high
Groundwater recharge potential	Very low; low;	Medium	High; very high
Water resource buffers	All areas outside of buffer zones	-	All areas within buffer zones around the following resources: coastline(100 m); stream (50 m); river (100 m); spring (200 m); lake(100 m)

Table 4 | **Crop Productivity Indicators and Suitability Classes**

INDICATOR	SUITABILITY CLASSES		
	HIGH POTENTIAL (1)	POTENTIAL (2)	NOT SUITABLE (3)
Elevation	< 500 m	500–1,000 m	> 1,000 m
Slope	< 8 percent	8–30 percent	> 30 percent
Rainfall	1,750–6,000 mm/yr	1,250–1,750 mm/yr	> 6,000 mm/yr; <1,250 mm/yr
Soil depth	> 50 cm	-	< 50 cm
Soil type	Silt loam; sandy clay loam; silty clay loam; clay loam (wet & dry inceptisol; oxisol) Sandy loam (alfisol); sandy loam, clay loam, clay (ultisol)	Sandy clay; silt (spodosol; entisol)	Heavy clay; sand (histosol)
Soil drainage	Good; moderately good	Excessive; poor	Very excessive; very poor; stagnant
Soil acidity	pH 4–6.5	pH 3.5–4 and 6.5–7	pH < 3.5 and > 7

c. Crop Productivity Layer

The crop productivity layer is created using indicators reflecting biophysical characteristics relevant to oil palm cultivation, including elevation, slope, rainfall, soil depth, soil type, soil drainage, and soil acidity (Table 4). These indicators are important economic factors impacting crop yields, the amount of management input required (that is, fertilizer, specialized crop strains, irrigation, terracing), and the long-term profitability of a plantation. For these indicators, appropriate suitability classes may vary according to individual company or project-specific requirements. Suitability classes could also be adjusted to identify potentially suitable sites for other crops, including timber plantations.

For this method, the crop productivity suitability classes were defined using a compilation of existing standards identified from the Roundtable on Sustainable Palm Oil (RSPO),[30] ISRIC World Soil Information,[31] Regional Physical Planning Programme for Transmigration (RePPProT),[32] and SarVision.[33] Of these, the standard with the most inclusive range of suitability is selected for most indicators. This allows for the widest range of potentially suitable areas, including areas that may require higher levels of management input and technology. The decision to select the most inclusive suitability ranges is based partly on feedback from palm oil companies, which indicates that current market trends and technological advances make it increasingly feasible to cultivate under less than ideal biophysical conditions. An exception to this is slope, for which the most restrictive standard is selected, due to additional implications of this indicator for soil and water protection.

Step 2. Field Survey Site Selection

In Step 2, survey sites are selected for field assessments from potentially suitable (high potential or potential) areas identified via suitability mapping (Step 1). Additional considerations regarding financial viability, zoning, and rights are then used to further prioritize locations for field sites. This process is designed to quickly identify priority sites that are most likely to fulfil the needs of a particular project or company, rather than to systematically assess all potentially suitable areas. The priority factors used to identify sites may vary between companies, and the selected sites may not represent all of the potentially suitable areas identified in the suitability mapping step. Table 5 describes the indicators and priority factors used to select field sites under Project POTICO.

Financial viability is a basic prerequisite for the long-term success of any investment. While long-term viability depends on many factors outside the scope of this method, the two most relevant indicators (based on interviews with companies) are size and accessibility.

- **SIZE** reflects the contiguous area of a potentially suitable site, which has implications for plantation and mill management decisions. For example, larger contiguous areas can support larger, more profitable mills. In the application of this method, a minimum size threshold of 5,000 hectares was chosen based on a common minimum size preference expressed by companies in interviews.[34] However, this minimum would not apply to all business models for oil palm cultivation, such as smallholder cultivation as part of mixed agroforestry systems or small independent mills. On the combined suitability map, the sizes of potentially suitable areas are calculated by GIS.

- **ACCESSIBILITY** reflects how easily a site can be reached by road or river, which has implications for how much infrastructure investment will be required for a project, as well as for the feasibility of conducting field surveys. Easy accessibility can enhance the attractiveness of a site, although companies also express willingness to invest in building infrastructure once they have gained legal access to land. Accessibility is assessed in this step by visually inspecting the combined suitability map, overlaid with spatial data of rivers and roads.[35]

  This step can also be automated using GIS by specifying a "minimum distance to roads" requirement.

Zoning and rights considerations are included in this step primarily to provide information to be verified during field surveys, rather than to eliminate otherwise potentially suitable sites. This is due to a combination of a lack of appropriate data and the fact that legal considerations can be changed depending on local interests. For example, these considerations can be changed through a government spatial planning process or when an existing concession expires, is revoked, or is held by a concessionaire with intentions to sell rather than develop.

Two indicators for zoning and rights are included in this step: legal classification and concessions.

- **LEGAL CLASSIFICATION** refers to the legal classifications described in the Forestry Law of 1999, which divides all land in Indonesia into either Forest Estate (Kawasan Hutan) or Non Forest Estate (Areal Penggunaan Lain - APL).[36] Land within the Forest Estate is further classified according to the following functions: Permanent Production Forest (Hutan Produski Tetap– HP), Limited Production Forest (Hutan produski Terbatas – HPT), Convertible Production Forest (Hutan Produski Konversi– HPK), Protected Forest (Hutan Lindung – HL), Conservation Forest (Hutan Konservasi – HK).

Table 5 | **Field Survey Site Selection Indicators and Priority Factors**

CONSIDERATION		INDICATOR	PRIORITY FACTOR
Combined suitability		Suitability class	High potential or potential (calculated in Stage I)
ECONOMIC	Financial viability	Size	Minimum 5,000 hectares
		Accessibility	Accessible by road or river
LEGAL	Zoning	Legal classification	All legal classifications aside from conservation areas that were classified as not suitable in Stage I
	Rights	Concessions	No known active concession

Oil palm plantations can be legally developed in APL areas, or in HPK areas when extra procedures are followed to release the HPK area from the Forest Estate, making these areas most attractive from a legal standpoint. However, legal classifications do not necessarily reflect biophysical characteristics such as tree cover and consequently some of the potentially suitable areas identified by this method may be classified as part of the Forest Estate (i.e., HP or HPT). Such areas require additional actions to be released from the forest estate in order to be legally eligible for development. In this step, legal classification data is collected for field verification by overlaying the combined suitability map with the most recent publicly available Ministry of Forestry land allocation map.[37]

