

FINAL TECHNICAL REPORT

**Consultancy for Literature Review, GIS Mapping and
Data Storage for Kubaan-Puak Corridor
under the Project of
Sustainable Forest Management in East Malaysia:
Kubaan-Puak Corridor in Sarawak and FMU 5 in Sabah**

(Project Code: BM010101-907-INTL)

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Client:

WWF-MALAYSIA

7th Floor, Bangunan Binamas,
Lot 138, Section 54,
Jalan Padungan,
93100 Kuching, Sarawak.

Tel: 082-247420 Fax: 082 - 241531

Consultant:

ENVISAR SDN. BHD.

2nd Floor, Lot 10528, Block 11,
Stutong Indah Commercial Centre,
Jalan Setia Raja, 93350 Kuching,
Sarawak.

Tel: 082 - 366935 Fax: 082 - 366937

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Mr. Tu Chu Lee of the Sarawak Biodiversity Centre for the information on SBC's activities within and surrounding the areas of interest.

KTN Timor Sdn. Bhd., Ravenscourt Sdn. Bhd. and Borlin Sdn. Bhd. for the respective EIAs for timber license areas (T/0280, T/0294 and T/0342).

1. The first step in the process of creating a new product is to identify a market need.

2. Once a market need is identified, the next step is to develop a concept for the product.

3. The third step is to create a prototype of the product.

4. After the prototype is created, the next step is to conduct market research.

5. The fifth step is to develop a business plan for the product.

6. The sixth step is to secure funding for the product.

7. The seventh step is to manufacture the product.

8. The eighth step is to distribute the product.

9. The ninth step is to promote the product.

10. The tenth step is to evaluate the product's performance.

11. The eleventh step is to make improvements to the product.

12. The twelfth step is to re-evaluate the product's performance.

13. The thirteenth step is to make further improvements to the product.

14. The fourteenth step is to re-evaluate the product's performance.

15. The fifteenth step is to make final improvements to the product.

16. The sixteenth step is to re-evaluate the product's performance.

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19. The nineteenth step is to make final improvements to the product.

20. The twentieth step is to re-evaluate the product's performance.

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List of Abbreviation

AOI	Areas of Interest
APFNet	Asia-Pacific Network for Sustainable Forest Management and Rehabilitation
DBH	Diameter at Breast Height
EIA	Environmental Impact Assessment
FMU	Forest Management Unit
GIS	Geographical Information System
HoB	Heart of Borneo
ITTO	International Tropical Timber Organisation
NREB	Natural Resources and Environment Board, Sarawak
Per. Comm.	Personal Communication
PFE	Permanent Forest Estate
Sg.	Sungai
UPM	Universiti Putra Malaysia
WWF	World Wide Fund for Nature

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1.0 INTRODUCTION

This report presents the outcome of the consultancy work for the *Literature review, GIS mapping and data storage for Kubaan-Puak Corridor under the Project of Sustainable Forest Management in East Malaysia: Kubaan-Puak Corridor in Sarawak and FMU 5 in Sabah*. The consultancy work was awarded by WWF-Malaysia.

1.1 OBJECTIVES

The objectives of the consultancy works are:

- i. To carry out literature review and GIS mapping for Kubaan-Puak Corridor; and
- ii. To set up a common database and store relevant information, including maps and shape files.

1.2 SCOPE OF WORK

The scope of the consultancy work covers:-

1.2.1 Literature Review

- i. Compile existing information that serves as baseline data on forest conditions, biodiversity and ecosystem services.
- ii. Carry out gap analysis to identify areas where information is lacking but the information is needed for implementation of a corridor landscape.

1.2.2 GIS Mapping

- i. To use data from the Literature Review to produce spatial data using GIS software to identify and map out areas of community, wildlife and ecosystem importance in the Kubaan-Puak Corridor.
- ii. To classify the various land use types within the Kubaan-Puak Corridor based on the satellite imagery (RapidEye) provided by WWF-Malaysia.

1.2.3 Data Storage

- i. To set up a common database that store relevant information, include maps and shape files, that can be shared and retrieved by all parties to the project.

1.3 AREAS OF INTEREST

The Areas of Interest (AOI) referred to in the *Terms of Reference* comprise two parcels of forest land – one spans between the Gunung Mulu National Park and Pulong Tau National Park; and the other from Ba'Kelalan to the head water of Hulu Trusan. It is part of the Heart of Borneo Corridor Project Implementation, comprising a 360,000 ha corridor project between the two national parks. The AOI lies between the latitude of 3°38' N - 4°22' N and the longitude of 114°56' E-115°42' E, and is shown in **Figure 1**. The Heart of Borneo corridor is also shown in **Figure 1**.

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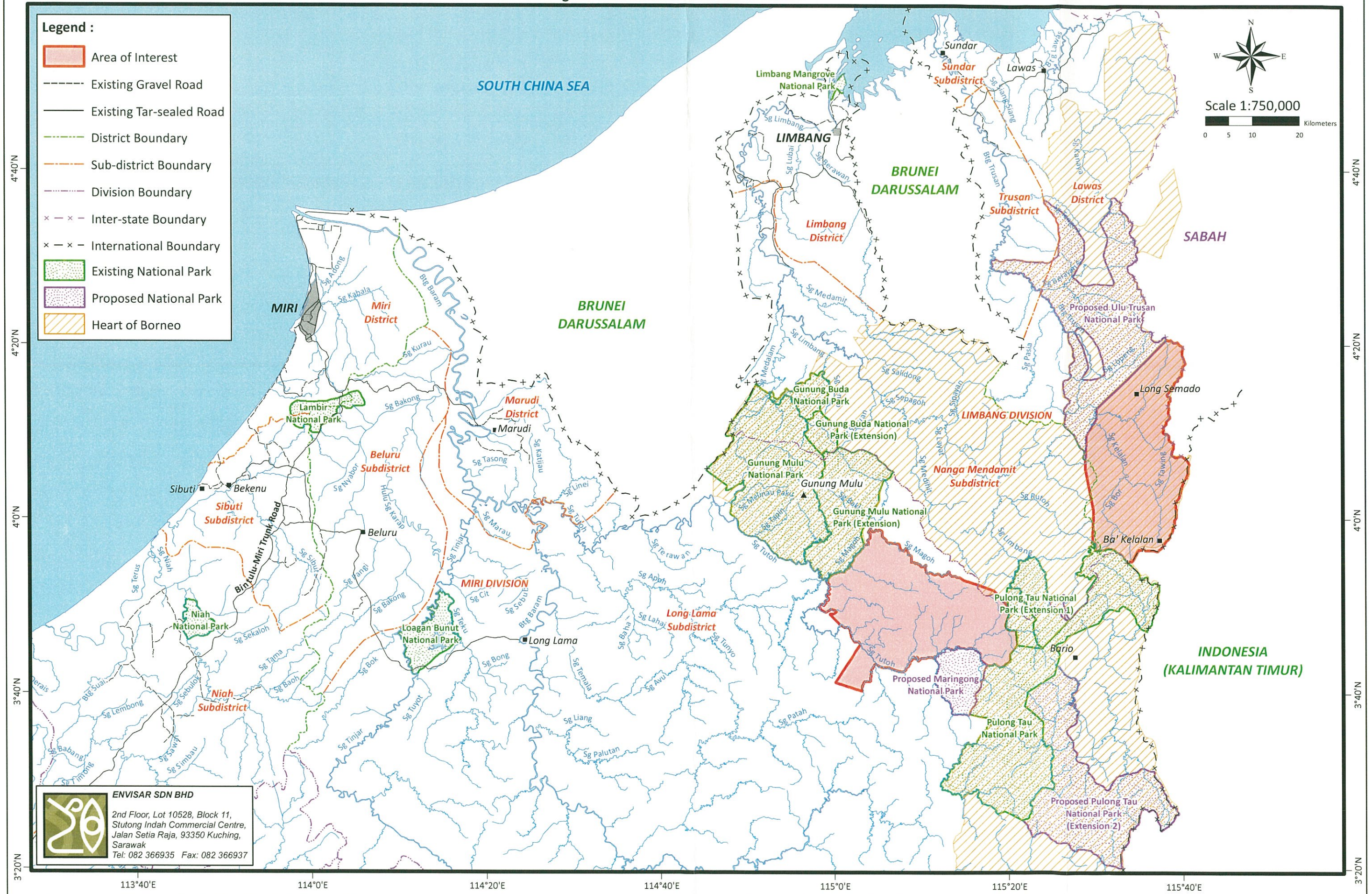
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Figure 1 Location of the Area of Interest





