



Hatfield

**Independent Report on Mixed Hardwood (MHW)
Moratorium Monitoring for April Group Concession
in Pulau Padang – Riau and April Supplier (AHL)
Concession in North Kalimantan**

Baseline Report as of 15th May 2015
Field Maps & Data Updated as of 30th June 2015

July 2015

Prepared for:

APRIL Group
JL M.H. Thamrin No.31, Tanah Abang
Jakarta Pusat 10230
INDONESIA



INDEPENDENT REPORT ON MIXED HARDWOOD (MHW) MORATORIUM MONITORING FOR APRIL GROUP CONCESSION IN PULAU PADANG – RIAU AND APRIL SUPPLIER (AHL) CONCESSION IN NORTH KALIMANTAN

**BASELINE REPORT AS OF 15TH MAY 2015
FIELD MAPS & DATA UPDATED AS OF 30TH JUNE 2015**

Prepared for:

APRIL GROUP

JL M.H. THAMRIN NO.31, TANAH ABANG
JAKARTA PUSAT 10230
INDONESIA

Prepared by:

PT HATFIELD INDONESIA

LIPI BUILDING 3RD FLOOR,
JL. IR. H. JUANDA NO. 18
BOGOR 16122,
INDONESIA

06 JULY 2015

APR.7359
VERSION 3.0

TABLE OF CONTENTS

TABLE OF CONTENTS	i
LIST OF TABLES	ii
LIST OF FIGURES.....	ii
LIST OF APPENDICES	ii
DISTRIBUTION LIST	iii
AMENDMENT RECORD	iii
EXECUTIVE SUMMARY.....	iv
1.0 INTRODUCTION	1
1.1 ACRONYMS AND ABBREVIATIONS	1
1.2 OBJECTIVES.....	1
1.3 STUDY AREA	2
2.0 DATA	5
2.1 RADAR SENSOR	5
2.1.1 Sentinel-1 (10m)	5
2.2 OPTICAL SENSOR	6
2.2.1 RapidEye (5m).....	6
2.2.2 Landsat 7/8 (15-30m)	6
2.3 REFERENCE DATA	7
2.3.1 Baseline Data	7
2.3.2 Auxiliary Data.....	7
3.0 METHODOLOGY	7
3.1 BASELINE LAND COVER MAPPING.....	7
4.0 RESULTS & DISCUSSION	13
4.1 PT ADINDO HUTANI LESTARI (AHL).....	14
4.2 PULAU PADANG	20
5.0 NEXT STEPS	24
6.0 ACKNOWLEDGMENTS	24
7.0 REFERENCES.....	24

LIST OF TABLES

Table 1	Acquired Satellite Image Data List (status of Jun 29, 2015).....	5
Table 2	RapidEye Data Acquisition Status of Jun 10, 2015.	6
Table 3	Landsat Quality and Status.....	7
Table 4	List of Dataset Provided by APRIL.....	7
Table 5	Satellite Image Interpretation Keys.....	9
Table 6	Interpretation Samples of Ground truths vs. Satellite Imagery.	11
Table 7	Compartments with NDVI > 0.6 requiring close monitoring.....	15
Table 8	Baseline summary as May 16 th , 2015.....	18
Table 9	Baseline summary as May 15 th , 2015.....	22

LIST OF FIGURES

Figure 1	APRIL Supplier's Concession (AHL).....	3
Figure 2	APRIL Concession in Pulau Padang (PPD).	4
Figure 3	Land cover mapping workflow.	8
Figure 4	Sentinel-1 profile plots of sample locations.	10
Figure 5	Field validation & Aerial survey in AHL.....	12
Figure 6	April Land Monitoring Portal (beta).	14
Figure 7	Land status of May 16 th , 2015.....	17
Figure 8	Land cover status of May 16 th , 2015.....	19
Figure 9	Land status of May 15 th , 2015.....	21
Figure 8	Land cover status of May 15 th , 2015.....	23

LIST OF APPENDICES

Appendix A1	Land Cover Analysis
Appendix A2	"Compartments with NDVI > 0.6 requiring close monitoring"



DISTRIBUTION LIST

The following individuals/firms have received this document:

Name	Firm	Hardcopies	Web	Email	FTP
Periasamy MP	APRIL Group	✓		✓	-
Goh Lin Piao	APRIL Group	✓		✓	-
Jemmy Chayadi	APRIL Group	✓	✓	✓	-
Joe Lawson	SAC APRIL	-		✓	-
Landmonitoring.com	Public access	-	✓	-	-

AMENDMENT RECORD

This report has been issued and amended as follows:

Issue	Description	Date	Approved by	
1	Third version of Report	2015-07-06		
			Dr. Andy Dean Project Director	Agus Salim Project Manager

EXECUTIVE SUMMARY

APRIL Group published its Sustainable Forest Management Policy (SFMP) on 28 January 2014. This policy subsequently evolved to include strengthened and new commitments on 3 June 2015 (SFMP '2.0') following input from APRIL Group's Stakeholder Advisory Committee (SAC) and contributions from stakeholders across civil society including NGOs.

To ensure compliance with key SFMP commitments, APRIL Group appointed PT Hatfield Indonesia as an independent third party to monitor and maintain data credibility in relation to its no-deforestation commitments for the PT Adindo Hutani Lestari (AHL) concession area (North Kalimantan) and Pulau Padang Concession (Riau). PT Hatfield Indonesia was commissioned to deliver baseline mapping, derived from high resolution satellite Earth observation imagery, as close as possible to the commencement of APRIL Group's 15 May 2015 moratorium on the harvesting of mixed hardwoods. A target baseline was to be delivered by 31 May 2015, with monthly land change monitoring reports to be compiled through to December 2015 within one-hectare minimum mapping units. This is in accordance with SFMP '2.0' which notes: "By 15 May 2015, APRIL Group and its suppliers halted all harvesting of mixed hardwoods. Mixed hardwoods harvested before 15 May 2015 will be utilized by APRIL Group's mill before end December 2015."

PT Adindo Hutani Lestari concession

Based on Landsat 7 images of the PT Adindo Hutani Lestari (AHL) concession area on 15 May 2015, Hatfield Indonesia conducted an analysis to define and develop a land classification scheme covering a total of 20,579 hectares made up of 887 compartments. PT Hatfield Indonesia used Normalized Difference Vegetation Index (NDVI) vegetation mapping to define areas of high and low forest density under the land classification scheme to illustrate where high density forest existed as at 15 May 2015. Where the NDVI rating is below 0.6, the area has been felled or comprises scrub. This baseline was then used to compare high density forest that existed on 15 May 2015 against Landsat 7 maps dated 9 and 17 June 2015.

Hatfield Indonesia confirms, based on the Landsat 7 analysis on 15 May 2015, that 861 compartments totaling 19,946 hectares can be considered "low risk" where some areas are neither operated (i.e. standing forests in claim area and moratorium area) or area with NDVI vegetation index below 0.6 indicating felled or scrub areas. There were 19 compartments comprising 481 hectares that recorded a NDVI rating greater than 0.6, which indicated areas with trees prior to 15 May 2015 (potentially felled and awaiting extraction). Further satellite analysis on 9 and 17 June confirmed no changes against the Landsat 7 map captured on 15 May 2015 in 19 compartments, i.e. NDVI remained above 0.6. The Landsat 7 analysis also detected forest cover changes in 7 compartments between 15 May 2015 and 9 and 17 June 2015. These 7 compartments make up 151 hectares, with about 45 hectares appearing to be disturbed.

The satellite Earth observation analysis was complemented by visual ground truthing and aerial survey of the 26 compartments described above on 25 June 2015 and comparison against the supplier's records (included in the appendices). The supplier's records indicate that felling took place prior to 15 May 2015 with land preparation activity (including pre-bunching and extraction) continuing quickly between 15 May

and 9 June 2015 in the 7 compartments. This may account for the change in forest cover detected in the current analysis. However, as we note in the report, confidence in this analysis is impacted by the 30 m spatial resolution and quality of the Landsat 7 satellite data, resulting in an overall accuracy assessment of just 54% for the 26 compartments. As a result, further analysis using 5 m spatial resolution RapidEye imagery is being sought to confirm the sequence of events and to confirm the completion of felling prior to 15 May 2015.

Pulau Padang Concession

All the area considered as no risk areas in terms of the 15 May 2015 MHW moratorium perspective as there is no MHW present.

1.0 INTRODUCTION

PT Hatfield Indonesia (Hatfield) is pleased to submit this baseline report for the land monitoring, mapping and wood tracking services (Mixed Hardwood Moratorium) for the APRIL Group concession in Riau and APRIL supplier (AHL) concession in North Kalimantan. This report describes how Hatfield has conducted the land monitoring service; the method used and the technical results, to fulfill the requirements for baseline mapping.

1.1 ACRONYMS AND ABBREVIATIONS

AHL	PT Adindo Hutani Lestari (APRIL supplier in North Kalimantan)
APRIL	APRIL Group
EO	Earth Observation
ESA	European Space Agency
Felled	Refers to trees which have been chain-sawed cut, but not pre-bunched and extracted
Hatfield	PT Hatfield Indonesia
MHW	Mixed hardwood
NDVI	Normalized Difference Vegetation Index
PIP	Planting In Progress
PPD	Pulau Padang Concession
RapidEye	Constellation of 5 earth observation satellites owned & operated by BlackBridge AG
RFP	Ready For Planting
SAR	Synthetic Aperture Radar Imagery
Sentinel-1	SAR C-band satellite imagery owned by ESA
SFMP	Sustainable Forest Management Policy

1.2 OBJECTIVES

The objective of the service is as follows:

- To provide a baseline map derived from high resolution satellite Earth Observation (EO) image analysis as of Moratorium date of May 15, 2015, with the target baseline established by May 31, 2015;
- To provide a monthly land change detection report on MHW moratorium monitoring status up to December 2015 with a one-hectare minimum mapping unit; and
- To provide a wood tracking monitoring report to determine (1) only MHW felled before the 15 May 2015 Moratorium can be delivered to Kerinci mill from Pulau Padang concession (PPD) and PT

Adindo Hutani Lestari (AHL) - APRIL supplier's concession; and (2) no MHW will be felled in line with the 15 May 2015 Moratorium.

To address the scope of work and the challenges, Hatfield's unique experience and land monitoring capabilities were applied to:

- Define a service based on high resolution RapidEye satellite imagery with a feasible monitoring plan. Utilize other available imagery including Landsat and Sentinel-1 as available;
- Interpret satellite imagery with an agreed classification scheme for the entire monitoring area to produce a baseline map;
- Perform ground and aerial check surveys for validation;
- Provide monthly change detection analysis to monitor MHW moratorium status;
- MHW wood tracking; and
- Reporting.

1.3 STUDY AREA

The study areas are located in the Sesayap-Sembakung river system of North Kalimantan province for the AHL site (Figure 1), and the Pulau Padang – Riau province for the PPD site (Figure 2). The region is dominated by peat land with a portion of land consisting of mineral soil. The total monitoring area for the AHL site is 20,579 hectares and 20,036 hectares for the PPD site.

Figure 1 APRIL Supplier's Concession (AHL).