- **CONCESSIONS** refers to whether or not there are known large-scale concessions in the area (e.g., for oil palm, timber, logging, or mining). Due to known inconsistencies in concession data, the presence of concessions is noted in this step for further investigation in the field but is not used to eliminate sites, unless the concession is known to be active. Information regarding concessions, sourced from the most recent publicly available Ministry of Forestry concessions data, is overlaid on top of the combined suitability map.[38]

STAGE II. FIELD ASSESSMENTS

Stage II consists of conducting and analyzing field surveys of the priority sites identified in Stage I, in order to confirm or eliminate these sites as potentially suitable. In Stage II, 18 indicators were used to further assess the considerations described in Figure 1. At each site, the field team collected directional photographs with GPS coordinates and responded to 18 survey questions based on information collected through direct observations and interviews. Table 6 provides a summary of field survey considerations, indicators, prompts, scoring, and methods for this stage.

In this method, field survey indicators related to the considerations of land use and local interests are included to provide preliminary social information. Avoiding areas that are heavily used by local communities for livelihoods or that have cultural significance is consistent with sustainability standards, while positive community perception is critical for minimizing social conflict and obtaining the FPIC of local people.[39]

The maps generated in Stage I have not been systematically verified and input data is known to vary in quality. Therefore, field assessments are required to identify and reclassify any sites that may have been misclassified during the desktop analysis.

Given their qualitative and site-specific nature, social considerations cannot be assessed through desktop analysis and can only be preliminarily documented by the field survey methods described in this paper. Fully addressing these considerations requires a comprehensive FPIC process, including active participatory methods such as community mapping, which are outside the scope of this working paper.

Site-level data are collected for three purposes:

- **VERIFICATION.** Several survey indicators used in the desktop analysis are also assessed in the field. Site-level data is collected for land cover, peat, erosion risk, slope, and soil type , which were used as weighted indicators in the suitability mapping process (Stage I, Step 1). Information regarding legal classification, accessibility, and size—which were considered in Stage I during the process of field survey site selection (Step 2), but were not included in the suitability mapping step—is verified in the field and included in the field assessment scoring.

- **DETAIL.** The status and type of existing concessions and the presence of active plantations, which were not included as indicators in the suitability mapping step, are assessed at the site-level and included in the field assessment scoring process. Additional qualitative information is also collected for several indicators that were included in the suitability mapping step, such as interviews regarding erosion history or observations regarding whether or not an area with peat soil has been drained.

- **NEW INFORMATION.** Interviews with local community members are used to collect preliminary information on social indicators related to land use—including manmade drainage, land history, and land use dependence—and to local interests, including public perception of palm oil, interest in oil palm cultivation, and political interests. New data is also collected through field surveys for indicators for which data is not available or not complete at a provincial scale, such as site-specific history of flooding.

Table 6 | **Field Survey Considerations, Indicators, Prompts, Scoring, and Methods**

CONSIDERATION		INDICATOR	DATA PURPOSE	RESPONSE PROMPT	SCORING (1 = HIGH POTENTIAL; 2 = POTENTIAL; 3 = NOT SUITABLE)	METHOD OF COLLECTION
ENVIRONMENTAL	Carbon and biodiversity	Land cover	Verification	Open-ended description	1 = open area/ grassland/shrub; 2 = agricultural area; 3 = settlement; forest	Direct observation
		Peat	Verification; detail	Peat: yes/no; depth (cm); Drained: yes/no	1 = none; 3 = present	Direct observation
	Soil and water protection	Erosion risk	Verification; detail	Open-ended description of current condition and erosion history	1 = no history of erosion; 3 = history of erosion	Direct observation and interview with local community members
		Flooding recharge potential	New	Open ended description of current condition and flood history	1 = never flooded; 3 = ever flooded	Direct observation and interview with local community members
ECONOMIC	Crop productivity	Slope	Verification	Keywords: flat; gently sloping; undulating; hilly; mountainous	1 = flat, gently sloping, undulating; 2 = hilly; 3 = mountainous	Direct observation
		Soil color	Detail	Keywords: red-yellow; red-yellow and occasionally white; white shimmering	1 = red-yellow; 2 = yellow and occasionally white; 3 = white	Direct observation
		Soil type	Verification; detail	Keywords: clay; some clay and some sand; quartz sand	1 = clay, 2 = some clay/ a little sandy; 3 = quartz/sand	Direct observation
	Financial viability	Accessibility	Verification	Roads: yes/no; Rivers: yes/no	1 = road and river; 2 = river; 3 = none	Direct observation
		Available area	Verification	Area (hectares)	1 = >15,000 ha, 2 = 5,000 – 15,000 ha; 3 = <5,000 ha	Map calculation; interview

Field surveys are conducted via a rapid assessment approach by combining the principles and techniques of two well known methodologies: the Rapid Rural Appraisal (RRA) and the Participatory Rural Appraisal (PRA). The RRA's quick and informal approaches to data collection are reflected in the utilization of direct observation, informal interviews, and simplified survey questions, answerable with yes/no or keyword responses. The more active participation described by the PRA is encouraged by eliciting the help of a locally operating NGO to assist with surveys and the help of local people to lead the survey expeditions. In addition, many survey indicators are assessed by facilitating open-ended discussions among community members and documenting key points.

For questions necessitating interview responses from local people, at least two community members are interviewed at each site. An effort is made to interview community

Table 6 | **Field Survey Considerations, Indicators, Prompts, Scoring, and Methods (cont.)**