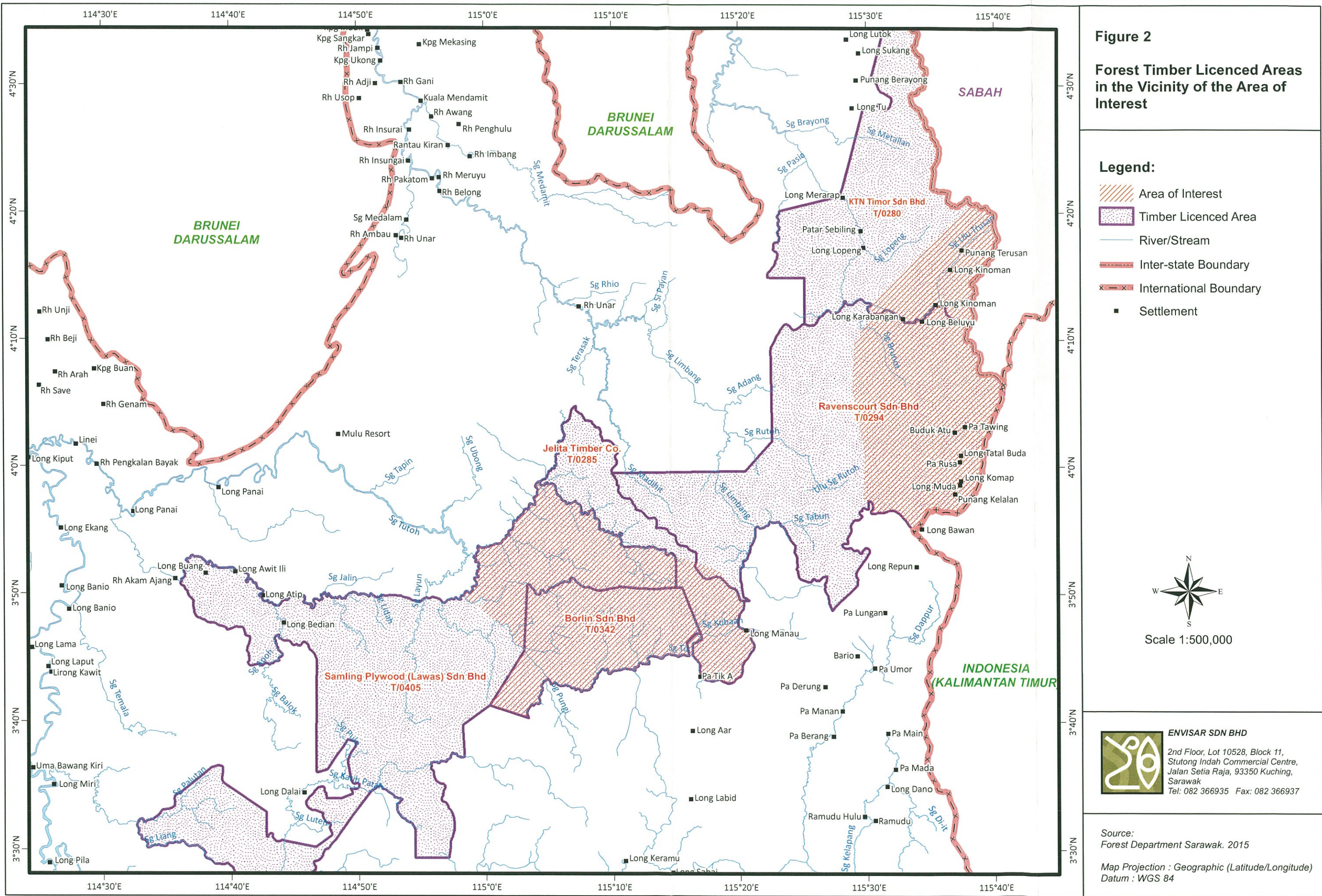
These areas of interest are located within five (5) forest timber licenced areas¹ (**Table 1** and **Figure 2**).

Table 1: Areas of Interest within Forest Timber Licenced Areas

No.	Areas of Interest	Forest Timber Licence Numbers and Holders
1	FMU 1	- T/0405 - Samling Plywood (Lawas) Sdn. Bhd. (part)
2	FMU 2	- T/0342 - Borlin Sdn. Bhd.
3	FMU 3	- T/0285 - Jelita Timber Co. (part)
4	FMU 4	- T/0294 - Ravenscourt Sdn. Bhd. (part)
5	FMU 5	- T/0294 - Ravenscourt Sdn. Bhd. (part) and - T/0280 - KTN Timor Sdn. Bhd. (part)

¹ It should be noted here that in the business of the Forest Department Sarawak, the forest areas licenced out for timber harvesting are referred to as "Forest Timber Licenced Area" whereas "Forest Management Unit" is referred to the forest area designated and managed for sustainable forest management certification purposes.

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2.0 LITERATURE REVIEW

2.1 SOURCES AND TYPES OF INFORMATION

The sources of information and the types of information that are made available and/or acquired are listed in **Table 2** below.