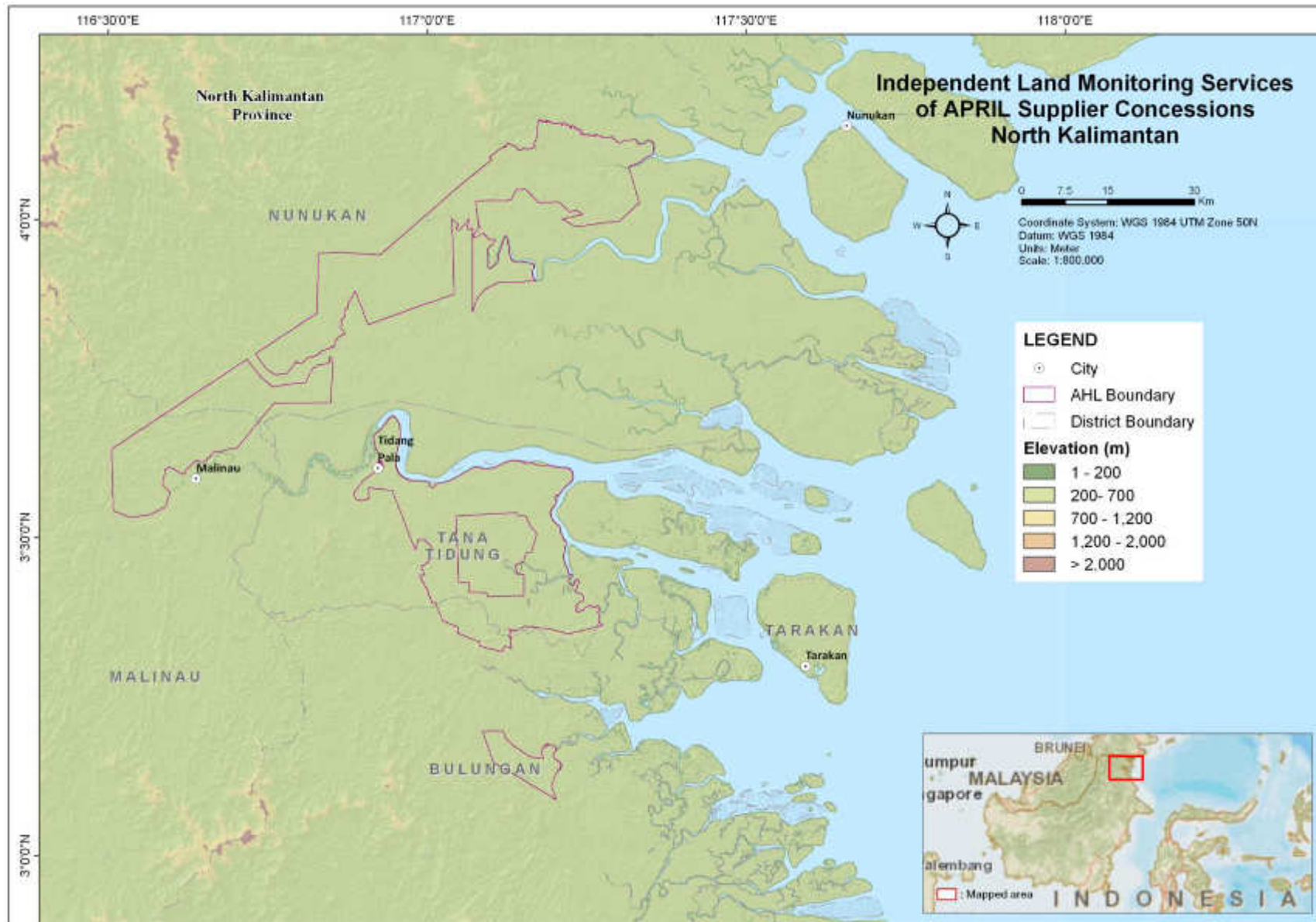
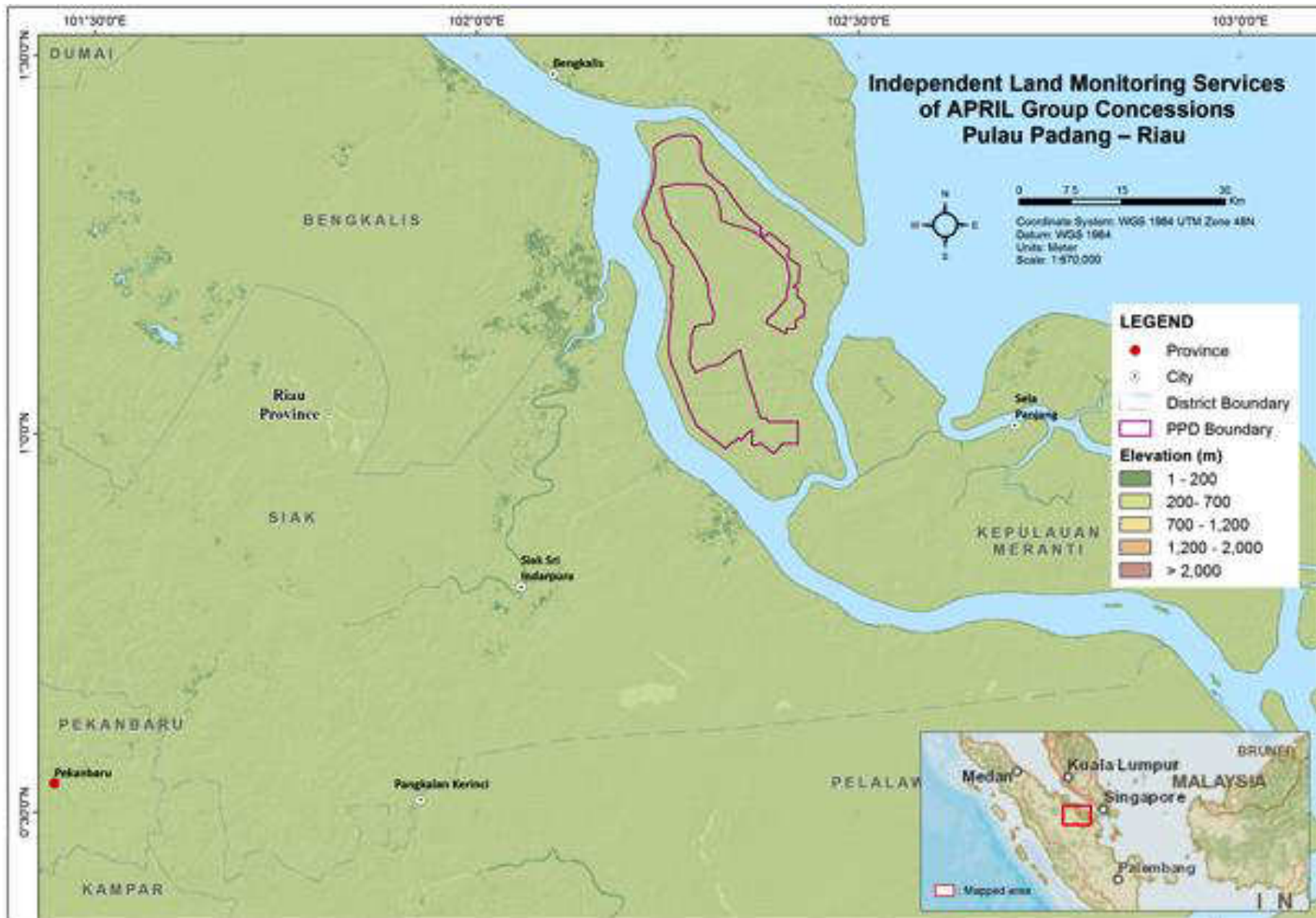


Figure 2 APRIL Concession in Pulau Padang (PPD).



2.0 DATA

Hatfield acquires satellite imagery from three (3) data sources: BlackBridge AG – RapidEye (<http://blackbridge.com/rapideye/>), the European Space Agency (ESA) Sentinel Data Hub (<https://scihub.esa.int/>), and Earth Resources Observation and Science Center (EROS) – NASA-USGS (<http://glovis.usgs.gov/>).

RapidEye satellite tasking (programming) has been initiated to acquire continuously over the study areas from May 15th up to November 2015 for optical data collection. In the same period the Hatfield team acquires regular Sentinel-1 radar imagery via the ESA Sentinel Data Hub. Landsat 7-8 data from the USGS-NASA data portal are also routinely monitored for new acquisitions. Details of the data used and scene acquisition status are described in the following sub-sections.

Details of acquired satellite imagery are shown in Table 1.

Table 1 Acquired Satellite Image Data List (status of Jun 29, 2015).

Satellite Image Data Source	AHL		PPD	
	Optical Sensor	Radar Sensor	Optical Sensor	Radar Sensor
Baseline	<u>RapidEye</u> : N/A <u>Landsat</u> : ETM7, May 16 2015 OLI8, May 24 2015	<u>Sentinel-1</u> : IW, May 16 2015	<u>RapidEye</u> : N/A <u>Landsat</u> : ETM7, May 16 2015 OLI8, May 24 2015	<u>Sentinel-1</u> : IW, May 15 2015
Change Analysis #1	<u>RapidEye</u> : N/A <u>Landsat</u> : ETM7, Jun 16 2015 OLI8, Jun 24 2015	<u>Sentinel-1</u> : <i>IW, Jul 03 2015*</i>	<u>RapidEye</u> : N/A <u>Landsat</u> : ETM7, Jun 16 2015 OLI8, Jun 24 2015	<u>Sentinel-1</u> : IW, Jun 14 2015

* There was no Sentinel-1 imagery available in June for this area; We plan to use the July 03, 2015 data acquisition.

Data analysis based on satellite imagery is complimented by ground-truthing analysis, which is a ground or aerial survey to obtain information on current forest status and composition.

2.1 RADAR SENSOR

2.1.1 Sentinel-1 (10m)

Sentinel-1 is an imaging radar mission providing continuous all-weather, day-and-night imagery in the radar C-band wavelength range. The Sentinel-1 constellation provides high reliability, improved revisit time for superior geographical coverage and rapid data dissemination to support operational applications in the priority areas of land monitoring, marine monitoring, and emergency services. For this work, Interferometric Wide swath (IW) mode has been used, which is Sentinel-1's primary operational mode over land.

The main advantage of this sensor is that operates as a cloud-free system and is suitable for identification of moisture in both soil and vegetation. On the other hand, SAR has limited capability for identifying detailed land cover classes and is susceptible to shadow effects in terrain/mountainous areas.

2.2 OPTICAL SENSOR

2.2.1 RapidEye (5m)

RapidEye comprises five satellites that are the first commercial satellites to include the Red-Edge band, which is sensitive to changes in chlorophyll content. Studies show that this band can assist in monitoring vegetation health, improve species separation. RapidEye images are 5 m resolution with sensor specifications as follows: 440 – 510 nm (Blue), 520 – 590 nm (Green), 630 – 685 nm (Red), 690 – 730 nm (Red Edge), 760 – 850 nm (Near IR).

Hatfield submitted a series of programming tasks to the RapidEye satellite provider to acquire imagery starting from May 15th 2015 over the study areas. Unfortunately, as of June 10th, 2015, there are no good quality images available due to excessive cloud cover. Four attempts have been made to date to collect images, as reported in Table 2.

Table 2 RapidEye Data Acquisition Status of Jun 10, 2015.

AHL: 4 Attempts (3 Catalogued, 1 Failed)		PPD: 4 Attempts (2 Catalogued, 2 Failed)	
Date	Status	Date	Status
May 15, 2015	Catalogued	May 24, 2015	Failed
May 31, 2015	Catalogued	May 31, 2015	Catalogued
May 29, 2015	Catalogued	June 5, 2015	Catalogued
June 9, 2015	Failed	June 9, 2015	Failed

Hatfield's team are still working with the RapidEye satellite operator to get catalogued images for generating composite cloud-free images from multi-date acquisitions, if possible. This may allow for an enhanced baseline map for May 15th, 2015 based on optical data.

2.2.2 Landsat 7/8 (15-30m)

Landsat data is widely used, free and provides long-term historic optical satellite imagery from the US Geological Survey. Landsat is a suitable data source for land monitoring applications at medium scale resolution. In this study, we are using Landsat 7 and Landsat 8 as input imagery when they are available.

Landsat 7 Enhanced Thematic Mapper Plus (ETM+) images consist of eight spectral bands with a spatial resolution of 30 m for Bands 1 to 7. The resolution for Band 8 (panchromatic) is 15 m..

Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) images consist of nine spectral bands with a spatial resolution of 30 m for Bands 1 to 7 and 9. The new band 9 is useful for cirrus cloud detection. The resolution of Band 8 (panchromatic) is 15 m.

Table 3 Landsat Quality and Status.

AHL (Path 117 Row 57-58)		PPD (Path 126 Row 59)	
Date	Status	Date	Status
L7, May 15, 2016	Stripping, 60% cloud cover	L7, May 15, 2015	Stripping, 80% cloud cover
L8, May 24, 2015	75% cloud cover	L7, May 31, 2015	Stripping, 85% cloud cover
L8, Jun 9, 2015	80% cloud cover	L8, Jun 8, 2015	75% cloud cover
L7, Jun 17, 2015	Stripping, 80% cloud cover	L8, Jun 24, 2015	70% cloud cover
L8, Jun 24, 2015	90% cloud cover		

2.3 REFERENCE DATA

2.3.1 Baseline Data

APRIL provided baseline data for the AHL and PPD concessions in shape files format and excel tables. All GIS data are in the WGS84/UTM zone 50N coordinate system for AHL, and WGS/UTM 48N for the PPD concession. The latest thematic data are listed on Table 4.

Table 4 List of Dataset Provided by APRIL.

Thematic Data (Shape file format)	AHL	PPD
Boundary concession	As of Jun 30, 2015	As of Jun 23, 2015
Working Plan (RKT)	As of Jun 30, 2015	As of Jun 23, 2015
Infrastructure: road, canals	As of Jun 30, 2015	As of Jun 23, 2015
Timber movement table	As of Jun 30, 2015	As of Jun 23, 2015

2.3.2 Auxiliary Data

Hatfield used SRTM 3 arc-second, or 30-meter resolution digital elevation model (DEM) data for systematic geometric correction of Sentinel-1 imagery.

3.0 METHODOLOGY

3.1 BASELINE LAND COVER MAPPING

The satellite Earth Observation data were pre-processed with commonly used techniques:

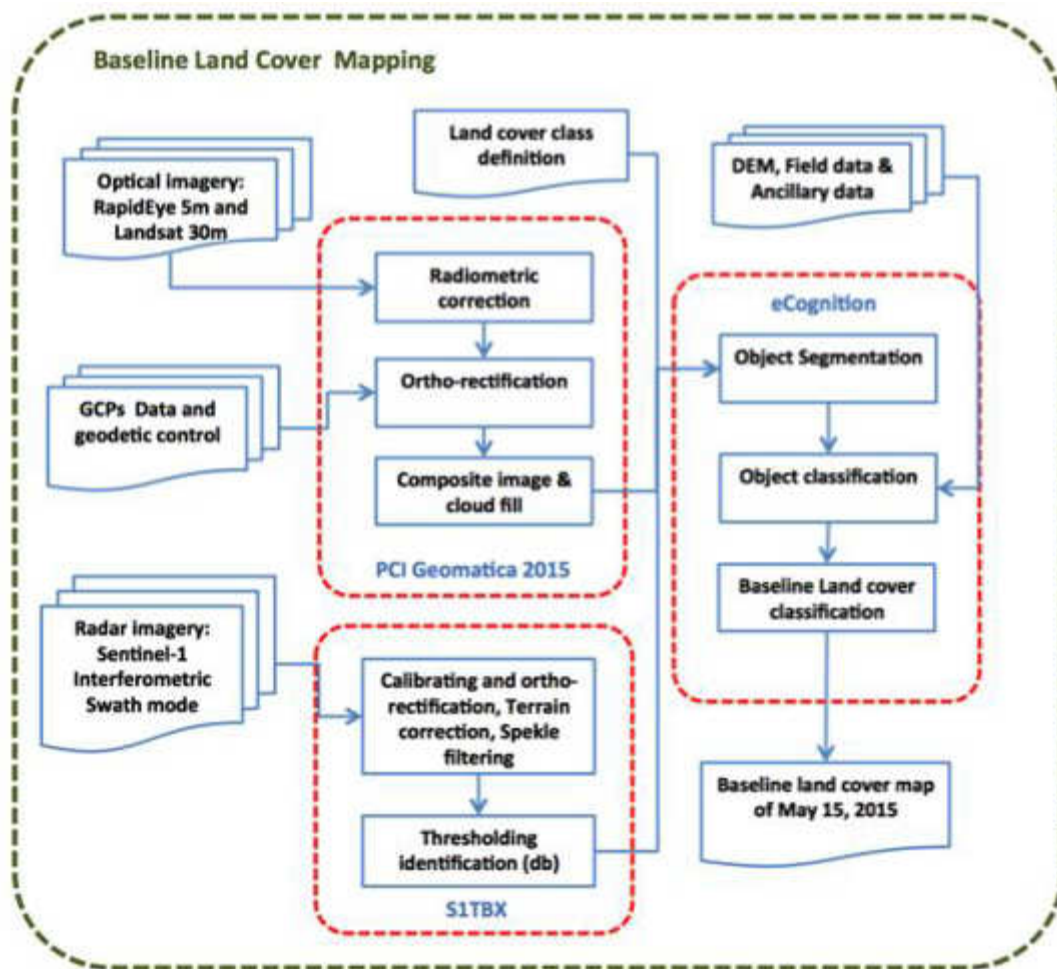
- For the calibration and geocoding of the radar data the Sentinel-1 Toolbox (S1TBX) software was used. As parts of the test site are characterized by significant topography, the normalization procedure proposed by Stussi et al. (1995) was applied to the Sentinel-1 data.