CONSIDERATION		INDICATOR	DATA PURPOSE	RESPONSE PROMPT	SCORING (1 = HIGH POTENTIAL; 2 = POTENTIAL; 3 = NOT SUITABLE)	METHOD OF COLLECTION
LEGAL	Zoning	Legal classification	Verification	Legal land use classification	1 = Other Land Use (APL); 2 = Production Forest (HP/HPT); 3 = Conservation Area (HL/HSAW)	Data and interviews with local government officials, i.e with Forestry and Plantation Departments (Dinas Perkebunan dan Kehutanan)
LEGAL	Rights	Concessions	Verification; detail	Concession present: yes/no; type; name of concession-aire, status	1 = none; 3 = exist	Interview with community and local government officials
LEGAL	Rights	Active plantations	Detail	Active oil palm plantation present: yes/no	1 = none; 3 = exist	Direct observation
LEGAL	Rights	Community claims/rights	This critically important consideration is outside the scope of this method and must be addressed through additional activities before the suitability of a site is confirmed (see Figure 2).			
SOCIAL	Land use	Land use dependence	New	Open-ended description. Degree of dependence and use of location, can include spiritual/cultural uses	1 = not used; 2 = periodically used; 3 = intensive use (i.e. agriculture/mining)	Direct observation; Discussion with community members and local NGOs
SOCIAL	Land use	Manmade drainage	New	Manmade drainage/water channel: yes/no	1 = no; 3 = yes	Direct observation; interview community members
SOCIAL	Land use	Land history	New	Open-ended description. History of land cover change and land function	1 = previously burned; 2 = shifting cultivation/ rice field 3 = garden/settlement	Discussion with community members and local NGOs
SOCIAL	Local interests	Public perception of palm oil	New	Open-ended description. Do community members agree with palm oil companies?	1 = agree with palm oil; 2 = indifference/ don't know; 3 = do not agree with palm oil	Discussion with community members
SOCIAL	Local interests	Willingness to plant oil palm	New	Open-ended description. How interested/willing is the community to plant oil palm?	1 = want oil palm; 2 = maybe/don't know; 3 = do not want oil palm	Discussion with community members
SOCIAL	Local interests	Political interests	New	Is there political opposition to palm oil? Are other organizations active in the area? Names?	1 = no opposition; 2 = opposition (also identified key stakeholders)	Discussion with local NGOs, government, community

leaders, such as the *kepala adat* and *kepala desa*, and recommendations are obtained regarding who should be interviewed and who is most knowledgeable to lead survey expeditions. Local government officials and other organizations are also interviewed regarding legal issues such as land status and concessions.

Responses to each of the 18 survey questions are categorized into three suitability classes, as in Stage I. For each site, the scores of the responses for all the questions are totaled and the average score is calculated. Sites are then ranked according to their average scores (lowest average score = highest potential for sustainable palm oil development). If at a given site a single response falls into the suitability class of not suitable, then the site is classified as not suitable.

APPLICATION

Sekala and WRI applied this method to identify potentially suitable areas for oil palm cultivation in the Indonesian province of West Kalimantan for a pilot sustainable palm oil project under Project POTICO. Sekala and WRI also applied the first step of this method to Central Kalimantan to produce a combined suitability map of the province.

Table 7 describes the data sources by indicator used in this application. Since insufficient Kalimantan-wide data was available to analyze groundwater recharge potential, this indicator was not included. Private companies, government officials, or NGOs conducting their own analysis using this method can obtain more project-relevant results by using more site-specific or up-to-date data.

Table 7 | **Application Data Sources By Layer and Indicator**

LAYER	INDICATOR	DATA SOURCE
Carbon and biodiversity	Land cover	Ministry of Forestry (2009, 1:250,000 scale)[a]
	Peat	Wetlands International (2004, 1:250,000 scale)[b]
	Conservation areas with buffer zones	Calculated by authors using 1,000 m buffer around conservation areas from Ministry of Forestry (Unknown, 1:250,000 scale)[a]
Soil and water protection	Erosion risk	Calculated based on modified version of the Universal Soil Loss Equation (USLE) as suggested by HCV Toolkit for Indonesia (2008), using topography, climate, and soil data described below.
	Groundwater recharge potential	Insufficient data – not included in application.
	Water resource buffers	Calculated by authors, using 100 m buffer around water resources data available in Interactive Atlas of Indonesia's Forests (2009, 1:250,000 scale)[b]
Crop productivity	Topography (elevation; slope)	Shuttle Radar Topography Mission (2008, 90 m resolution)[c]
	Climate (rainfall)	WorldClim Global Climate data (1989–2009, 1000 m resolution)[d]
	Soil (depth; type; drainage; acidity)	RePPProT (1990, scale 1:250,000); Soil type classification from FAO Soil Map guidelines.[e]

a. Ministry of Forestry data available as of February 2012 at <http://appgis.dephut.go.id/appgis/ >: *Penutupan Lahan 2009* (Land cover 2009) and *Kawasan Hutan* (Forest Estate), no year provided.
b. Data available in S. Minnemeyer, L. Boisrobert, F. Stolle, Y.I. Ketut Deddy Muliastra, M. Hansen, B. Arunarwati, G. Prawijiwuri, J. Purwanto, and R. Awaliyan. 2009. Interactive Atlas of Indonesia's Forests CD-ROM. Washington, DC: World Resources Institute.
c. Available at < http://www2.jpl.nasa.gov/srtm/cbanddataproducts.html >.
d. Available at <http://www.worldclim.org/ >.
e. The FAO Digital Soil Map of the World and associated information can be downloaded at: <http://www.fao.org/geonetwork/srv/en/metadata.show?id=14116>.

WEST KALIMANTAN RESULTS

Using this method, Sekala and WRI identified nine potentially suitable areas for oil palm cultivation in the Indonesian province of West Kalimantan for a pilot sustainable palm oil project under Project POTICO. These nine sites were identified through targeted field assessments of high priority sites identified through the desktop analysis using project-specific criteria, and do not represent all potentially suitable areas in the province.

Map 1 summarizes the results of both the desktop analysis (Stage I) and field assessments (Stage II). Table 8 summarizes the suitability mapping results for West Kalimantan by layer and indicator.

Based on Stage I, Step 1 suitability mapping, roughly 4.5 million hectares (31 percent) of the 14.6 million hectares of land in the province of West Kalimantan were classified as potentially suitable (high potential or potential). Of the potentially suitable land in West Kalimantan, 0.2 million hectares were classified as high potential and 4.3 million hectares as potential.

Areas with potentially suitable land cover —that is, without forest cover of any type—totaled roughly 8.0 million hectares (55 percent). This is a rough estimation of the extent of degraded land in terms of above-ground carbon and biodiversity. Taking into account the other indicators in the analysis, approximately 56 percent of these degraded lands were found to be potentially suitable for oil palm cultivation.

The 3.5 million hectares of potentially suitable land that were identified on the combined suitability map (Map 1) are located where potentially suitable areas on the carbon and biodiversity (Map 1.a), soil and water protection (Map 1.b), and crop productivity layers (Map 1.c) all overlap. Consequently, these areas of overlap are significantly smaller than the potentially suitabile areas identified by each of these layers individually. For example, 48 percent of the potentially suitable area on the crop productivity layer was classified as potentially suitable in the combined suitability map.