Table 2: Sources and Types of Information Acquired

Source	Description	Type
WWF-Malaysia	High Conservation Value Forest Assessment Report: Kubaan-Puak Forest Management Unit, Sarawak (March 2012)	Report
	EIA Reports of re-entry logging of the following timber licenced areas: <ul style="list-style-type: none"> • T/0280 (KTN Timur Sdn. Bhd.) • T/0294 (Ravenscourt Sdn. Bhd.) • T/0342 (Borlin Sdn. Bhd.) 	Report
Forest Department Sarawak	Forest Timber Licences T/0405, T/0342, T/0285, T/0294 and T/0280	Document for view only
	Forest Type Map of the relevant forest timber licenced areas	Map
	Permanent Forest Estates	Map
	Botany Unit's activity within and surrounding the areas of interest	Personal Comm. (Hajah Mohizah binti Hj Mohamad)
	Heart of Borneo	Personal Comm. (Mr. Michael Ngelai)
In-house Library	Establishment and Assessment of Permanent Sample Plots at the Kubaan-Puak Forest Management Unit, Marudi, Sarawak (August 2009)	Report
	Landuse Map, Sarawak Series No. 22, Edition 2, Sheet NB50-13 and Sheet NA50-1 (Based on reliability of year 1976)	Map
Sarawak Biodiversity Centre	SBC's activity within and surrounding the areas of interest	Personal Comm. (Mr. Tu Chu Lee)
International Tropical Timber Organisation (ITTO)	ITTO's activity within and surrounding the areas of interest	Personal Comm. (Dr. Paul Chai)

2.2 HIGH CONSERVATION VALUE FOREST ASSESSMENT REPORT: KUBAAN-PUAK FOREST MANAGEMENT UNIT, SARAWAK (MARCH 2012)

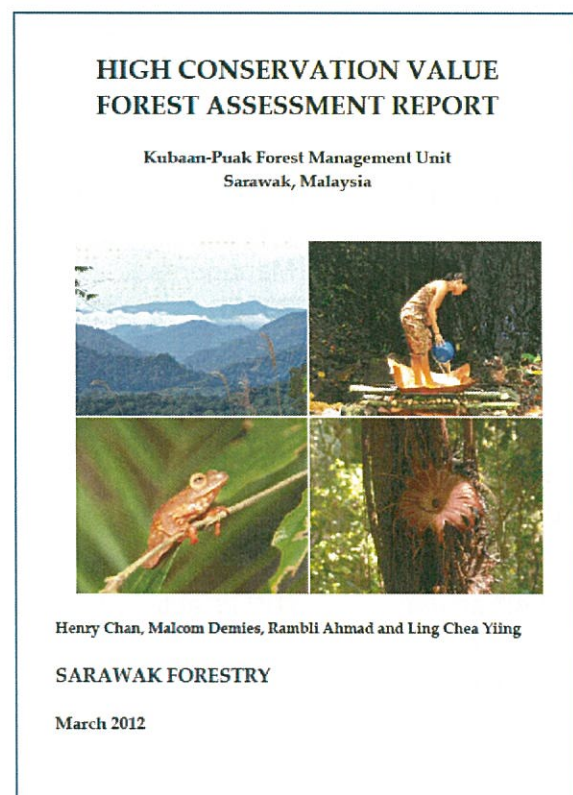
This report presents the outcomes of the high conservation value (HCV) forest assessment conducted within the Kubaan-Puak Forest Management Unit (FMU). The assessment indicated that the site possessed attributes of the six categories of HCV.

In term of biodiversity value, a total of 300 flora species from 62 genera were recorded. Of these, 15 species are protected plants under the Wild Life Protection Ordinance 1998 and 22 species are categorised under the IUCN Red List as Critically Endangered, Endangered or Vulnerable. In term of endemism, there are 22 dipterocarp species and 27 non-dipterocarps identified as endemic to Borneo.

The fauna assessment recorded diverse fauna species i.e. 18 mammals, 43 birds, 6 reptile, 19 amphibians and 13 fish. There are 14 fauna species identified to be endemic to Borneo. Various temporal usage sites for wildlife have been identified, such as saltlicks, tree holes for nesting, fruit trees, wallows and roosting sites.

There are 13 Penan communities living within and adjacent to the FMU. These communities are relying on the forested area for their basic subsistence or health needs.

The HCV assessors has made several management and monitoring recommendations for each HCV attributes identified, which follow the conservation specifications and timber harvesting methodology of the Reduced Impact Logging Guidelines.



2.3 FOREST TIMBER LICENCES OF T/0280, T/0285, T/0294, T/0342 and T/0405

The relevant Timber Licence documents are made available at the office of Forest Department HQ for review by the consultant. As these documents are classified as "Confidential", no copy was made for retention.

Included in the Timber Licence is a Forest Type Map (1:50,000 scale) that depicts the distribution of the forest types and terrain classes. The forest types are mapped from aerial photographs and are categorised into Mixed Dipterocarp Forests, Kerangas Forest, Non-Commercial Forest, Shifting Agriculture land, Plantation and Barren land.

The mixed dipterocarp forests are further stratified into three density classes based on the percentage of area covered by crowns of over-storey trees estimated to be 45cm DBH or larger. The crowns of over-storey trees (i.e. co-dominant, dominant and emergent) usually have crowns with diameters exceeding 9 metres. These classes are:-

Mixed Dipterocarp Stand Density Class		Description
MD1	(Low Density)	Less than 33% of crown canopy occupied by over-story trees.
MD2	(Medium Density)	From 33% to 67% of crown canopy occupied by over-story trees.
MD3	(High Density)	More than 67% of crown canopy occupied by over-story trees.

The terrain is classified into four (4) classes, namely:-

Terrain Class		Description
I	(Flat to gently rolling)	Level, gently to moderately undulating or sloping country. Includes lowlands, flat plains, plateaus, wide U-shaped valleys, gentle hill country or level country broken by a series of low hills that form a corrugated or washboard appearance.
II	(Undulating)	Dissected broken hill country. Moderately hilly with short slopes, slope gradient moderate to steep. Valleys V-shaped, ridge tops sharp and narrow.
III	(Mountainous)	Prominent mountains running parallel or converging ranges with interlocking main ridges. Moderate to long slopes, slope gradient variable but frequently steep. Spur ridges numerous, main and spur ridge tops narrow and sharp. Country usually rough and sharply dissected.
IV	(Steep mountainous)	Excessively steep country. More than half of area with slopes 35 degrees or greater.

2.3.1 T/0280 (KTN Timor Sdn. Bhd.)

The Timber Licence was issued to KTN Timor Sdn. Bhd. on 23rd June 1984 and to be expired on 22nd June 1999. It has been renewed to expire on 22nd June 2019.