- The optical data were atmospherically corrected with ATCOR and orthorectified using the SRTM DEM.

After pre-processing of all EO data, land cover maps were generated applying an object-based, hierarchical decision tree classification scheme. Image objects were delineated from the optical data using the multi-resolution segmentation approach (Baatz & Schäpe, 2000) implemented in eCognition software. The procedure decreased the scale factor in a stepwise fashion. The data processing workflow is illustrated on Figure 3.

As agreed with APRIL’s technical team, all data for AHL are processed in the WGS84-UTM50N map projection system and in WGS84-UTM48N for the PPD concession.

Figure 3 Land cover mapping workflow.



Interpretation Keys

Hatfield developed a classification procedure with two levels of land cover mapping, based on data availability:

- The first land cover level is derived from Sentinel-1 image datasets and portions of cloud-free Landsat imagery that was available for the study areas.
- The second land cover level includes classes that can only be determined through complementary operational data and field observations, with some potential contribution from the higher resolution RapidEye data.

Table 5 shows the detailed parameters for each land cover class and the chart on Figure 4 illustrated threshold values chosen for Sentinel-1 data as representative of each land cover class.

Table 5 Satellite Image Interpretation Keys.

Land cover class (Level 1)	Land cover class (Level 2)	Parameters/ Quantitative index		
		Sentinel-1***:	Landsat 7/8	RapidEye
High density vegetation	MHW standing	C-VH > -16.9 dB, C-VV > -9 dB	NDVI* > 0.6	To be determined
Low density vegetation	Felled**			
	Pre-bunching	C-VH: -16.9 to -10.5 dB, C-VV: -9.99 to -6.8 dB	NDVI: 0.2 to 0.6	To be determined
	Scrub			
Open land	Extraction	C-HV > -10.5 dB,	NDVI < 0.2	To be determined
	PIP, RFP	C-HH < -6.8 dB		
Water	Water	C-VH ≤ -20.5 dB, C-VV < -13 dB		

* Notes: the NDVI value was calculated based on Landsat 7 Path 117 Row 57-58 acquisition date on May 15th 2015. Imagery was atmospheric corrected using ATCORR module to reduce atmospheric noise that may influence NDVI value.

** Felled refers to trees which have been chain-sawed cut, but not pre-bunched and extracted.

***For the first level Sentinel-1 analysis, C-VV indicates band C radar with vertical-vertical polarization intensity values in decibels (dB) and C-VH indicates vertical-horizontal polarization intensity values.

Figure 4 Sentinel-1 profile plots of sample locations.

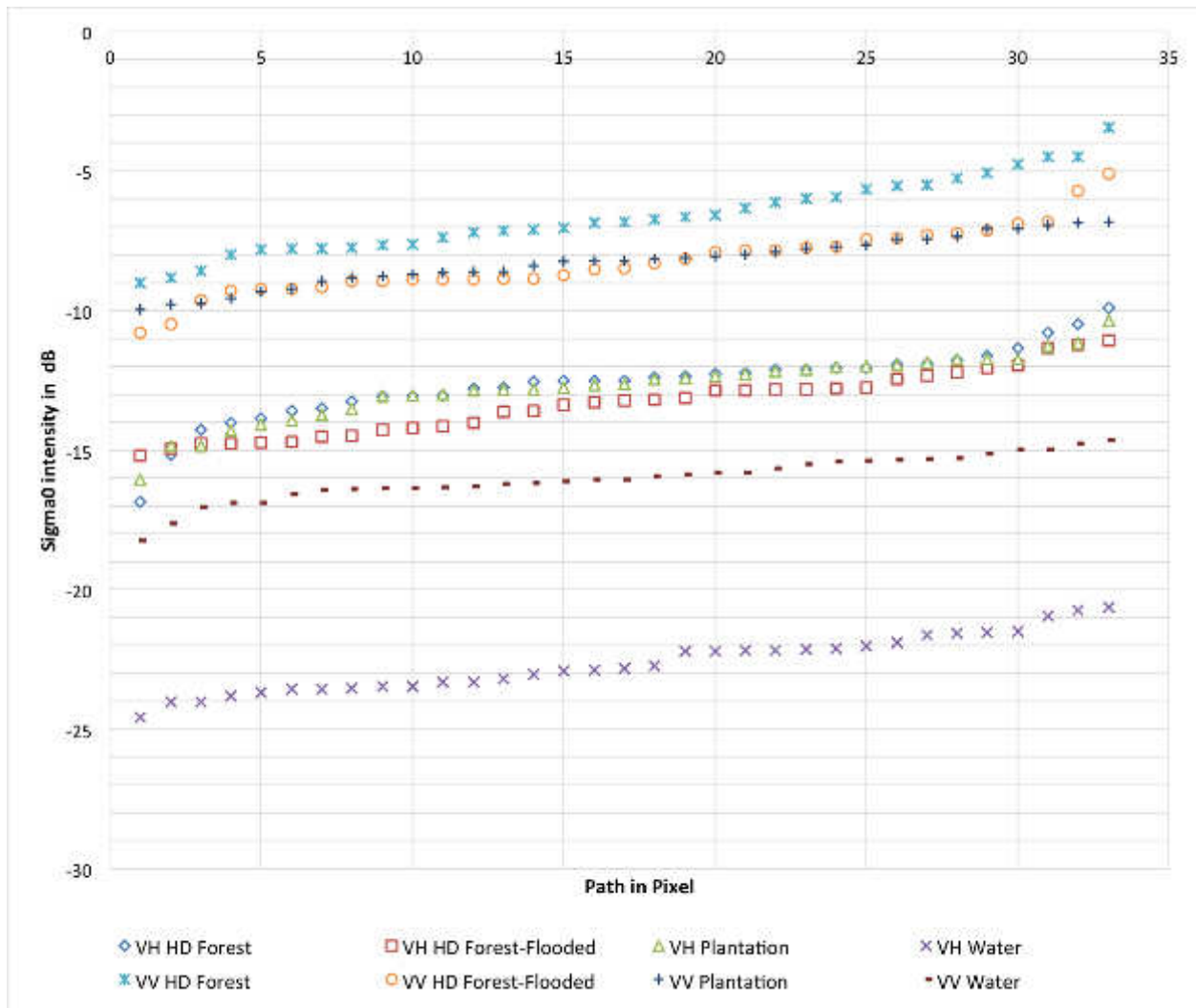

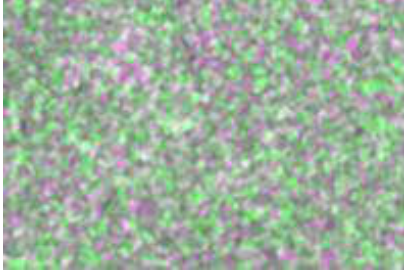

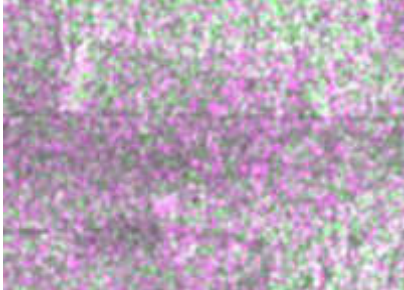

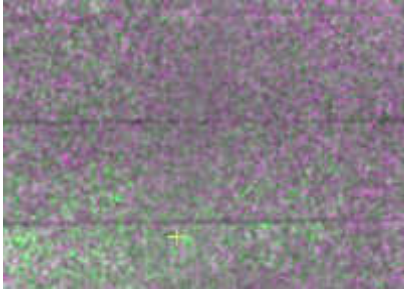




Table 6 Interpretation Samples of Ground truths vs. Satellite Imagery.

Land cover class (Level-1)	Ground truth/ Aerial survey photos May 15, Jun 25, 2015	Sentinel-1 (Red=VV, Green=VH, Blue=VV/VH)
High density vegetation (MHW standing)		
Low density vegetation (Felled, pre-bunching)		
Open land (Extraction, ready for planting)		
Water		

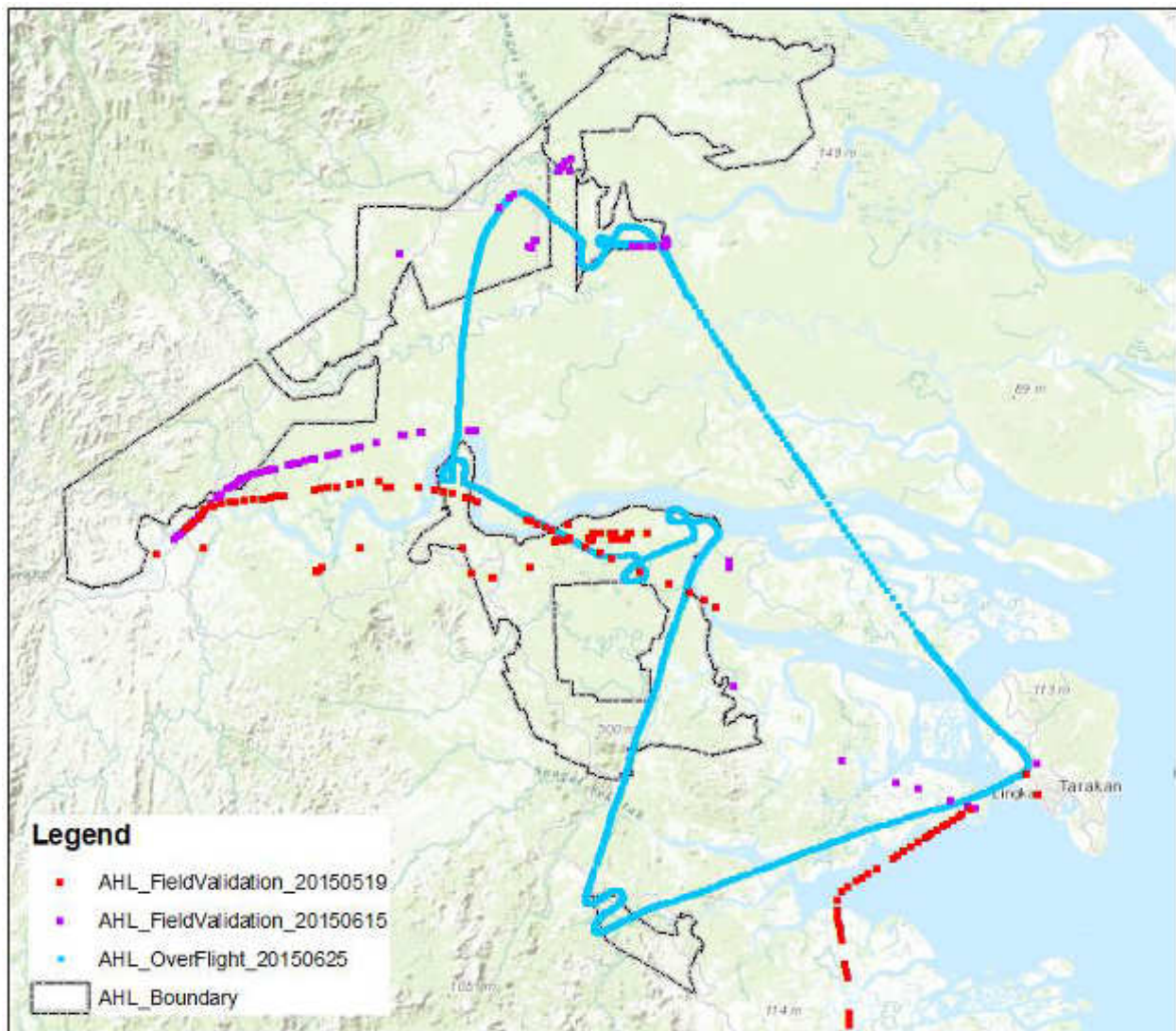
Field survey & Data Validation

Prior to fieldwork activities, Hatfield prepared a field survey plan document, which contains field target locations and all related health and safety procedures for conducting fieldwork activities.

Hatfield conducted a ground check survey in the project area to obtain information on current forest status and composition. The field survey provided data for development of the forest cover classification process, as well as for independent validation.

The field survey and data validation at AHL concession were conducted on May 19–20 and June 16–17, 2015 followed with an aerial survey on June 25 2015 (Figure 5). The field validation exercise for the PPD concession areas was conducted on June 11-13, 2015.

Figure 5 Field validation & Aerial survey in AHL.



Accuracy Assessment

Land cover map (level 1) accuracy was assessed using eCognition software as follows:

1. Reference segments were selected based on medium resolution optical data, ground truth data collection and aerial survey photographs.
2. For each field collection location, an analyst reviewed the field notes and examined the classification result.
3. The analyst evaluated the predominant land cover class of the segmentation object in which the field location falls. In some cases, the field location may occur at the boundary of the classified segment, in which case the validation location was not used in the accuracy assessment.
4. The segment class was then compared to the field-based class, and tallies of correct or incorrect classified output made.