Indicators for carbon and biodiversity were, collectively, the most influential in limiting the amount of potentially

Map 1 | **Combined Suitability Map and Field Assessment Results, West Kalimantan**

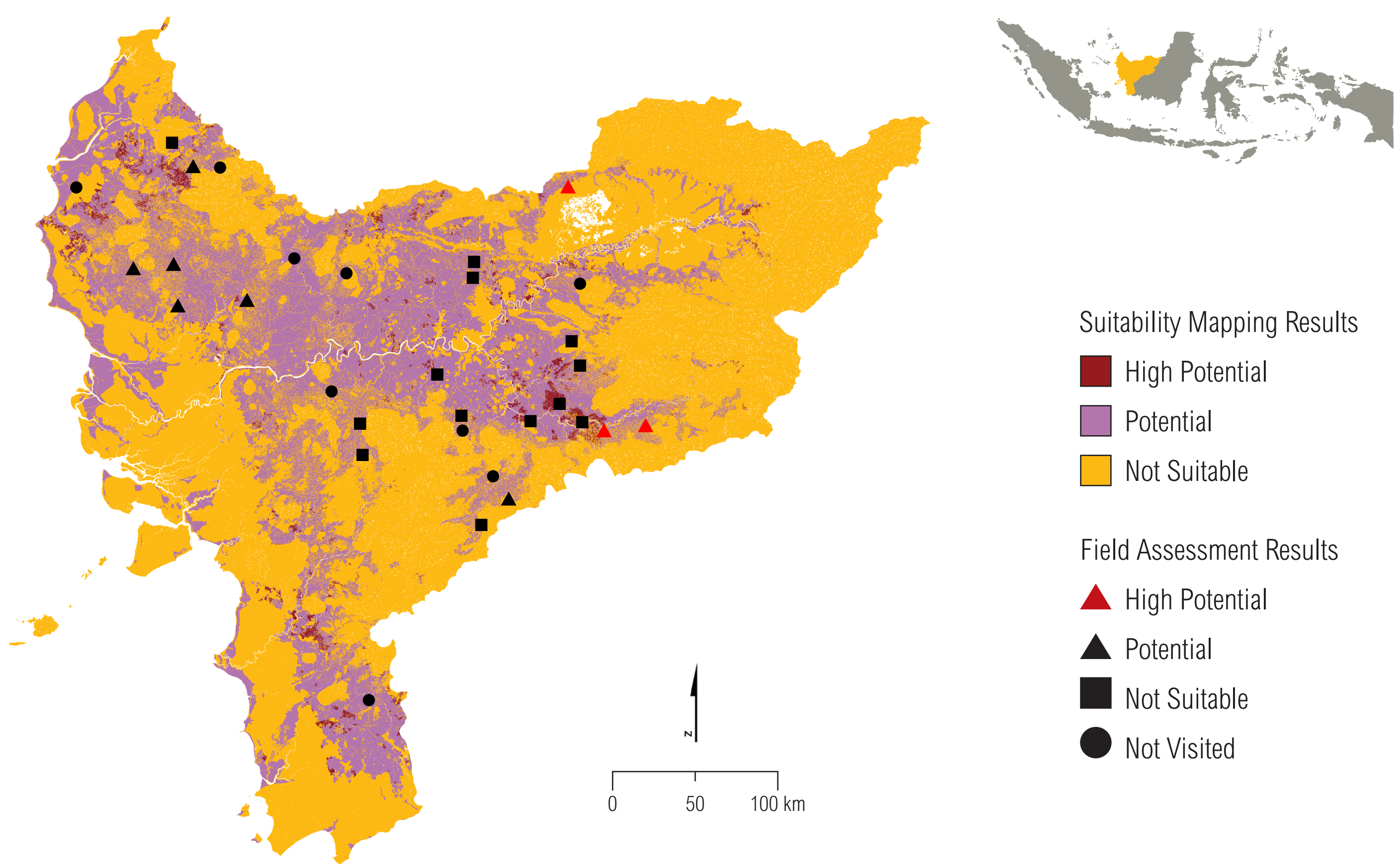
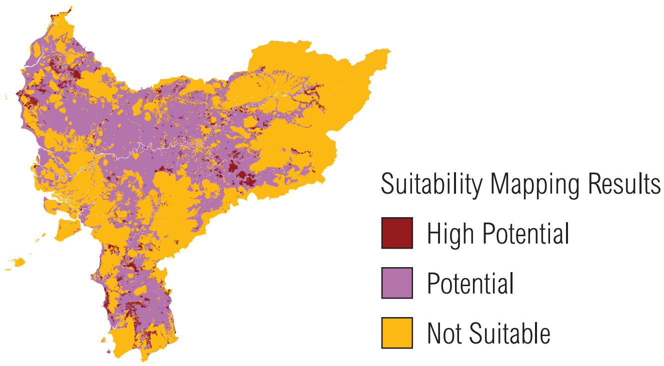


Table 8 | **Suitability Mapping Results by Layer and Indicator, West Kalimantan* (Area in Million Hectares)**

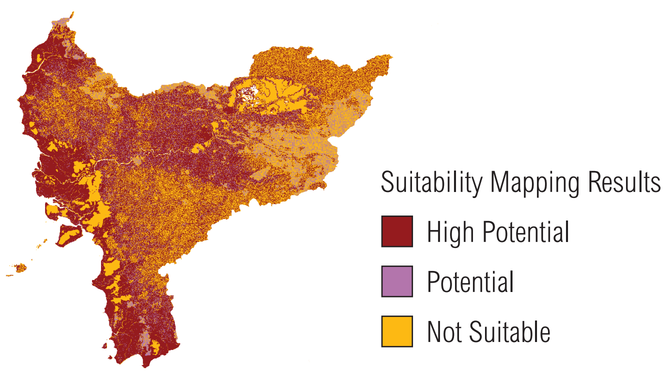
LAYER	INDICATOR	POTENTIALLY SUITABLE		NOT SUITABLE
		HIGH POTENTIAL	POTENTIAL	
Carbon and biodiversity	Land cover	0.8	7.2	6.7
	Peat	12.8	0.0	1.7
	Conservation	10.2	0.0	4.5
	Carbon and biodiversity layer	**0.5**	**5.9**	**8.2**
Soil and water protection	Erosion risk	7.8	1.8	4.8
	Groundwater recharge potential	No data	No data	No data
	Water resource buffer zones	14.1	0.0	0.6
	Soil and water protection layer	**7.5**	**1.7**	**5.2**
Crop productivity	Elevation	13.2	1.2	0.2
	Slope	9.1	4.0	1.6
	Rainfall	14.7	0.0	0.0
	Soil depth	12.1	0.0	2.4
	Soil type	11.3	2.4	0.9
	Soil drainage	11.0	0.9	2.6
	Soil acidity	12.6	0.8	1.1
	Crop productivity layer	**7.5**	**1.7**	**5.2**
Combined suitability		**0.2**	**4.3**	**9.9**

* The total area of West Kalimantan is 14.6 million hectares.