The timber licenced area covers about 71,441 hectares and largely falls within the Proposed Ulu Trusan Protected Forest (formerly Ulu Trusan – Long Semadoh Stateland forest). The Management Plan prescribed a cutting cycle of seven (7) years and cutting limits of DBH 45 cm and above for Non-Dipterocarps and 60cm and above for Dipterocarp species.

The forest types and terrain classes within the timber licenced area are also depicted in the Forest Type Map “B” appended in the Timber Licence.

The area of interest covers only the south-eastern portion of this timber licenced area.

2.3.2 T/0285 (Jelita Timber Co.)

The Timber Licence was issued to Jelita Timber Co. on 25th June 1984 for a period of five (5) years and was subsequently renewed to expire on 24th September 2016. The licenced area falls within Tutoh-Apoh Forest Reserve (formerly Kubaan Stateland forest) and the prescribed Felling Plan is appended as First Schedule of the Timber Licence.

Forest types and terrain classes within the timber licenced area are depicted in the Forest Type Map “B” appended in the Timber Licence.

The area of interest covers only the southern portion of this timber licenced area.

2.3.3 T/0294 (Ravenscourt Sdn. Bhd.)

The Timber Licence was issued to Ravenscourt Sdn. Bhd. on 28th January 1985 for a period of fifteen (15) years and was subsequently renewed to expire on 27th January 2016. The licenced area falls within the Limbang Protected Forest and Proposed Trusan-Kelalan Protected Forest. The Working Plan is appended as First Schedule of the Timber Licence which prescribed a cutting cycle of 15 years.

The forest types and terrain classes within the timber licenced area are depicted in the Forest Type Map “B” appended in the Timber Licence.

The area of interest covers only the eastern portion of this timber licenced area.

2.3.4 T/0342 (Borlin Sdn. Bhd.)

Timber Licence No. T/0342 was issued to Borlin Sdn. Bhd. on 30th September 1988 and to expire on 29th September 1998. The licence has been renewed to expire on 29th September 2025.

The licenced area covers about 32,023 hectares within the Tutoh-Apoh Forest Reserve (formerly Kubaan-Puak Stateland forest). The timber licenced area is managed under a Working Plan for cutting cycle of 25 years. The prescribed cutting limits are DBH 45cm and above for Non-Dipterocarps and 60cm and above for Dipterocarp species.

Forest types and terrain classes within the timber licenced area are depicted in the Forest Type Map "B" appended in the Timber Licence.

The area of interest covers the entire timber licenced area.

2.3.5 T/0405 (Samling Reforestation (Lawas) Sdn. Bhd.)

Timber Licence No. T/0405 was issued to Samling Plywood (Lawas) Sdn. Bhd. on 15th May 1993 and to expire on 14th May 2013. The licence has been renewed to expire on 14th May 2033.

The timber licenced area covers about 158,661 hectares within the Telang Usan Protected Forest and Tutoh-Apoh Forest Reserve (formerly Apoh Palutan Magoh Forest) in Baram District. Management of the forest subscribed to the Forest Management Plan (appended as First Schedule of the Timber Licence) where the forest shall be harvested under a cutting cycle of 25 years with cutting limits of DBH 45cm and above for Non-Dipterocarps and 60cm and above for Dipterocarp species.

Forest types and terrain classes within the timber licenced area are depicted in the Forest Type Map "B" appended in the Timber Licence. This Forest Type Map was drawn in 1976 based on aerial photographs taken in the earlier 1970's. Approximately 70% of the forested areas are under Terrain Classes I, II and III while the rest is under Terrain Class IV.

The area of interest covers only the north-eastern portion of this timber licenced area.

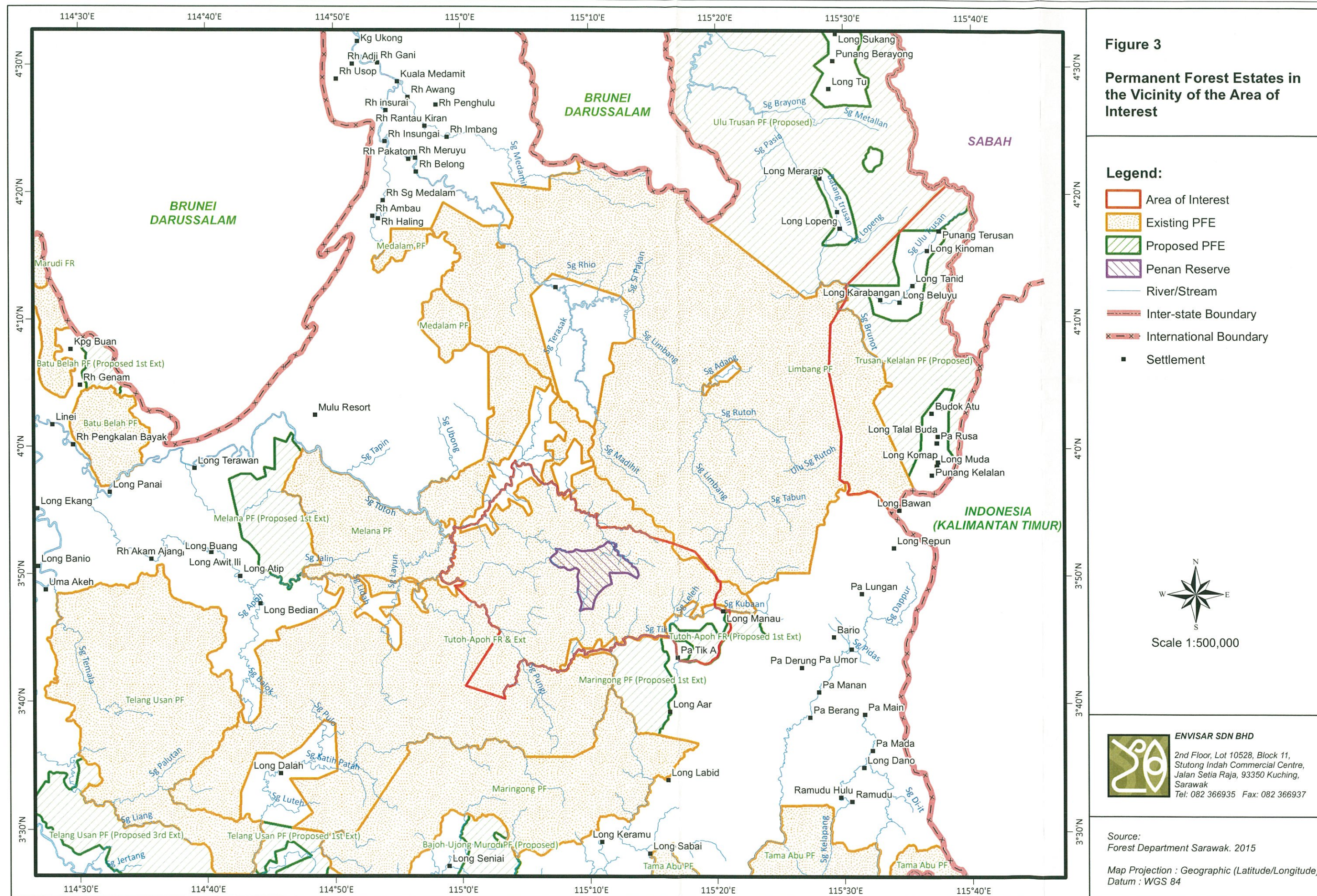
2.4 PERMANENT FOREST ESTATES

The areas of interest fall within three Permanent Forest Estates (PFE) i.e. Tutoh-Apoh Forest Reserve, Limbang Protected Forest and proposed Trusan-Kelalan Protected Forest (**Table 3** and **Figure 3**).