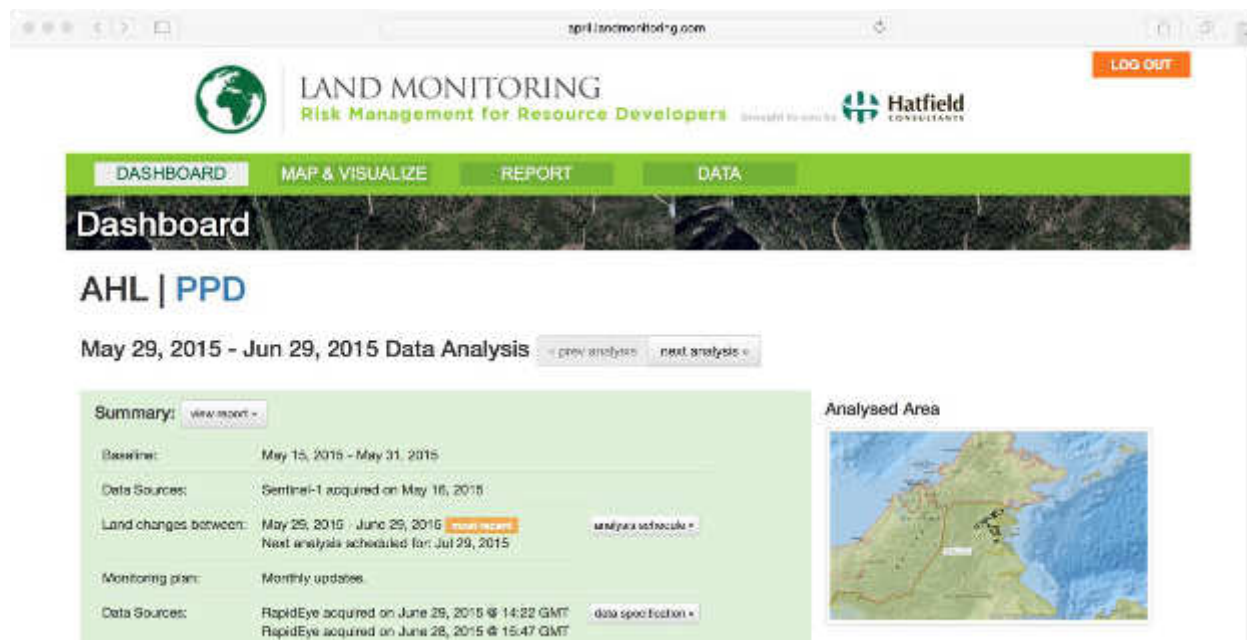
4.0 RESULTS & DISCUSSION

The land cover baseline as at 15 May 2015 for AHL and PPD concession is depicted in Figures 7-to-8. However, limitations of the data sources due to high cloud cover and spatial resolution mean that the overall accuracy assessment of the land cover map is 54%. We are seeking additional optical data sources from RapidEye to improve this accuracy assessment.

We note that the NDVI classification does not clearly differentiate between standing trees and felled areas, where felled areas are those where trees have been chainsaw cut and remain on the ground with intact crown along with existing scrub and undergrowth. In addition to ground truthing and aerial survey, further high-resolution analysis using additional optical data sources from RapidEye is being sought to improve this accuracy assessment.

The current baseline map is available for review at: <http://april.landmonitoring.com> (see Figure 6). For user id and password, please contact: Jemmy Chayadi at Jemmy_Chayadi@aprilasia.com

Figure 6 April Land Monitoring Portal (beta).



4.1 PT ADINDO HUTANI LESTARI (AHL)

AHL has an operating area of 20,579 hectares, consisting of 887 compartments. Following a systematic process of analysis, 861 compartments of 19,946 hectares are considered as “low risk areas” from Monitoring point of view, since the areas are neither operated (i.e. standing forests in claim area and moratorium area) or have NDVI values under 0.6 (i.e.: felled areas, scrub, etc). The NDVI value was calculated based on Landsat 7 Path 117 Row 57-58 after atmospheric correction.

Hatfield identified 26 compartments with NDVI of more than 0.6 which contain some percentage of high density forest, from NDVI analysis, and require close monitoring (See Table 7). Most of these compartments are on the periphery of concessions areas.

Out of 26 compartments, there were 19 compartments comprising 481 hectares that recorded a NDVI rating greater than 0.6 which included areas with trees felled prior to 15 May 2015 (awaiting extraction). Further satellite analysis on 9 and 17 June confirmed no changes against the Landsat 7 map captured on 15 May 2015 in 19 compartments.

However the Landsat 7 analysis also detected some forest cover changes in the remaining 7 compartments between 15 May 2015 and 9 and 17 June 2015. These 7 compartments, which were compartment: SSP-A037, SSP-A017, SSP-A028, SSP-A022, SSP-A023, SSP-A035, and SSP-A019, make up 151 hectares, with about 45 hectares appearing to be disturbed.

This analysis was complemented by further visual ground truthing and aerial survey of the 26 compartments on 25 June 2015 and comparison against the supplier’s records (included in the appendices). The supplier’s records indicate that felling took place prior to 15 May 2015 with land preparation activity (including pre-bunching and extraction) continuing quickly between 15 May and 9 June 2015 in the 7 compartments. This may account for the change in forest cover detected between

May 15 and June 9. On June 25 during the aerial survey it was observed that these 7 compartments were cleared with the exception of some trees that included protected honey tree species.

However, as we note in the report, confidence in this analysis is impacted by the quality of the satellite data, resulting in an overall accuracy assessment of 54%. As a result, further high-resolution analysis using RapidEye is being sought to confirm the sequence of events and to confirm the completion of felling prior to 15 May 2015.

Table 7 Compartments with NDVI > 0.6 requiring close monitoring.

NO	COMP ID	AREA (Ha)	% Area NDVI > 0.6	Status of Landsat Changes Between MAY 15 vs. JUN 09 & 17	Comment on 15 May 2015 status after Aerial Survey as Jun 25 2015
1	SSP-A037	14.76	80%	Changed	Land cleared
2	SSP-A017	20.49	50%	Changed	Land cleared
3	SSP-A028	24.13	15%	Changed	Land cleared
4	SSP-A022	26.49	25%	Changed	Land cleared
5	SSP-A023	30.00	15%	Changed	Land cleared
6	SSP-A035	28.86	15%	Changed	Land cleared
7	SSP-A019	6.98	50%	Changed	Land cleared
8	SSP-G005	35.0	100%	No change	Nipah formation
9	SSP-G006	16.0	100%	No change	Nipah formation
10	SSP-G015	30.0	90%	No change	Nipah transition to forest
11	SSP-G026	5.3	100%	No change	Nipah transition to forest
12	SBG-E069	34.8	65%	No change	Confirmed Felled
13	SBG-H022	30.0	60%	No change	Felled
14	SBG-H023	12.2	60%	No change	Felled
15	SBG-C008	60.1	75%	No change	25% Felled (not full coverage photo)
16	SBG-C009	22.8	98%	No change	Cannot conclude (no photo)
17	SBG-C010	22.7	98%	No change	Felled
18	SBG-C094	30.0	95%	No change	Felled
19	SBG-C083	10.8	98%	No change	Felled
20	SBG-E004	28.6	85%	No change	Felled
21	SSP-G030	20.3	45%	No change	Felled
22	SSP-G031	27.3	75%	No change	Felled
23	SSP-G020	30.3	75%	No change	Felled

NO	COMP ID	AREA (Ha)	% Area NDVI > 0.6	Status of Landsat Changes Between MAY 15 vs. JUN 09 & 17	Comment on 15 May 2015 status after Aerial Survey as Jun 25 2015
24	SSP-F168	24.9	35%	No change	65% Felled, Balance dead tree
25	SSP-F169	15.6	5%	No change	95% Felled
26	SSP-F170	24.8	80%	No change	Felled

Figure 7 Land status of May 16th, 2015.

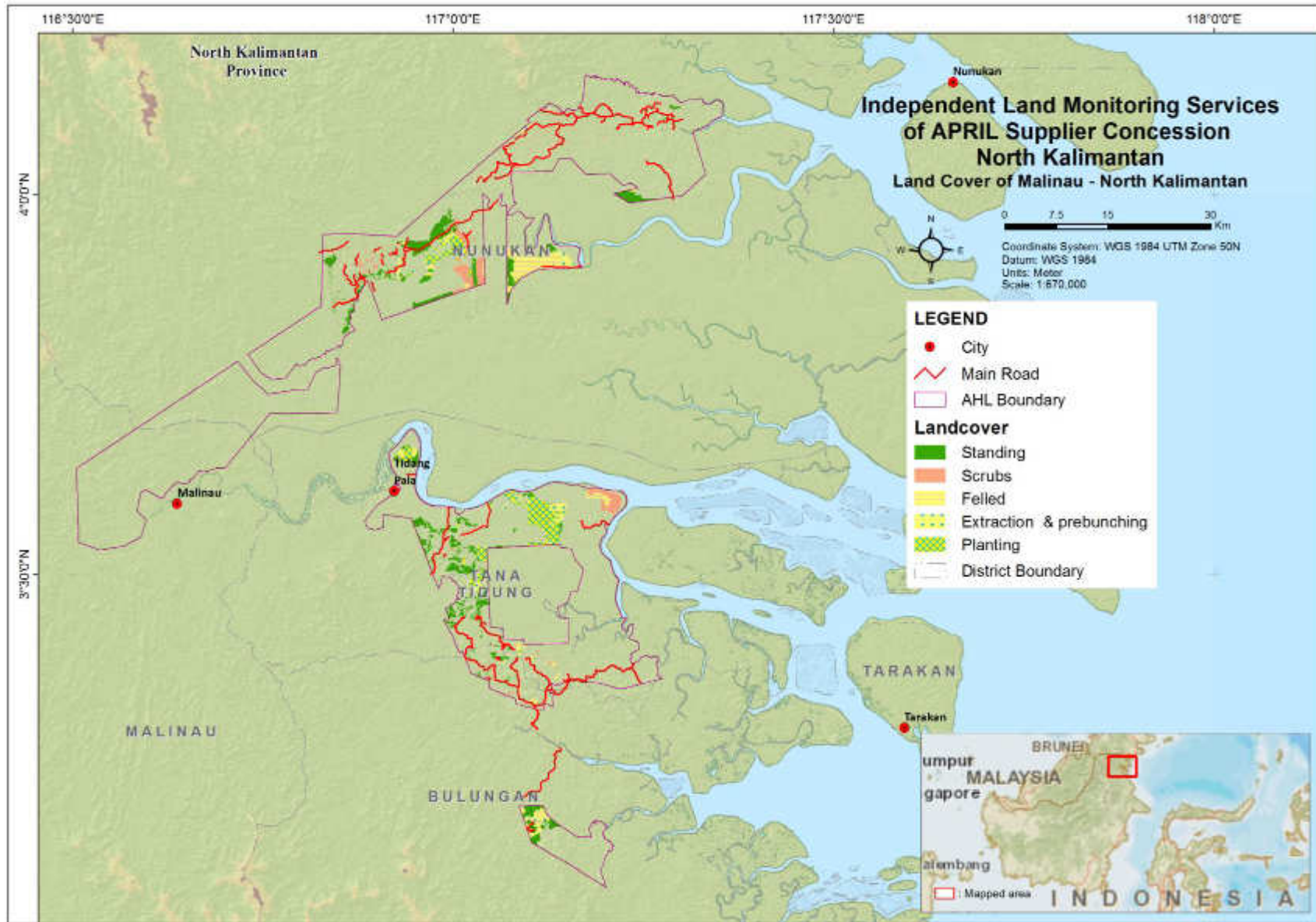


Table 8 **Baseline summary as May 16th, 2015.**








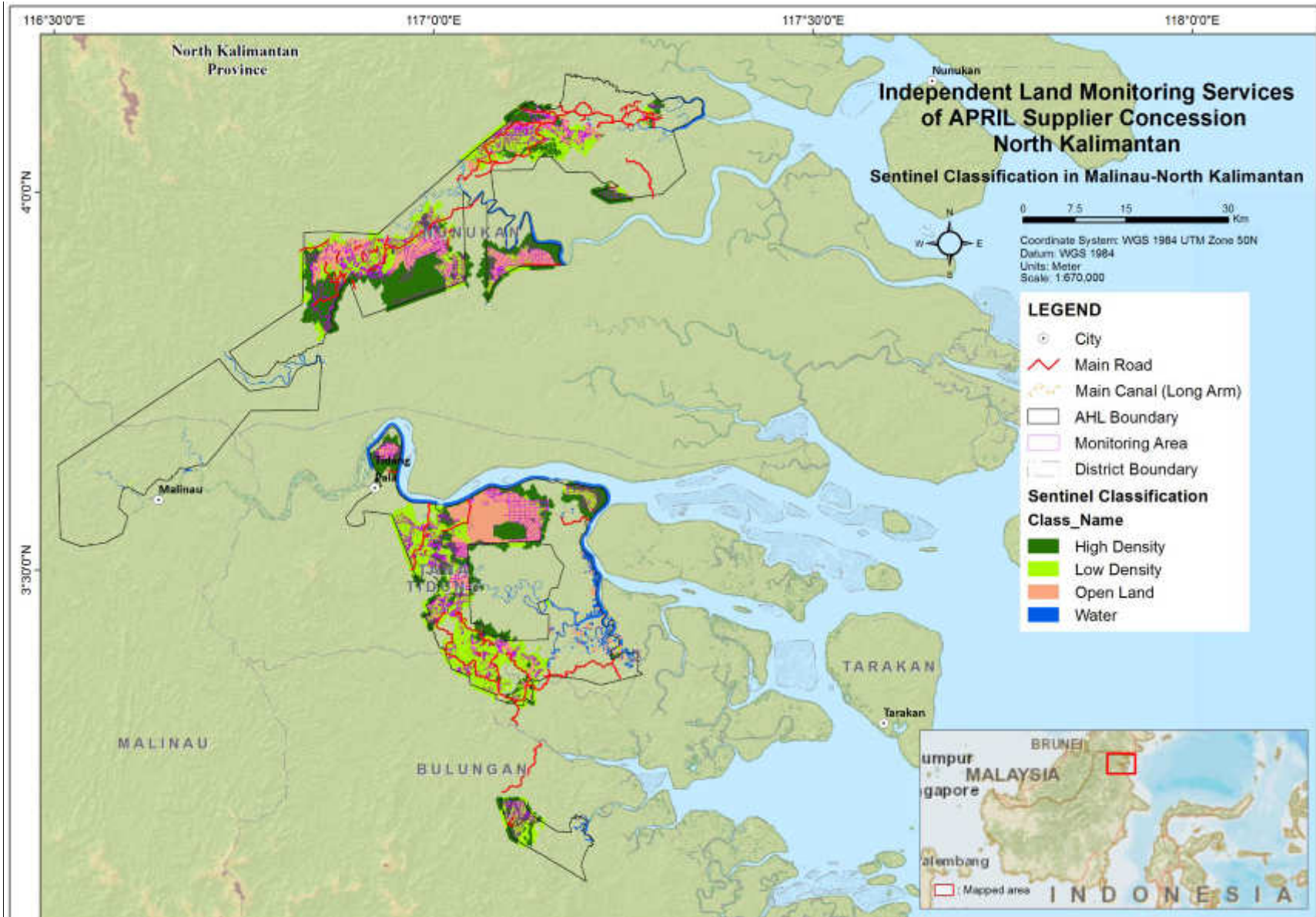
No	Description	Legend Colour	As 15 May 2015 (in Ha)
NET PLANTABLE AREA			20,579
1	Standing		1,483
2	Claim		5,234
3	Scrubs		2,415
4	Felled confirmed		4,807
5	Felled subject to RapidEye analysis		633
6	Extraction & prebunching		1,340
7	Planting		4,667

Figure 8 Land cover status of May 16th, 2015.