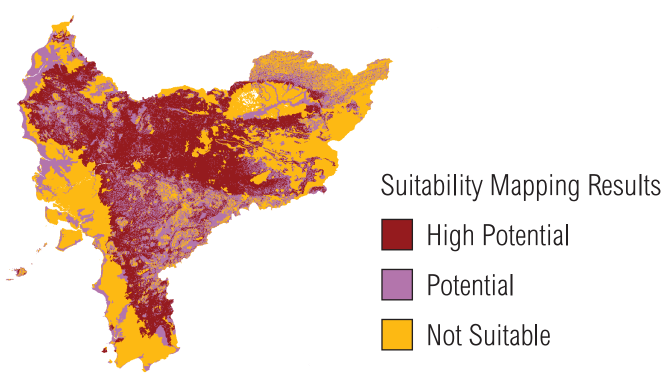
Map 1.a | **Carbon and Biodiversity Layer, West Kalimantan**



Map 1.b | **Soil and Water Protection Layer, West Kalimantan**



Map 1.c | **Crop Productivity Layer, West Kalimantan**



suitable land for oil palm cultivation in West Kalimantan, resulting in the classification of 8.2 million hectares (56 percent) as not suitable. Within the carbon and biodiversity layer, land cover was the most significant limiting factor, contributing to 82 percent of the not suitable area.

A total of 31 priority sites were identified in Stage I, Step 2. In Stage II, field surveys were successfully conducted at 22 sites with the assistance of a locally operating NGO (People Resources and Conservation Foundation or PRCF). The sites averaged 19,000 ha in size and were located across eight districts within West Kalimantan, including Kapuas Hulu, Ketapang, Sintang, Melawi, Sekadu, Bengkayang, Landak, and Sambas. Of the sites surveyed, nine were found be potentially suitable for palm oil development (three high potential, six potential).

Thirteen field sites were eliminated as not suitable for one or more reasons, mostly due to new or detailed data that was collected in the field and unavailable for desktop analysis. For example, seven sites were found to already have active oil palm plantations. Six sites were found to have culturally important land history, such as community gardens or settlements. At four sites, communities expressed a negative interest in oil palm cultivation and public perception of palm oil. One site was found to have intensive land use dependence in terms of agriculture or mining, and four sites were found to be not suitable based on survey results indicating a history of significant flooding.

Of the five indicators that served the purpose of verification, field survey scores for soil type, erosion, and slope closely matched those of the desktop analysis. Results for land cover and peat showed more discrepancy between the desktop and the field, indicating the importance of verifying Stage I results.

CENTRAL KALIMANTAN RESULTS

This desktop analysis classified 3.3 million hectares as potentially suitable for sustainable palm oil production in Central Kalimantan, about 21 percent of the province's total land area of 15.3 million hectares. Of this, 0.5 million hectares were identified as high potential. Table 9 summarizes the suitability mapping results for Central Kalimantan by layer.

DISCUSSION

This working paper demonstrates how to implement a quick and cost-effective method for identifying potentially suitable areas for oil palm cultivation. The method is designed in accordance with established standards for sustainable palm oil production such as those of the Roundtable on Sustainable Palm Oil (RSPO), incorporates relevant Indonesian laws and policies, and is consistent with proposed national REDD+ strategies to support palm oil production on degraded land. The method consists of a desktop analysis using readily available data and rapid field assessments and is based on a set of indicators related to selected environmental, economic, social, and legal considerations.

The results of the application of this method by WRI and Sekala in the Indonesian provinces of West Kalimantan and Central Kalimantan indicate that:

- **THE METHOD CAN BE USED BY COMPANIES TO QUICKLY AND COST-EFFECTIVELY IDENTIFY POTENTIALLY SUITABLE AREAS FOR OIL PALM CULTIVATION.** WRI and Sekala used this method to identify nine potentially suitable field sites for a pilot project in West Kalimantan. These nine sites were identified through targeted field assessments of sites prioritized during a desktop analysis using project-specific criteria. They do not represent all potentially suitable areas in the province. This demonstrates that even with the suboptimal data available at the provincial level, the method can be used to quickly and cost-effectively identify potentially suitable areas for oil palm cultivation.