Table 3: Areas of Interest within Permanent Forest Estates

No.	Areas of Interest	Forest Timber Licences Number	Permanent Forest Estate
1	FMU 1	T/0405 – Samling Plywood (Lawas) Sdn. Bhd. (part)	- Tutoh-Apoh Forest Reserve
2	FMU 2	T/0342 – Borlin Sdn. Bhd.	- Tutoh-Apoh Forest Reserve
3	FMU 3	T/0285 – Jelita Timber Co. (part)	- Tutoh-Apoh Forest Reserve
4	FMU 4	T/0294 – Ravenscourt Sdn. Bhd. (part)	- Limbang Protected Forest - Proposed Trusan-Kelalan Protected Forest
5	FMU 5	T/0294 – Ravenscourt Sdn. Bhd. (part) and T/0280 – KTN Timor Sdn. Bhd.	- Proposed Trusan-Kelalan Protected Forest

It was noted from the GIS database of the Forest Department Sarawak that the forest area covering the headwater of Sg. Teping and Sg. Puak (in northern portion of T/0342), as well as Sg. Magoh and Sg. Bareh (in T/0405) is being marked as “Penan Reserve”. This land covers about 5,000 hectares and has been reserved for the communal use of the Penan communities therein, but not being gazetted accordingly. The area earmarked as the “Penan Reserve” is shown in **Figure 3**.



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2.5 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) REPORTS OF RE-ENTRY LOGGING WITHIN THE RELEVANT FOREST TIMBER LICENCED AREAS

Environmental Impact Assessment (EIA) has been conducted for the re-entry logging activities within the relevant timber licenced areas. The EIA reports are proprietary documents of the project proponents and the Natural Resources and Environment Board (NREB), Sarawak, and arrangement has been made to officially procure these documents. At the time of reporting, approvals for access to the following EIA Reports have been granted by the respective timber licence holders:

- i. EIA for the Re-Entry Hill Logging under Timber Licence No. T/0280 at the Btg. Trusan – Sg. Tengoa – Sg. Lopeng Area, Lawas District, Limbang Division, Sarawak (March 2010);
- ii. EIA for the Re-Entry Hill Logging under Timber Licence No. T/0294 in the Ulu Btg. Trusan – Ulu Sg. Limbang – Ulu Sg. Kubaan Area, Limbang and Miri Divisions, Sarawak (November 2008); and
- iii. EIA for the Proposed Re-Entry Logging under the Forest Timber Licence No. T/0342 in the Kubaan – Puak Area, Miri Division, Sarawak (July 2014).

The EIAs were conducted in 2008-2010 and 2014, and the reports presented the baseline data on the physical, biological and human environmental settings of the assessment sites; as well as recommended mitigation measures to abate potential impacts that may arise during the re-entry logging operation.

2.5.1 EIA Report of the Re-Entry Hill Logging under Timber Licence No. T/0280 at the Btg. Trusan – Sg. Tengoa – Sg. Lopeng Area, Lawas District, Limbang Division, Sarawak (March 2010)

The timber licenced area is demarcated into eight (8) coupes for harvesting. The AOI of this study falls within Coupe 08A Part II and part of Coupe 03A.

Tree enumeration was undertaken in Coupe 06A. More than 88% of the enumerated trees are from the non-dipterocarps which was dominated by Medang, Ubah, Bantas, Empenit, Nyatoh, Menggeris, Legai and Benuang. The dipterocarps are largely represented by the Yellow, Red and White Meranti. Protected and rare plant species reported include *Koompassia* spp., wild orchids (*Calanthe*, *Dendrobium* and *Bulbophyllum* spp.), *Begonia* spp., *Nepenthes* spp., *Aeschynanthus* spp., *Cyrtandra* spp., and *Areca chaiana*.

Considerably diverse fauna communities are reported. These include mammals (i.e. wild boar, sambar deer, barking deer, long-tailed and pig-tailed macaques, Bornean gibbon, otter, porcupine, civet, squirrel and rats), birds (i.e. hornbills, Argus pheasant, woodpeckers, kingfishers and imperial pigeon), reptiles, amphibians, insects and fish (i.e. Semah, Empurau, catfish and *Gastromyzon* spp.).

The report presented findings of socio-economic survey covering a total of 16 Lun Bawang settlements found within 3km radius of the timber licenced area. Of these, six (6) settlements are located within the AOI. These are Long Telingan, Long Punang Trusan, Long Semadoh Naseb, Long Semada Rayeh, Long Semadoh Airport and Long Karabangan. These settlements had a total of 174 households and population of 1,052 person.

The forest areas adjacent to the settlements are used as catchment for gravity feed water supply. Irrigation dams to supply water for wet paddy planting are found along Sg. Brayong, Sg. Tuyo, Sg. Derayah, Sg. Tinape, Sg. Belaban, Sg. Lebaluh, Sg. Rebatu, Sg. Kerabangan, Sg. Beluyu and a tributary of upper Btg. Trusan. The Tagang fisheries conservation system had been adopted at some stretches of the streams at Long Sukang, Long Tuyo, Punang Brayong and Long Berayong Tengah.

2.5.1 EIA Report of the Re-Entry Hill Logging under Timber Licence No. T/0294 in the Ulu Btg. Trusan – Ulu Sg. Limbang – Ulu Sg. Kubaan Area, Limbang and Miri Divisions, Sarawak (November 2008)

The forest area is demarcated into 14 coupes for harvesting, which ranges from 6,125 ha to 11,444 ha. The AOI of this study is located within Coupe 03/01A, Coupe 04/02A, Coupe 06/03A, Coupe 06/04A and Coupe 07/05A.