4.2 PULAU PADANG

Based on the satellite image analysis PPD has an operating area of 20,036 ha, with following stats:

- Claim / burnt /standing areas 1,935 ha
- Scrub land 185 ha
- Felled area 288 ha
- Extraction area 194 ha
- Balance areas are either planted or planting in progress

All the area considered as no risk areas in terms of the 15 May 2015 MHW moratorium perspective as there is no MHW present.

Figure 9 Land status of May 15th, 2015.

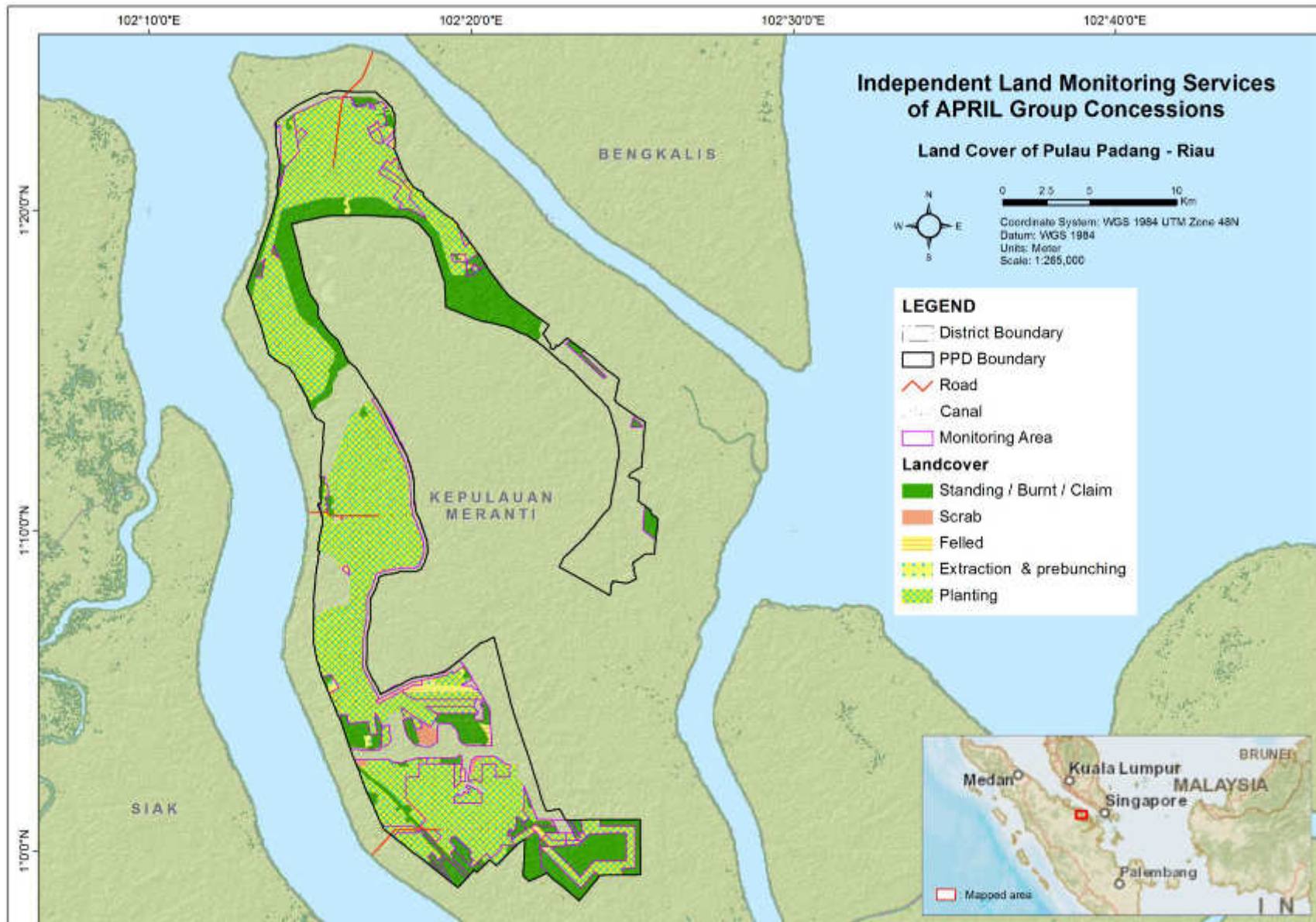


Table 9 **Baseline summary as May 15th, 2015.**






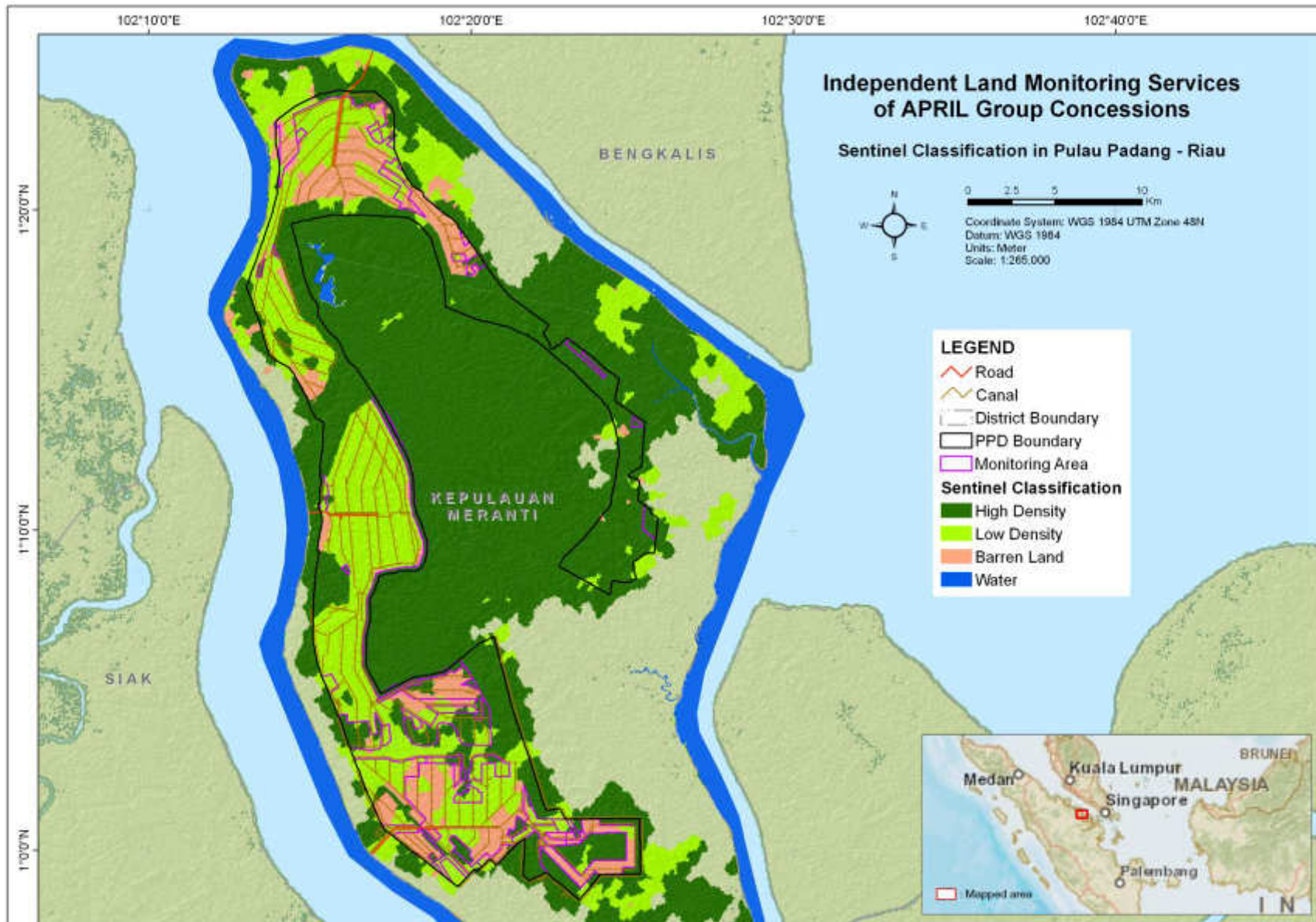
No	Description	Legend Colour	As 15 May 2015 (in Ha)
NET PLANTABLE AREA			20,036
1	Standing / Burnt / Claim		1,935
2	Scrab		185
3	Felled		288
4	Extraction & prebunching		194
5	Planting		17,434

Figure 10 Land cover status of May 15th, 2015.



5.0 NEXT STEPS

Additional analysis of 5 m resolution RapidEye satellite imagery will be conducted in an effort to improve the accuracy of the level 1 and level 2 land cover maps.

6.0 ACKNOWLEDGMENTS

The Sentinel-1 data were provided courtesy of the European Space Agency and The Landsat data are distributed by the Land Processes Distributed Active Center (LP DAAC). Located at USGS/EROS, Sioux Falls, SD <http://lpdaac.usgs.gov>.

Hatfield would like to thank to APRIL Group management on execution of this study, especially for Mr. Periasamy MP, Taufan Mega Chrisna, Yan Octayan, Ronald Pangaribuan, I Gede Nyoman Marianta, Dikdik Sopiandi and to all supporting staffs in the field offices.

7.0 REFERENCES

- Baatz M & A Schape, 2000. Multiresolution segmentation – an optimization approach for high quality multi-scale image segmentation. In: *Angewandte Geographische Informationsverarbeitung XII*. (AGIT, Salzburg), 12–23.
- Stussi N, A Beaudoin, T Castel & P Gigord, 1995. Radiometric correction of multi-configuration spaceborne SAR data over hilly terrain. In: *International Symposium on Retrieval of Bio- and Geophysical Parameters from SAR Data for Land Applications* (Toulouse, France, 10-13 October 1995), 469-478.

APPENDICES

Appendix A1

Land Cover Analysis

APPENDIX A1

LAND COVER ANALYSIS INCLUDING GROUND TRUTHING RESULTS

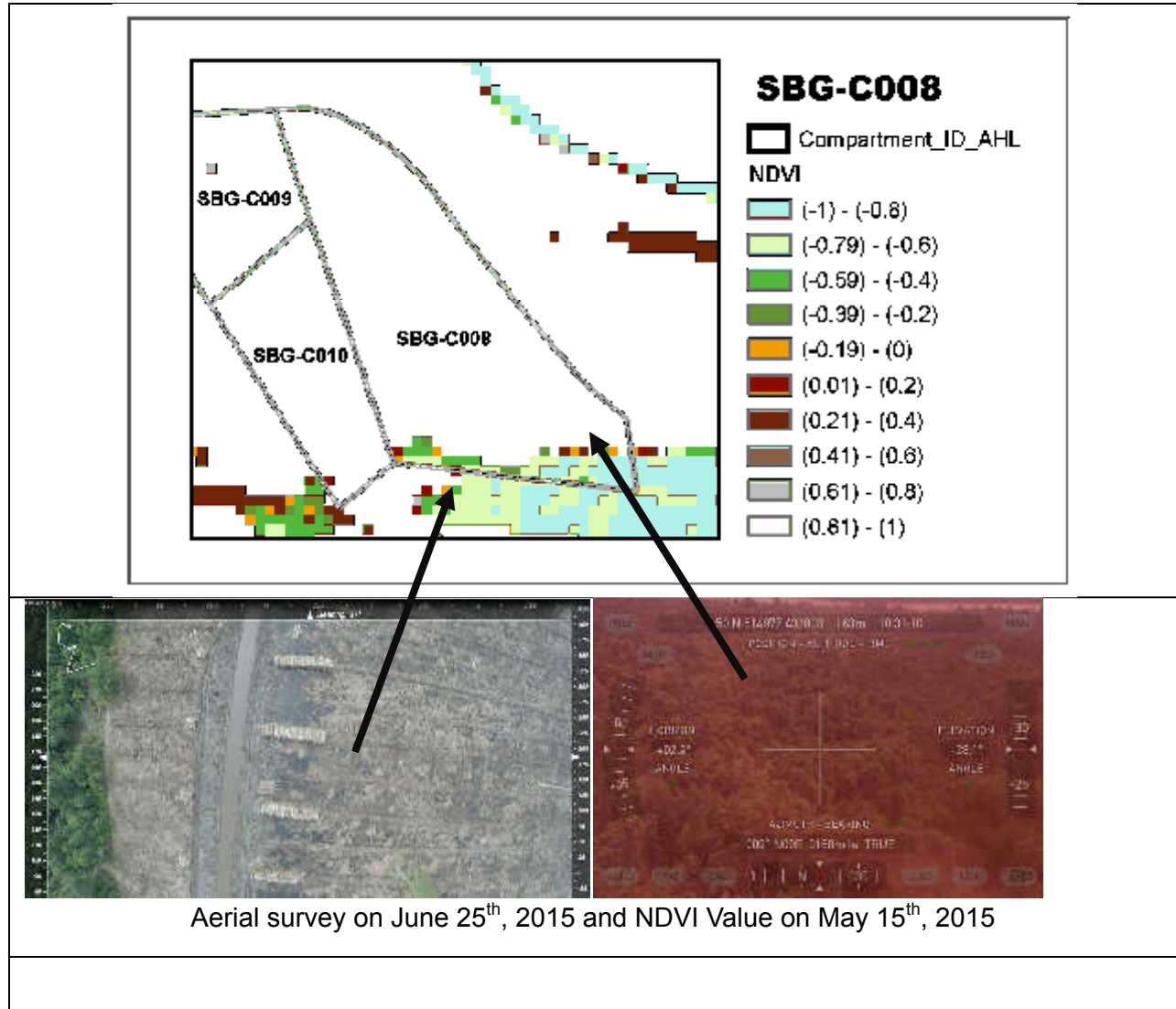
NO	Compartment ID	ADINDO Database as MAY 15	HATFIELD Comments as Landsat MAY15	% Area NDVI > 0.6	Status of Landsat Changes Between MAY 15 vs. JUN 09 & 17	Comment on 15 May 2015 status after Aerial Survey as Jun 25 2015
1	SSP-A037	Felled	Standing tree	80%	Changed	Land cleared
2	SSP-A017	Felled	Standing Tree (portion)	50%	Changed	Land cleared
3	SSP-A028	Felled	Standing	15%	Changed	Land cleared
4	SSP-A022	Felled	Standing Tree (portion)	25%	Changed	Land cleared
5	SSP-A023	Felled	Standing Tree (portion)	15%	Changed	Land cleared
6	SSP-A035	Felled	Standing Tree (portion)	15%	Changed	Land cleared
7	SSP-A019	Felled	Standing Tree (portion)	50%	Changed	Land cleared
8	SSP-G005	Scrubs	Standing tree	100%	No change	Nipah formation
9	SSP-G006	Scrubs	Standing tree	100%	No change	Nipah formation
10	SSP-G015	Scrubs	Standing tree	90%	No change	Nipah transition to forest
11	SSP-G026	Scrubs	Standing tree	100%	No change	Nipah transition to forest
12	SBG-E069	Felled	Standing tree (portion)	65%	No change	Confirmed Felled
13	SBG-H022	Felled	Standing tree	60%	No change	Felled
14	SBG-H023	Felled	Standing tree	60%	No change	Felled
15	SBG-C008	Pre-bunching	Standing tree (portion)	75%	No change	25% Felled (not full coverage photo)
16	SBG-C009	Felled	Standing tree	98%	No change	Cannot conclude (no photo)
17	SBG-C010	Felled	Standing tree	98%	No change	Felled
18	SBG-C094	Felled	Standing tree (portion)	95%	No change	Felled
19	SBG-C083	Felled	Standing tree (portion)	98%	No change	Felled
20	SBG-E004	Felled	Standing tree (portion)	85%	No change	Felled