Map 2 | **Combined Suitability Map, Central Kalimantan**

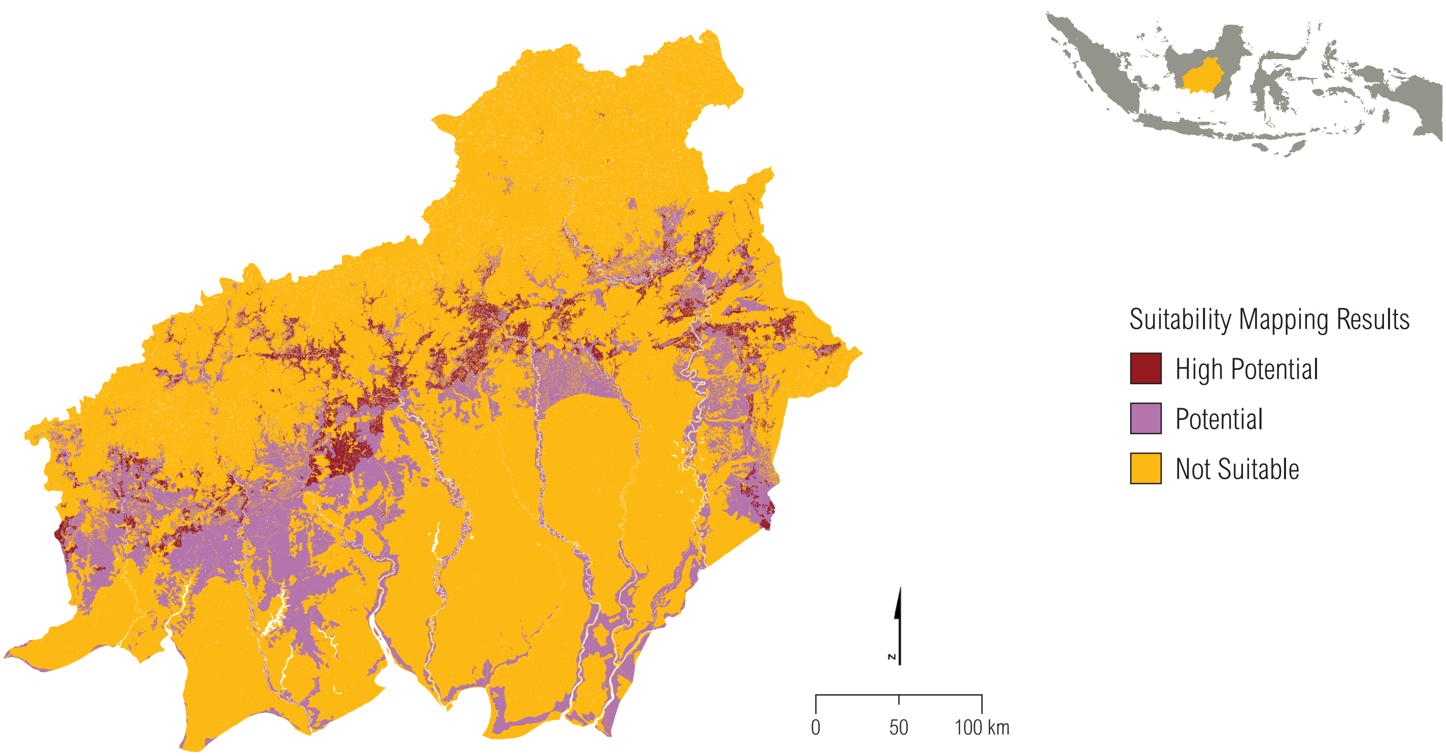


Table 9 | **Suitability Mapping Results by Layer, Central Kalimantan* (Area in Million Hectares)**

LAYER	POTENTIALLY SUITABLE		NOT SUITABLE
	HIGH POTENTIAL	POTENTIAL	
Carbon and biodiversity	1.7	3.2	10.3
Soil and water protection	7.8	2.3	5.0
Crop productivity	3.1	5.4	6.8
Combined suitability	0.5	2.8	11.8

* The total area of Central Kalimantan is 15.3 million hectares.

- **THE DESKTOP ANALYSIS CAN INFORM GOVERNMENT OFFICIALS IN ASSESSING POLICY OPTIONS FOR THE USE OF DEGRADED LAND.** The desktop analysis, the first step of this method, classified a total of approximately seven million hectares of land as potentially suitable in the provinces of West Kalimantan and Central Kalimantan alone. The analysis used the best publicly available data at the time of publication and a classification process consistent with proposed national policies to promote palm oil production on degraded land. For comparison, experts have predicted a total of 3 to 7 million hectares of oil palm cultivation expansion in all of Indonesia by 2020.[40]

- **FIELD ASSESSMENTS ARE NECESSARY TO CONFIRM OR REJECT THE POTENTIAL SUITABILITY OF EACH SITE.** The accuracy of the desktop analysis relies heavily on good input data. Unfortunately, there has been no systematic verification of the input data, and not all data layers are complete or up-to-date. As a result, some areas that were classified as potentially suitable in the desktop analysis were later found to be not suitable according to the field assessments. Indicators that include modeling using several input parameters, such as erosion risk and groundwater recharge potential, are particularly important to verify. In addition, field assessments are necessary to preliminarily assess important social considerations such as local interests and rights, which cannot be addressed by a desktop analysis.

- **THE DESKTOP ANALYSIS CAN BE EASILY REPLICATED OR CUSTOMIZED—BUT SHOULD NOT BE USED TO CONCLUSIVELY DETERMINE WHERE OIL PALM CULTIVATION EXPANSION SHOULD OCCUR.** The desktop analysis and associated data used in this study will be easily accessible on a public website. Suitability classes for some considerations—such as crop productivity and financial viability—may vary by company or project. The website will also allow users to generate their own suitability maps—using parameters of their choice—that can be used to guide their own targeted field assessments. However, since the desktop analysis is designed primarily to rapidly identify the highest priority areas for further investigation, it should not be used to conclusively determine where oil palm cultivation expansion should occur.

- **USING THIS METHOD AS A FIRST STEP IN A SITE SELECTION PROCESS CAN REDUCE THE COSTS OF IMPLEMENTING ADDITIONAL ACTIVITIES REQUIRED TO CONFIRM THE SUITABILITY OF A POTENTIAL SITE.** Confirming site suitability requires additional due diligence activities, including community mapping to document community claims/rights, conducting HCV and social and impact assessments, implementing a comprehensive FPIC process, and fulfilling legal requirements. Using field assessments to preliminarily assess environmental, economic, social, and legal considerations that cannot be addressed by a desktop study can help companies prepare for these activities.

CONCLUSION

Ultimately, the local impact of oil palm cultivation depends on many long-term planning and management decisions. A site selection process that incorporates environmental, economic, social and legal considerations from the outset can enhance local benefits, reduce the costs of achieving sustainable palm oil certification, and help avoid social conflicts.

This paper demonstrates how to implement a method that can quickly and cost-effectively identify potentially suitable areas for oil palm cultivation. The results of applying this method in West Kalimantan and Central Kalimantan suggest that there are substantial areas of degraded land that may be potentially suitable for oil palm cultivation in Indonesia. The results also indicate that a desktop analysis cannot substitute for field assessments that consider local interests and that additional activities designed to address project-specific environmental, economic, social, and legal considerations are required to confirm site suitability.

The widespread application of this method—combined with appropriate due diligence activities conducted once a potentially suitable site is identified—could contribute to more sustainable palm oil production, reduced poverty, and improved natural resource management in Indonesia.