Vegetation covers include mixed dipterocarp forest (MDF), lower montane forest, kerangas forest, riparian forest and degraded forest. Within the MDF, dominant species are *Shorea parvifolia*, *S. platyclados*, *S. resinosa*, *Dipterocarpus palembanicus*, *Vatica* sp., *Koompassia excelsa*, *K. malaccensis*, *Parkia* sp., *Syzygium* spp., *Litsea* sp., *Palaquium* sp. and *Lithocarpus* spp. The lower montane forest is found above 1,000 m.asl. and is dominated by species of Theaceae, Lauraceae, Anacardiaceae, Fagaceae, Elaeocarpaceae and Clusiaceae. Tree enumeration was conducted within Coupe 12, Coupe 14A(II) and Coupe 05A. The average merchantable stock is 39.85 m³/ha.

Considerably diverse fauna communities are reported. These include mammals (i.e. wild boar, sambar deer, barking deer, long-tailed and pig-tailed macaques, Bornean gibbon, otter, porcupine, Malay civet, squirrel and rats), birds (i.e. hornbills, Argus pheasant, woodpeckers, kingfishers and imperial pigeon), reptiles, amphibians, insects and fish (i.e. Semah, Empurau, catfish and three species of *Gastromyzon*).

The EIA study recorded 18 settlements found within 3-km radius of the timber licenced area. These are mostly Lun Bawang settlements in three clusters at Long Semadoh (217 households, 1,306 persons), Kpg Berunut (7 households, 32 persons) and Ba'Kelalan (180 households, 1,071 persons).

The forest catchments that are used to provide gravity feed water supply to Long Semadoh, Ba' Kelalan and Kpg Berunut cover about 2,001 ha; and are excluded from the logging activity. The Department of Agriculture Sarawak has implemented Paddy Infrastructure Improvement Projects within the area. These are mainly minor projects to install dams and piping at along rivers /streams for wet paddy cultivation. The affected rivers at Long Semadoh are Sg. Karabangan, Sg. Beluyu, Sg. Lebaluh, Sg. Rebatu, Sg. Belaban and Sg. Trusan; whereas at Ba'

Kelalan are Sg. Komap, Sg. Muda, Sg. Saroi, Sg. Kelalan, Sg. Tanid, Sg. Talai, Sg. Langai, Sg. Gelateh, Sg. Dukung and Sg. Ritan.

2.5.3 EIA Report of the Proposed Re-Entry Logging under the Forest Timber Licence No. T/0342 in the Kubaan – Puak Area, Miri Division, Sarawak (July 2014)

The timber licenced area is demarcated into twelve (12) coupes for harvesting, which ranges from 1,534 ha to 3,193 ha. An area of about 3,230 ha in the northern region is demarcated as Penan Reserve. The AOI includes the entire timber licenced area.

The vegetation cover is largely MDF and kerangas forests, and the flora and fauna species recorded is similar to the above EIA Reports. There are a total of 14 protected flora species (8 tree species and 6 non-tree species). The protected fauna recorded includes 18 mammals, 5 reptiles, 12 birds and an insect.

Two Penan settlements are located within the area i.e. Long Kajau (18 households, 95 persons) and Ba Teping (3 households, 9 persons). They are depending on the natural resources for sustenance – wild fruits, wild vegetables, fire wood, fishing and traditional medicinal plants.

2.6 ESTABLISHMENT AND ASSESSMENT OF PERMANENT SAMPLE PLOTS AT THE KUBAAN-PUAK FOREST MANAGEMENT UNIT, MARUDI, SARAWAK (AUGUST 2009)

This report presents the outcomes of the assessment and analysis of Permanent Sample Plots (PSPs) within Kubaan Puak Forest Management Unit (i.e. in T/0342). A total of eight (8) PSPs (each 50m x 50m) were established and enumerated from March to May, 2008. There were two (2) plots each located in kerangas forest, mixed dipterocarp forest, terrain class III and terrain class IV areas.

A total of 397 tree species from 57 families and 151 genera were recorded. The ten most dominant families are Dipterocarpaceae, Euphorbiaceae, Fagaceae, Lauraceae, Myrtaceae, Rubiaceae, Burseraceae, Moraceae, Sapindaceae and Myristicaceae. For rattans and palms, more than 26 species from 13 genera were recorded, and *Calamus*, *Daemonorops* and *Korthalsia* are the dominant genera.

Mean stocking of all trees 10 cm DBH and above was 645 stem/ha. Young recruits between 10 and 30 cm DBH made up 89% of the stand and 44% of the total volume. Trees between 30 and 45 cm DBH constituted only about 8% of the stand.

Terrain class IV forest has nearly 30% more volume of timber than terrain class III and the mixed dipterocarp forest has about 15% more volume of timber than the kerangas forest. Non-dipterocarp stocking ratio to dipterocarps was almost 9 to 1 but their volume ratio was 4 to 1.

2.7 BOTANY COLLECTIONS

Two (2) agencies had conducted botanical collections within the areas of interest.

The Botany Unit, Research Development and Innovation Division of the Forest Department Sarawak had collected herbarium specimens of following plants along the trails from Bario – Batu Lawi – Ba’Kelalan – Long Semadoh in the 1990’s (Per. Comm., 2015a²). However, the data are kept in the office and not published.

Sarawak Biodiversity Centre, through its Traditional Knowledge Documentation Programme, had conducted several field expeditions to Ba’Kelalan, Long Semadoh, Long Telingan, Long Kerabangan, Long Seridan and Long Iman to compile and document the traditional use of indigenous medicinal plants by the local people (Per. Comm. 2015b³). The information compiled are kept in the office and not published.

2.8 RESEARCH AND CONSERVATION ACTIVITIES

Two (2) international collaborative projects (Per. Comm. 2015c⁴) are currently in progress within and adjacent to the areas of interest. These are:-

- i. Buffer Zone Project: undertaken by International Tropical Timber Organisation (ITTO), covering about 6,000 hectares along Sg. Kubaan and its tributaries; and
- ii. Watershed Management Project: jointly undertaken by ITTO and Asia - Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet), covering about 35,400 hectares within the watershed of Sg. Medihit.

On the other hand, the Forest Department Sarawak has a dedicated unit to look into activities pertaining to the Heart of Borneo (HoB) initiative. The forest area identified and included in the HoB is shown in **Figure 1**. Current activities focus on collaborative scientific expeditions with UPM covering the Payeh Maga area (located within eastern portion of T/0280) and to promote sustainable forest management certification among the affected forest timber licence concessions (Per. Comm. 2015d⁵).

² Per. Comm. 2015a. Hajah Mohizah Binti Hj. Mohamad, Research Officer, Botany Unit, Research Development and Innovation Division, Forest Department Sarawak. 17th September 2015.

³ Per. Comm. 2015b. Mr. Tu Chu Lee, Research Officer, Traditional Knowledge Documentation Programme, Sarawak Biodiversity Centre, Kuching. 17th September 2015.