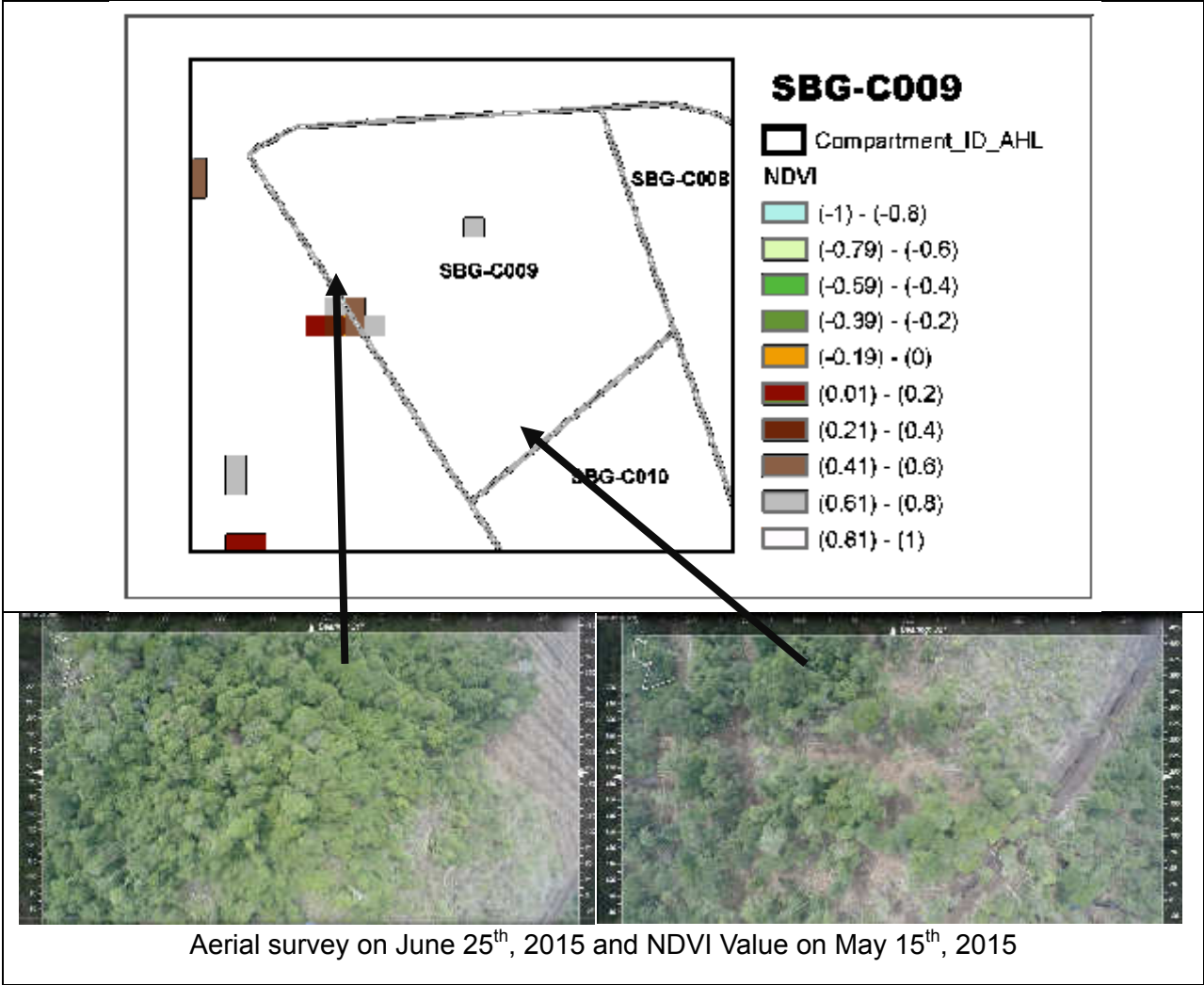
NO	Compartment ID	ADINDO Database as MAY 15	HATFIELD Comments as Landsat MAY15	% Area NDVI > 0.6	Status of Landsat Changes Between MAY 15 vs. JUN 09 & 17	Comment on 15 May 2015 status after Aerial Survey as Jun 25 2015
21	SSP-G030	Felled	Standing tree (portion)	45%	No change	Felled
22	SSP-G031	Felled	Standing tree (portion)	75%	No change	Felled
23	SSP-G020	Felled	Standing tree (portion)	75%	No change	Felled
24	SSP-F168	RFP Without Field Drain	Standing tree (portion)	35%	No change	65% Felled, Balance dead tree
25	SSP-F169	RFP Without Field Drain	Standing tree (portion)	5%	No change	95% Felled
26	SSP-F170	RFP Without Field Drain	Standing tree (portion)	80%	No change	Felled

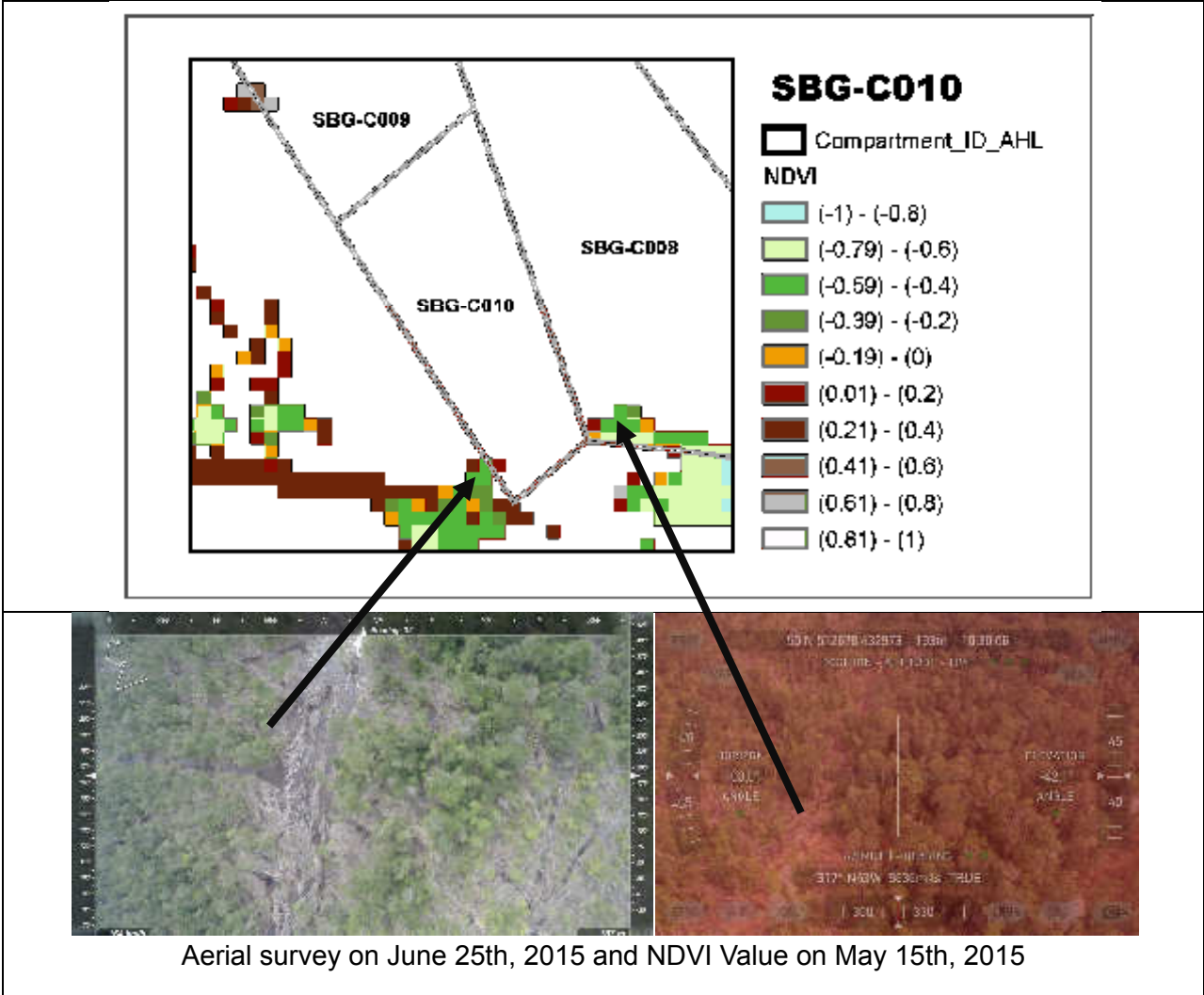
Appendix A2

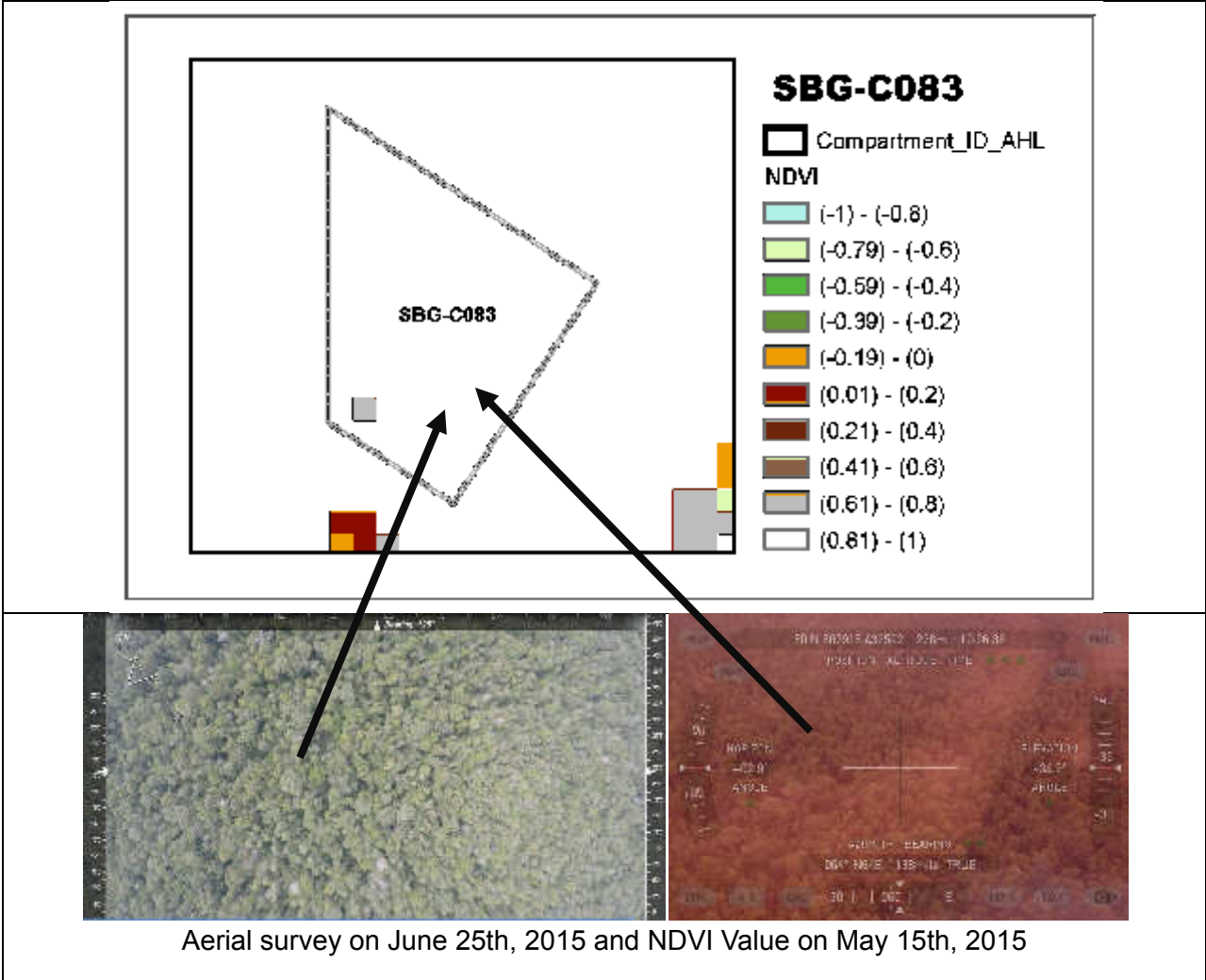
**"Compartments with NDVI > 0.6
requiring close monitoring"**