NOTES AND REFERENCES

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2. REDD+ is an international effort to increase financial benefits of reducing emissions from deforestation and degradation in developing countries. For more on REDD+, see <http://www.un-redd.org/>. Indonesia's national REDD+ strategy is under development as part of a $1 billion partnership with Norway on "Cooperation on reducing greenhouse gas emissions from deforestation and degradation." For discussion of this partnership agreement, see: <http://www.wri.org/stories/2010/07/whats-next-indonesia-norway-cooperation-forests>.
3. Roundtable on Sustainable Palm Oil Indonesian National Interpretation Working Group. 2008. "National Interpretation of RSPO Principles and Criteria for Sustainable Palm Oil Production." Accessible at: <http://www.rspo.org/sites/default/files/NI_INANIWG_Final_English_May2008_ver01.pdf>.
4. Major palm oil company Golden Agri Resources has announced a "Forest Conservation Policy," which includes no conversion of high carbon stock areas, and is working with The Forest Trust, a nonprofit organization, to implement this policy. See: <http://www.smart-tbk.com/announcement/100204_SMART_Announcement_to_Partners_026_English.pdf>. The cut-off value for high carbon stock is 35 tons carbon per hectare, the same amount proposed by Indonesia's national draft REDD+ strategy. See: <http://www.smarttbk.com/smart/pdfs/Announcements/07072011%20GAR%20and%20TFT%20provide%20update%20on%20Forest%20Conservation%20Policy%20fieldwork.pdf>.
5. IFC. 2011. "World Bank Group adopts new approach for investment in palm oil sector." IFC Press Release. See: <http://www.ifc.org/ifcext/media.nsf/content/SelectedPressRelease?OpenDocument&UNID=604030A064E50DE185257865005A4AE0>.
6. For summary of definitions of degraded land, see: <http://www.wri.org/stories/2010/11/faq-indonesia-degraded-land-and-sustainable-palm-oil>.
7. Multiple drafts of Indonesia's national REDD+ strategies have been produced. For one version, see: <http://www.un.or.id/sites/default/files/COMPLETEStranas1RevisedEng%20final%20version.pdf>.
8. Refer to Table 1 in Lian Pin Koh, Holly K. Gibbs, Peter V. Potapov, Matthew C. Hansen. 2011. "REDDcalculator.com: a web-based decision-support tool for implementing Indonesia's forest moratorium." In Methods in Ecology and Evolution (in press). See: <http://reddcalculator.com/media/files/Moratorium_report.pdf>.
9. Colchester, M., N. Jiwan, Andiko M. Sirait , A.Y. Firdaus, A. Surambo, and H. Pane. 2006. "Palm oil and land acquisition in Indonesia: Implications for local communities and indigenous peoples." Forest Peoples Programme and Perkumpulan Sawit Watch. McCarthy, J.F., P. Gillespie, and Z. Zen. 2011. "Swimming upstream: local Indonesian production networks in globalized palm oil production." World Development, In Press.
10. According to the Ministry of Forestry, 21 percent of Indonesia's "Forest Estate" (40 million hectares) is non-forested. Source: Ministry of Forestry using Landsat imagery 7 ETM+ of 2005/2006 (217 scenes). Interpreted in 2007 and published in 2008.
11. Established sustainability standards reviewed to identify these considerations and associated indicators include the Roundtable on Sustainable Palm Oil Principles and Criteria. See: (http://www.rspo.org/files/resource_centre/RSPO%20Principles%20&%20Criteria%20Document.pdf), the Roundtable on Sustainable Biofuels Principles and Criteria (http://rsb.epfl.ch/files/content/sites/rsb2/files/Biofuels/Version%202/PCs%20V2/11-03-08%20RSB%20PCs%20Version%202.pdf), and the International Finance Corporation's Performance Standards (http://www.ifc.org/ifcext/sustainability.nsf/Content/PerformanceStandards).