⁴ Per. Comm. 2015c. Dr. Paul Chai P.K., International Tropical Timber Organisation (ITTO) Office, Kuching. 18th September 2015.

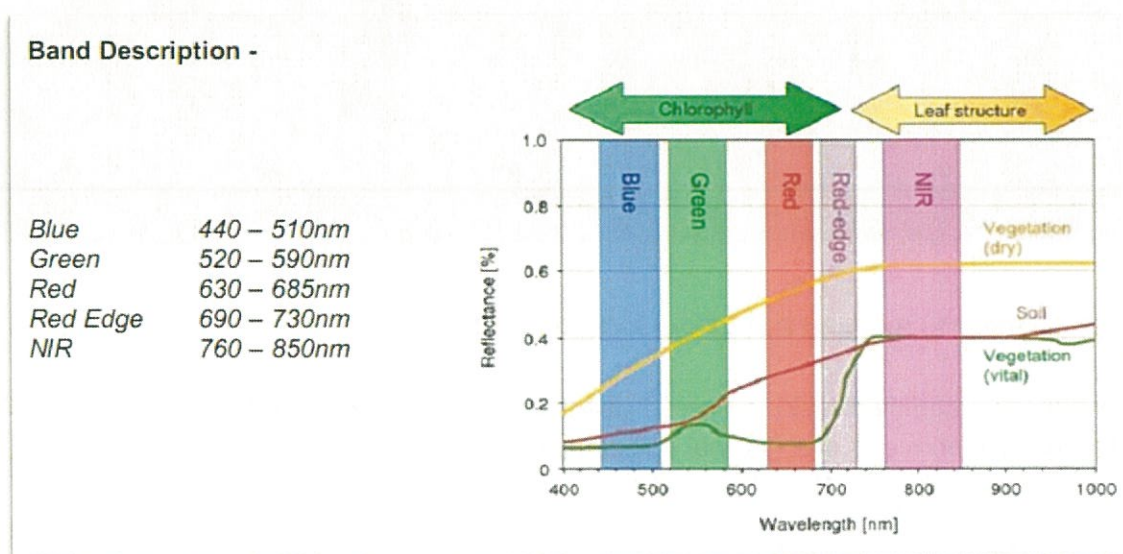
⁵ Per. Comm. 2015d. Mr. Michael Nyelai, Executive Forester, Heart of Borneo Unit, International Affair Division, Forest Department Sarawak. 14th September 2015.

3.0 GIS MAPPING

3.1 SATELLITE IMAGERY DATA (RAPIDEYE)

RapidEye is a German satellite of five (5) satellite constellations in a low earth orbit that was launched in August of 2008. The five (5) identical satellites allow a large amount of imagery to be collected and allow for short revisit cycles (< 5 days). The swath width of the sensors is 78 km. These satellites have a lifespan of 7 years with a sun-synchronous orbit of 630 km and a ground sampling distance of 6.5 m which was resampled to 5 m. The satellite sensors have five (5) bands: blue, green, red, red edge, and NIR. The spectral resolution of the RapidEye satellite imagery is shown in **Figure 4**.

Figure 4: Spectral Resolution of RapidEye Satellite Imagery



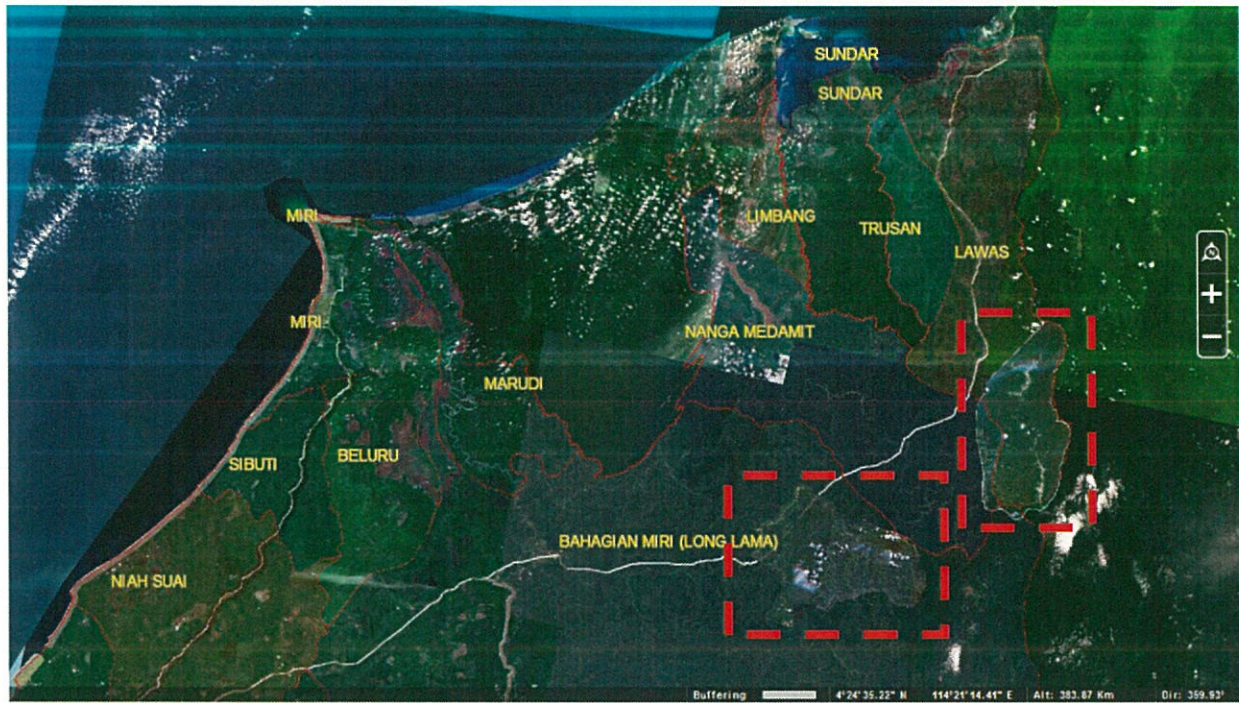
The imagery data was delivered as level 3A that were stored in GeoTIFF format and featured in a UTM map projection (UTM-50N, WGS-84).

The RapidEye imageries supplied by WWF-Malaysia were from different date, predominantly acquired from 2013 – 2014 and are tabulated in **Table 4**; the regional overview of the mosaic of the imageries is shown in **Figure 5**.

Table 4: General Specification of RapidEye Imageries Used in the Study

No	Area	Platform	Date
1	Kubaan-Puak FMU	RapidEye 03	2014-04-26
2		RapidEye 05	2013-01-21
3		RapidEye 05	2014-06-24
4	KTN FMU	RapidEye 04	2013-09-24

Figure 5: Regional Overview of the AOI, Overlain with RapidEye Imageries to Create a 5 m Basemap Mosaic for Classification



3.2 REMOTE SENSING DATA PROCESSING AND ANALYSIS

In general, identified tasks progress according to following work flow as shown in **Figure 6**. Three (3) interim and one (1) final milestones have been nominated.