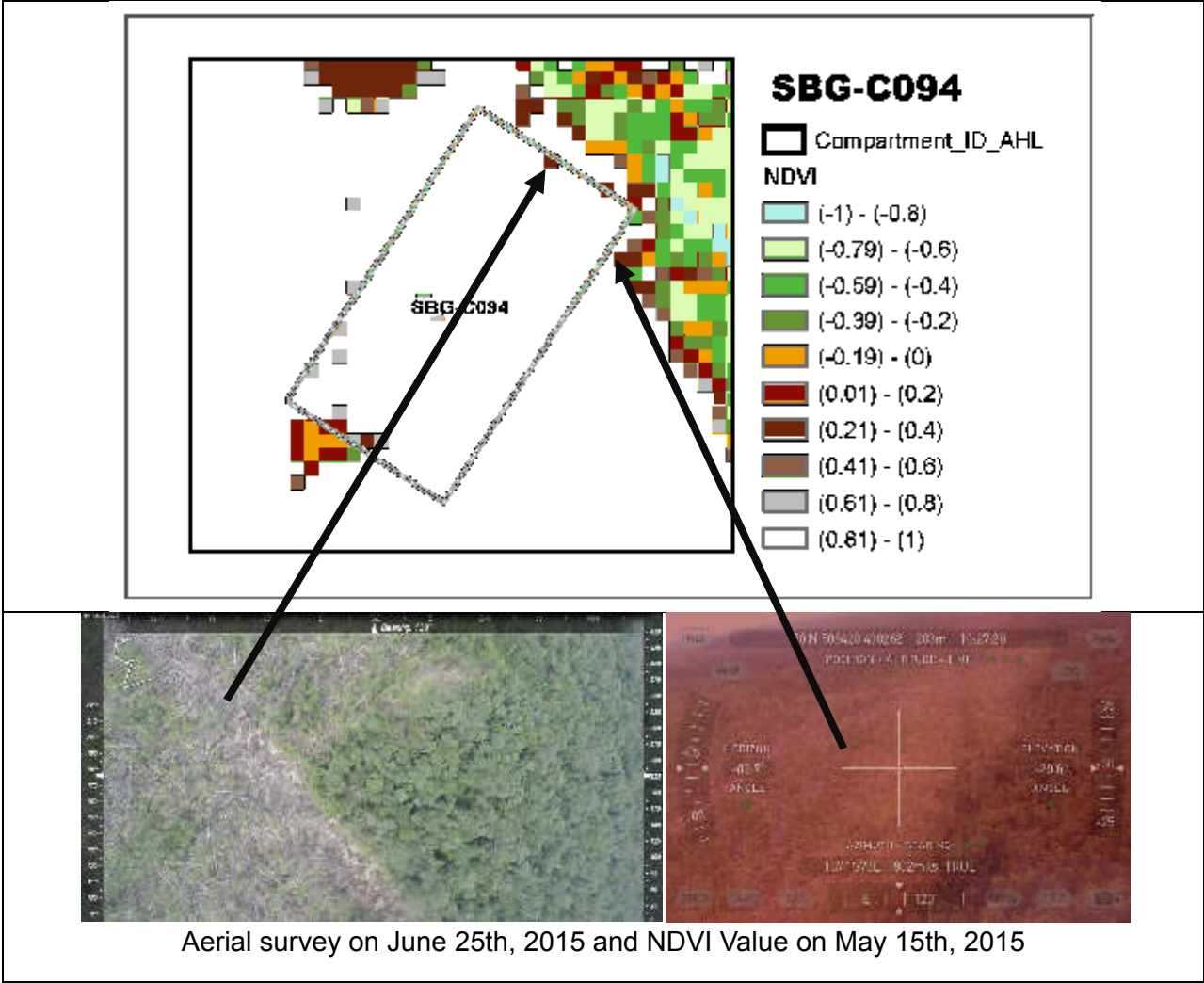
APPENDIX A2 "COMPARTMENTS WITH NDVI > 0.6 REQUIRING CLOSE MONITORING"