12. RSPO Criterion 7.3. states that new plantings since November 2005 must not replace primary forest or any area “required to maintain or enhance one of more High Conservation Values,” and conducting an HCV assessment is part of the RSPO New Planting Procedures. Resources on established HCV concepts and methodologies can be are provided by the HCV Resource Network at http://www.hcvnetwork.org/ . The updated Guidelines for the Identification of High Conservation Values in Indonesia can be accessed at:< http://www.tropenbos.org/images/Tropenbos/Indonesia/Publications/toolkit-hcvf-english-version_final.pdf>. A high conservation value area is an area containing one or more of the six HCVs described in this toolkit, which can be divided into three categories: biodiversity (HCV1-3), ecosystem services (HCV 4), and social and cultural (HCV 5-6).
13. For example, RSPO Criterion 7.3 states that new plantings since November 2005 must not replace primary forest or any area “required to maintain or enhance one of more High Conservation Values,” while Criterion 7.5 states that no new plantings may be established “on local peoples’ land without their free, prior and informed consent.” Conducting an HCV assessment is part of the RSPO New Planting Procedures. Resources on established HCV concepts are available on the HCV Resource Network (http://www.hcvnetwork.org/). For more information on obtaining free prior consent see the Forest People’s Program’s “Free, prior and informed consent and oil palm plantations: a guide for companies” available online at: <http://www.forestpeoples.org/sites/fpp/files/publication/2009/12/fpicandrspocompaniesguideoct08eng.pdf>.
14. For more information on Project POTICO, see: <http://www.wri.org/project/potico>.
15. See, for example: Dehue, B., S. Meyer, and J. van de Staaij. 2010. “Responsible Cultivation Areas – Identification and certification of feedstock production with a low risk of indirect effects.” Ecofys. Available online at: <http://www.ecofys.nl/com/publications/documents/EcofysRCAmethodologyv1.0.pdf>. For examples of complementary projects, see Fauna & Flora International’s work in West Kalimantan (http://www.ifc.org/ifcext/sustainability.nsf/AttachmentsByTitle/BACP_projectProfiles/$FILE/BACP_ProjectProfile_July+2011.pdf) and The Nature Conservancy’s work in East Kalimantan (http://www.nature.org/ourinitiatives/urgentissues/climatechange/placesweprotect/berau-indonesia.xml).
16. Community claims/rights refers to the presence of claims or rights of local people and communities, including but not limited to those that are recognized or documented by traditional or official means. Unfortunately, no data is available on undocumented claims and comprehensive documentation cannot be addressed using a rapid assessment methodology. Therefore, this consideration must be addressed through additional activities outside the scope of this paper before the suitability of a site is confirmed.
17. Data and details will be available at <http://wri.org/publication/identifying -degraded-land-sustainable-palm-oil-indonesia>. For information regarding the status and use of the website, please contact beth.gingold@wri.org.
18. Ibid.
19. To simplify the analysis, only the land area is considered. Water bodies are excluded from the analysis.
20. Suitability maps were developed based on a GIS approach, using ArcGIS’s Model Builder. Overlay operations were applied based on the weighted values of each variable within each thematic layer map (carbon and biodiversity, soil and water protection, suitability for oil palm cultivation). A weighted overlay was used to combine the layer maps, generating an individual value for each pixel and producing a new map based on the combined factors. The weighted values used in the overlay operations were only performed on raster maps.
21. Guidelines for the identification of high conservation values in Indonesia (HCV Toolkit Indonesia). Consortium to Revise the HCV Toolkit for Indonesia. Jakarta. See: <http://www.tropenbos.org/file.php/132/toolkit-hcvf-english-version_final.pdf>. Indonesian policies and regulations include recent proposed REDD+ strategies as well as presidential decrees and regulations.
22. HCV 1 refers to “Areas with Important Levels of Biodiversity;” HCV 2 to “Natural Landscapes & Dynamics;”HCV 3 to “Rare or Endangered Ecosystems” (Toolkit for Identification of High Conservation Values in Indonesia, 2008)
23. Land cover and additional data from the Ministry of Forestry are available at <http://appgis.dephut.go.id/appgis/>.
24. This is more restrictive than previous Indonesian legislation regarding the use of peat (Presidential Decree 32/1990, Article 10), which designated only areas of deep peat (greater than 3 meters) for protection.
25. Elsen., D. 2011. “Cost-benefit analysis of a shift to a low carbon economy in the land use sector in Indonesia.” See: <http://ukinindonesia.fco.gov.uk/resources/en/pdf/2011/d-elson-presentation>.
26. Indonesian policy identifies “water catchment areas” (areas with high rainfall, permeable soil, and geomorphology allowing for significant rainwater penetration) and buffer zones surrounding water resources (rivers, streams, springs, lakes, coastlines) as hydrological areas to be protected (Presidential Decree No. 32/1990).
27. In the HCV Toolkit, HCV 4 “Environmental Services” includes consideration of: 4.1 Areas or Ecosystems Important for the Provision of Water and Prevention of Floods for Downstream communities; 4.2 Areas Important for the Prevention of Erosion and Sedimentation. The Indonesian HCV Toolkit defines water protection areas in terms of specific ecosystems, including cloud forest, ridge line forest, riparian ecosystems, and a several wetland ecosystems such as peat swamp, swamp forest, mangrove forest, lakes and grass swamps.
28. The GIS model used in this analysis will be made available as supplemental materials. For background, see Appendix 5 to HCV Toolkit for Indonesia: Soil Risk Assessment, An example from Landak District, West Kalimantan, Indonesia. Phillip Wells (Daemeter consulting) See: <http://www.gaiacommoditas.com/WP/wp-content/uploads/2011/06/Appendix-5_Case-Study_Soil-erosion-risk_HCV4.2.pdf >.
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expansion also depend on the location of their current operations.

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36. Undang-undang No. 41 tahun 1999 tentang kehutanan (Law No. 41 of 1999 regarding forestry)
37. At the time of POTICO's initial analysis, this was the land allocation 2005 map available on the Interactive Atlas of Indonesia's Forests CD. Additional data is now available on the Ministry of Forestry's interactive map website at: <http://appgis.dephut.go.id/appgis/>.
38. At the time of POTICO's initial analysis this was the logging and timber concessions from 2005 and plantation concessions from 2006 maps available on the Interactive Atlas of Indonesia's Forests CD. Additional data is now available on the Ministry of Forestry's interactive map website at: <http://appgis.dephut.go.id/appgis/>.
39. For example, see RSPO Criterion 7.1 ("A comprehensive and participatory independent social and environmental impact assessment is undertaken...") Criterion 7.3 ("New Plantings...have not replaced primary forest or any area containing one or more High Conservation Values"), and Criterion 7.5 ("No new plantings are established on local peoples' land with their free, prior and informed consent...").
40. For a discussion of various estimates, see: <http://www.wri.org/stories/2010/11/faq-indonesia-degraded-land-and-sustainable-palm-oil>.

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ABOUT THE AUTHORS

Beth Gingold leads WRI's Project POTICO research team in developing publications and web-based mapping applications to support sustainable palm oil in Indonesia.
Contact: beth.gingold@wri.org

Anne Rosenbarger is a research fellow at Sekala, where she is working jointly with WRI to document activities conducted under Project POTICO.
Contact: anne.rosenbarger@sekala.net

Yohanes I Ketut Deddy Muliastra is the director of Sekala. He has been working on environmental and development issues for more than 18 years, primarily through international agencies, such as the World Bank, World Wide Fund for Nature, Department of International Development (DFID), and the European Union.
Contact: kdeddy@sekala.net

Fred Stolle is a program manager for WRI's Forest Landscape Objective specializing in quantifying land use change, drivers, and impacts especially related to climate change.
Contact: fred.stolle@wri.org

Made Sudana is a social forestry specialist at Sekala with expertise in participatory mapping and conflict resolution, working to implement the POTICO pilot project in West Kalimantan.

Masita Dwi Mandini Manessa is a GIS and spatial analysis specialist at Sekala.

Ari Murdimanto worked as a remote sensing and GIS staff member for Sekala, focusing on remote sensing/GIS technical support and community mapping for Project POTICO.

Sebastianus Bagas Tiangga worked as a GIS staff member at Sekala in the development of the POTICO desktop analysis.

Cicilia Cicik Madusari contributed to the development of the POTICO desktop analysis as a GIS staff member at Sekala.

Pascal Douard is a GIS research analyst for WRI's Forest Landscape Initiative, focusing on the Central Africa forest atlases, and spatial analysis for Indonesia forest/climate projects.

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Sekala aims to develop realistic, tangible, and innovative solutions for environmental problems to generate benefits for local people and the environment. Established in Bali in 2005, Sekala works at local, provincial, and national levels across Indonesia, focusing on land use planning, forest governance, community mapping, capacity building, conflict resolution, remote sensing, and spatial analysis.

Jl. Subak Sari, Gg. Mango No. 1
Pantai Brawa, Canggu 80361, Badung – Bali, Indonesia
Phone: +62 361 8555171
Fax: +62 361 2733061
Email: info@sekala.net
Website: www.sekala.net; www.forestclimatecenter.org

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