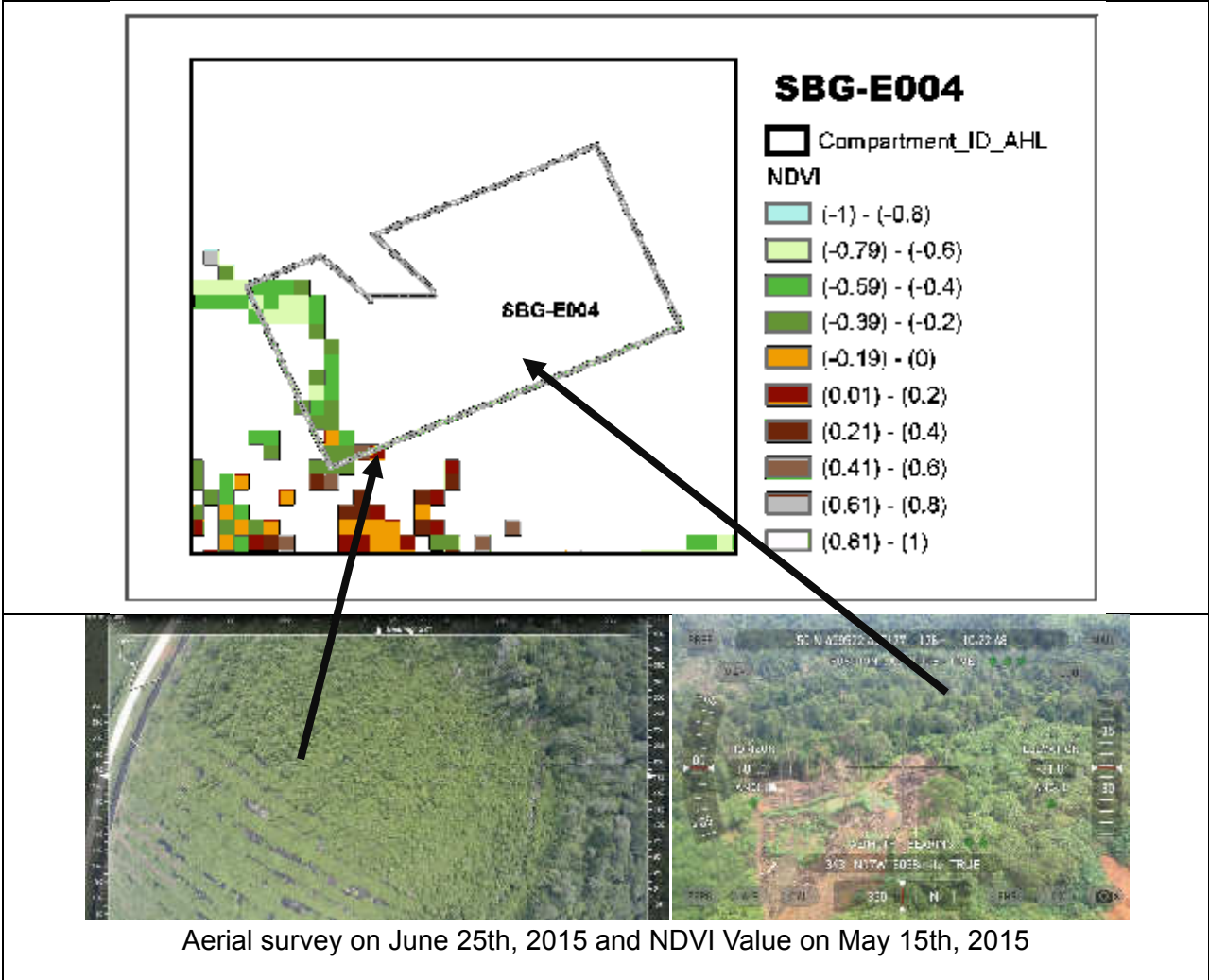


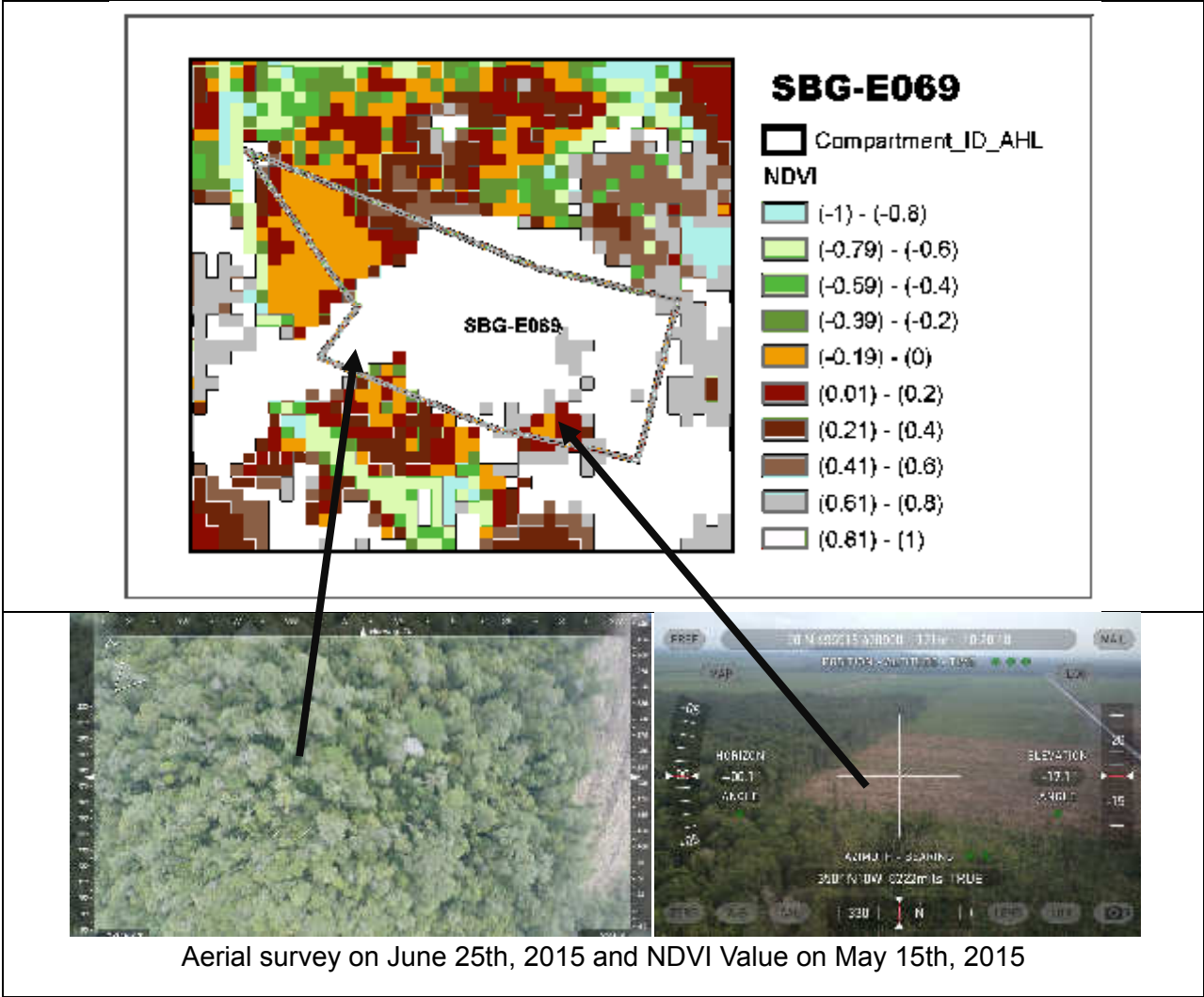


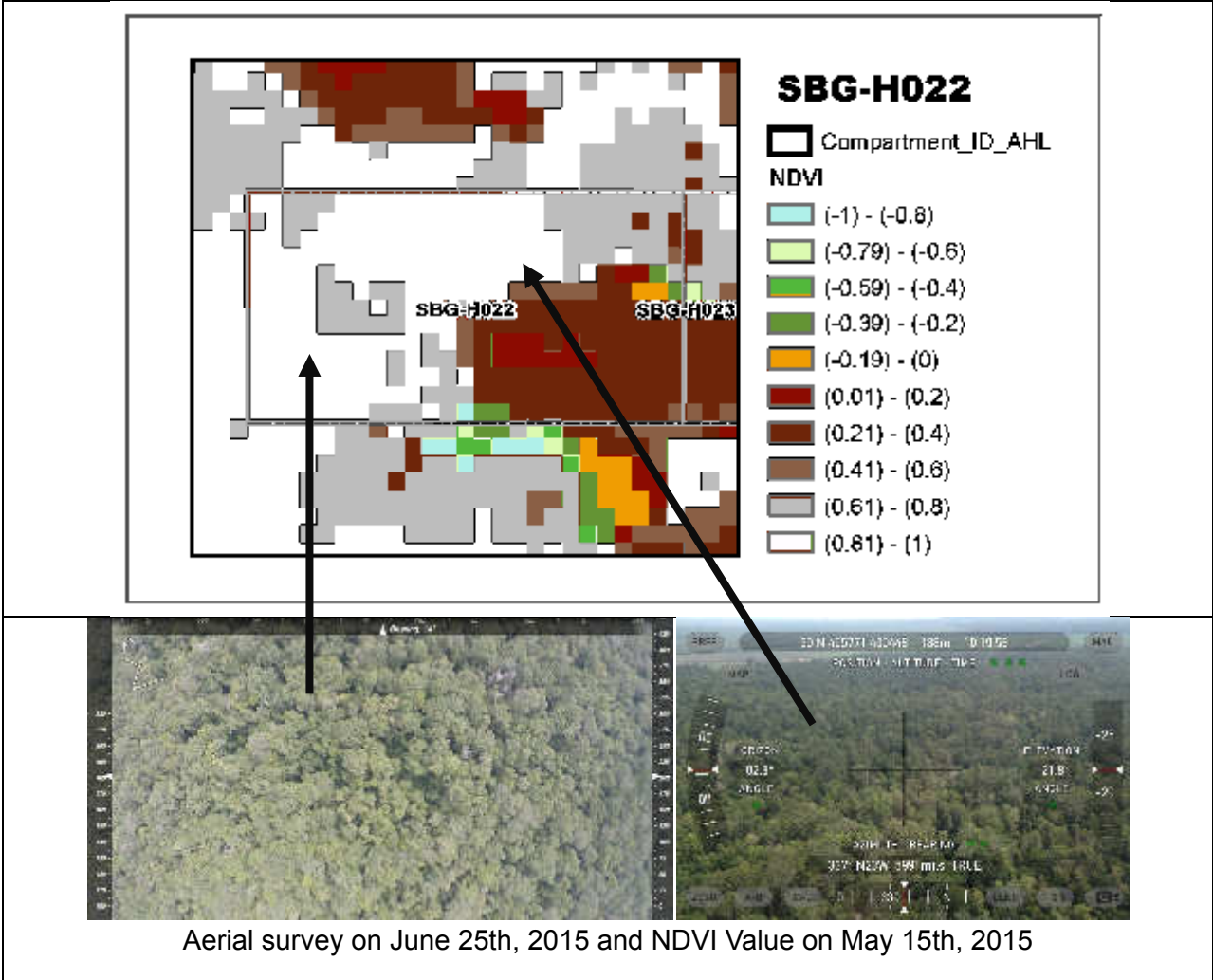


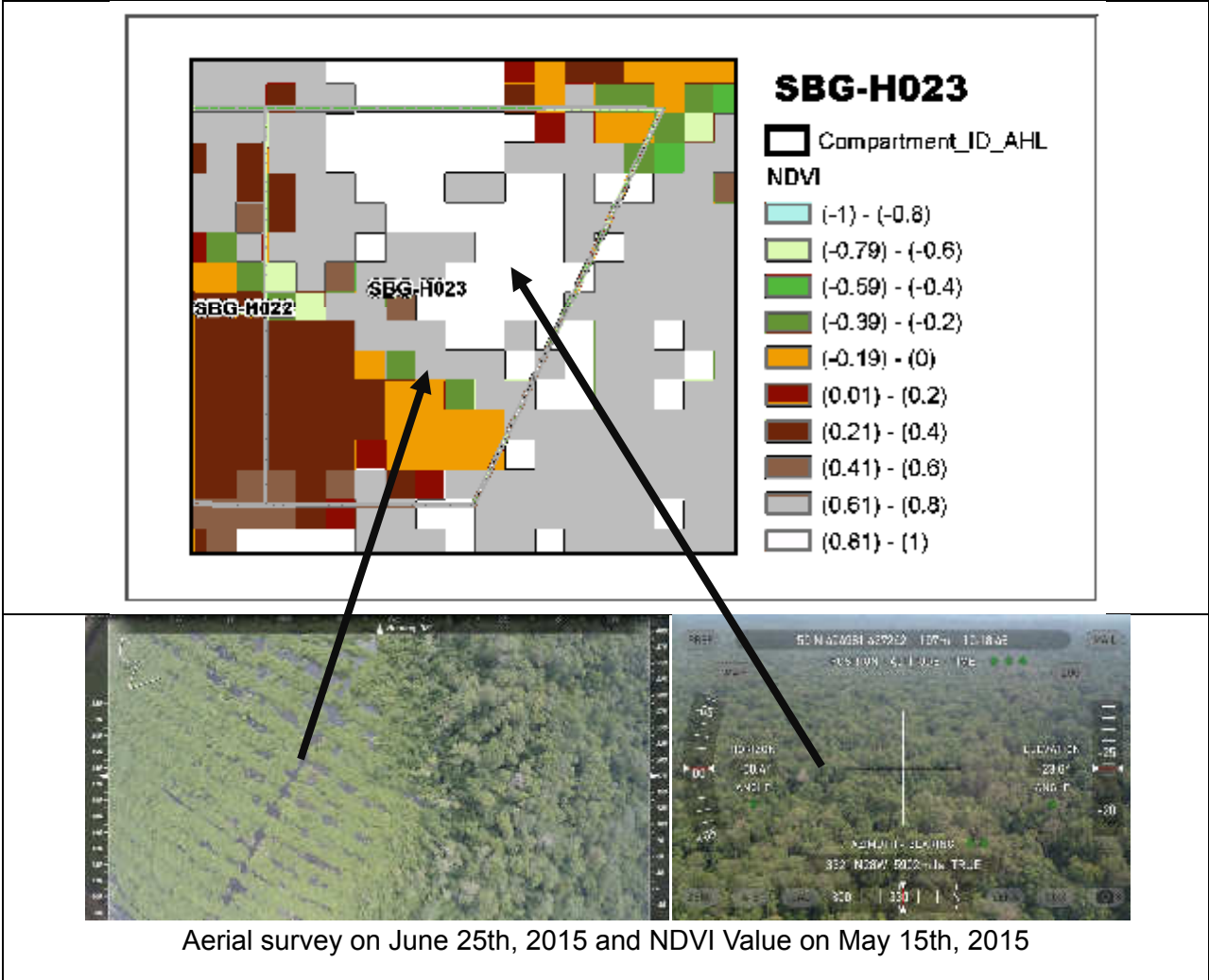


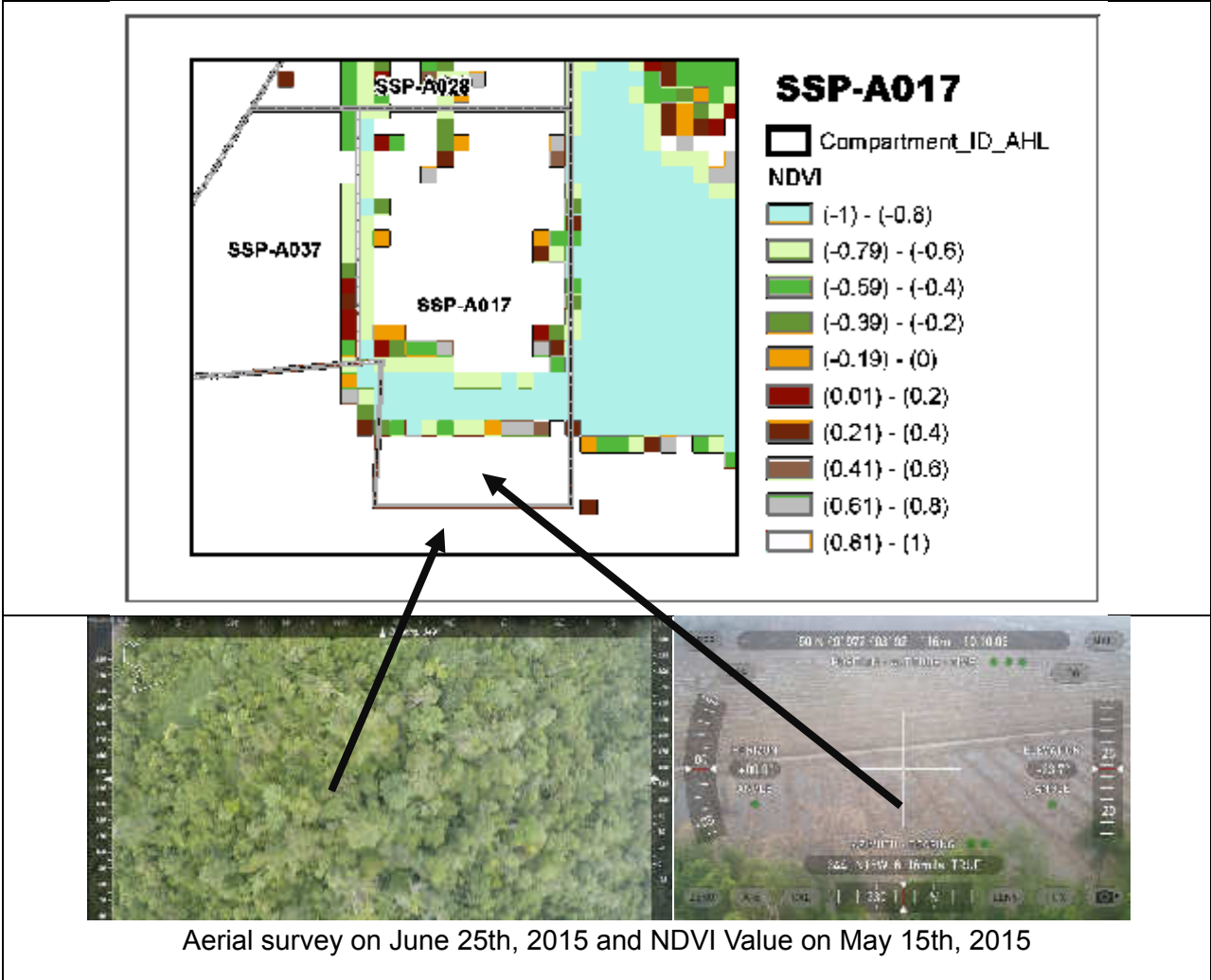


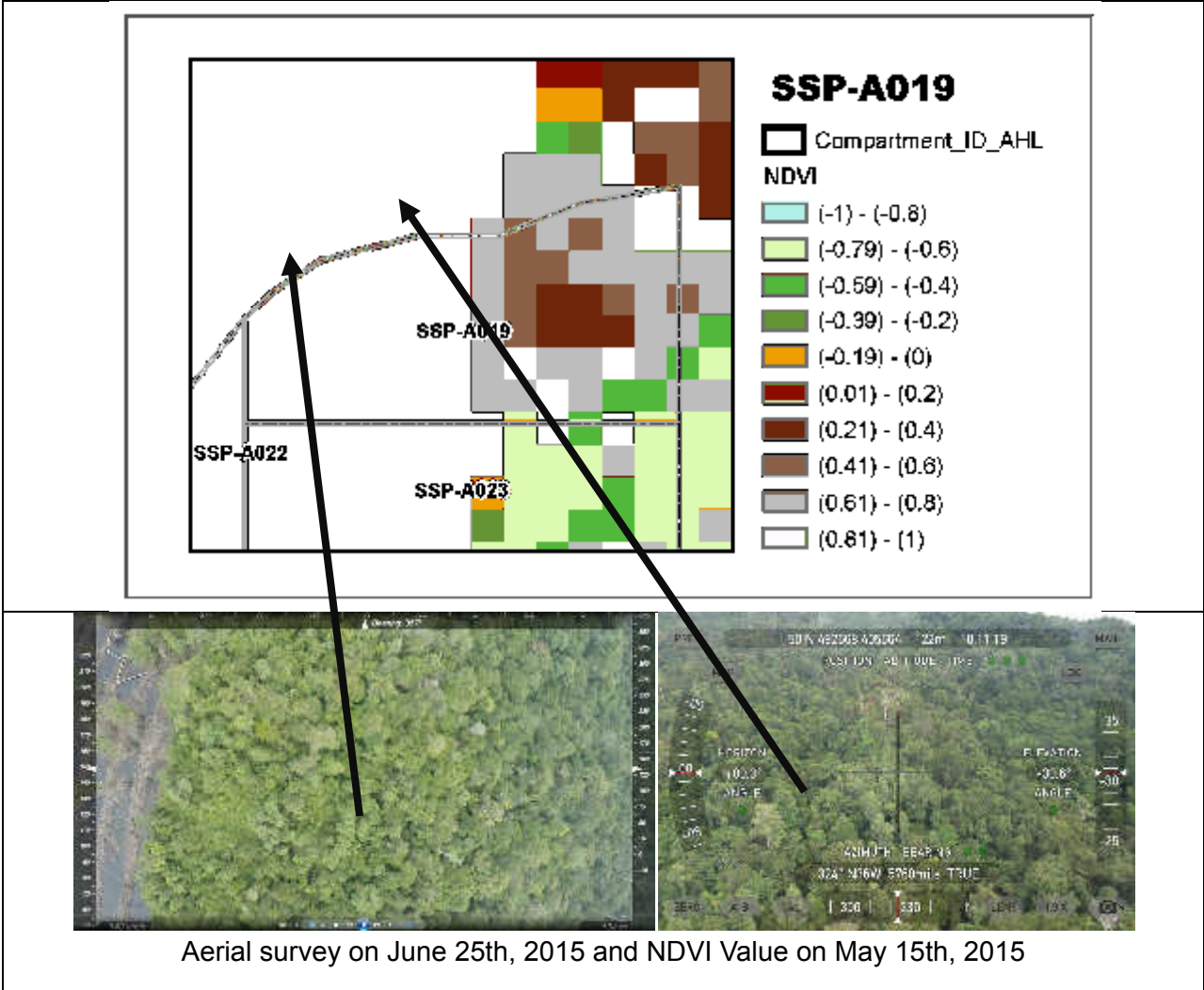


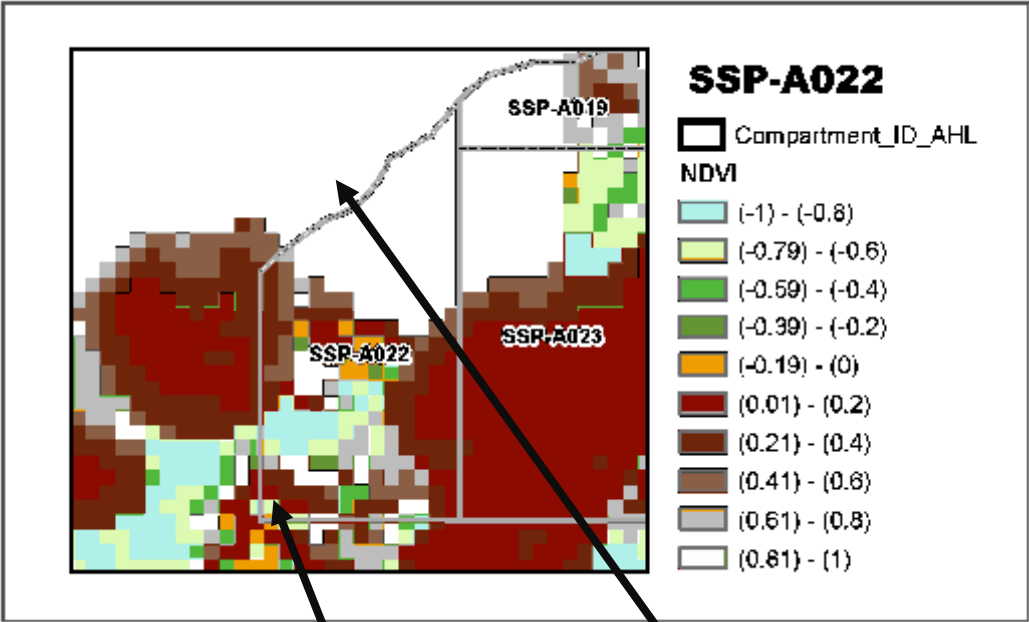












Aerial survey on June 25th, 2015 and NDVI Value on May 15th, 2015