3.2.1 Satellite Imagery Processing

Top of Atmosphere (TOA) Calculation

Conversion of radiances into a reflectance by relating the radiance values (i.e. the pixel DNs) to the radiance of the object is illuminated with (i.e. Sun Distance, Solar Zenith and EAI: Exo-Atmospheric Irradiance).

The radiometric scale factor for each band can be found in the image XML metadata file under the band specific metadata. Reflectance is generally the ratio of the reflected radiance divided by the incoming radiance. Note that this ratio has a directional aspect. To turn radiances into a reflectance it is necessary to relate the radiance values (i.e. the pixel DNs) to the radiance of the object is illuminated with.

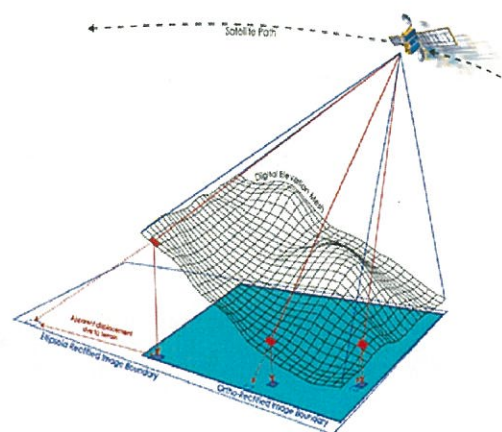
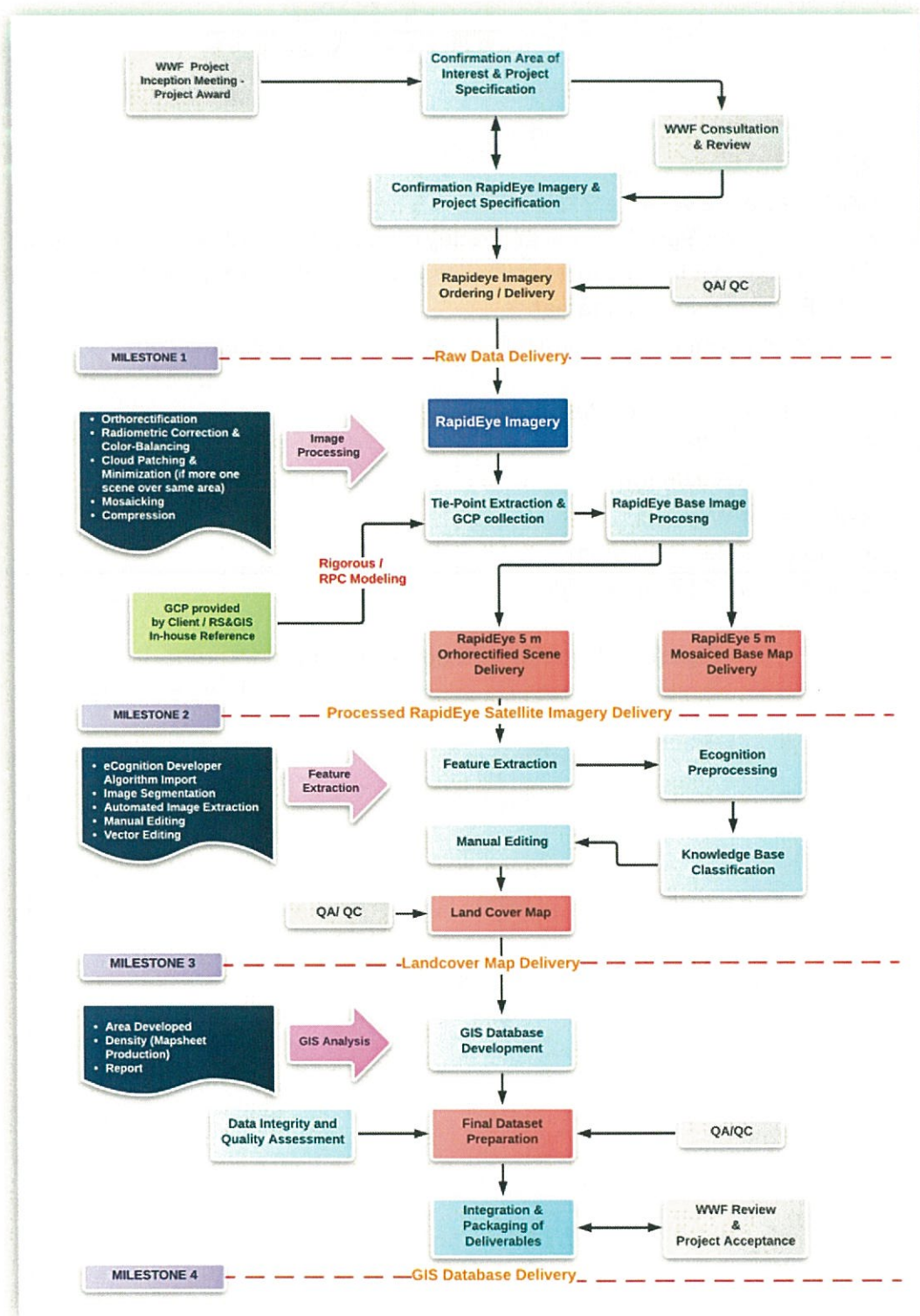


Figure 6: The Schematic Work Plan for Major Task for the Land Cover Classification based on the RapidEye Imagery



The formula to calculate the TOA reflectance not taking into account any atmospheric influence is as follows:

$$REF(i) = RAD(i) \frac{\pi * SunDist^2}{EAI(i) * \cos(SolarZenith)}$$

with:

- i : Number of the spectral band
- REF : reflectance value
- RAD Radiance value
- $SunDist$: Earth-Sun Distance at the day of acquisition in Astronomical Units (Note: This value is not fix, has to be calculated for the image acquisition point in time.
- EAI : Exo-Atmospheric Irradiance
- $SolarZenith$: Solar Zenith angle in degrees ($= 90^\circ - \text{sun elevation}$)

For RapidEye the EAI values for the 5 bands are:

- Blue: $1997.8 \text{ W/m}^2\mu\text{m}$
- Green: $1863.5 \text{ W/m}^2\mu\text{m}$
- Red: $1560.4 \text{ W/m}^2\mu\text{m}$
- Red Edge: $1395.0 \text{ W/m}^2\mu\text{m}$
- Near Infrared: $1124.4 \text{ W/m}^2\mu\text{m}$

Figure 7: Equation Structure in Erdas Imagine

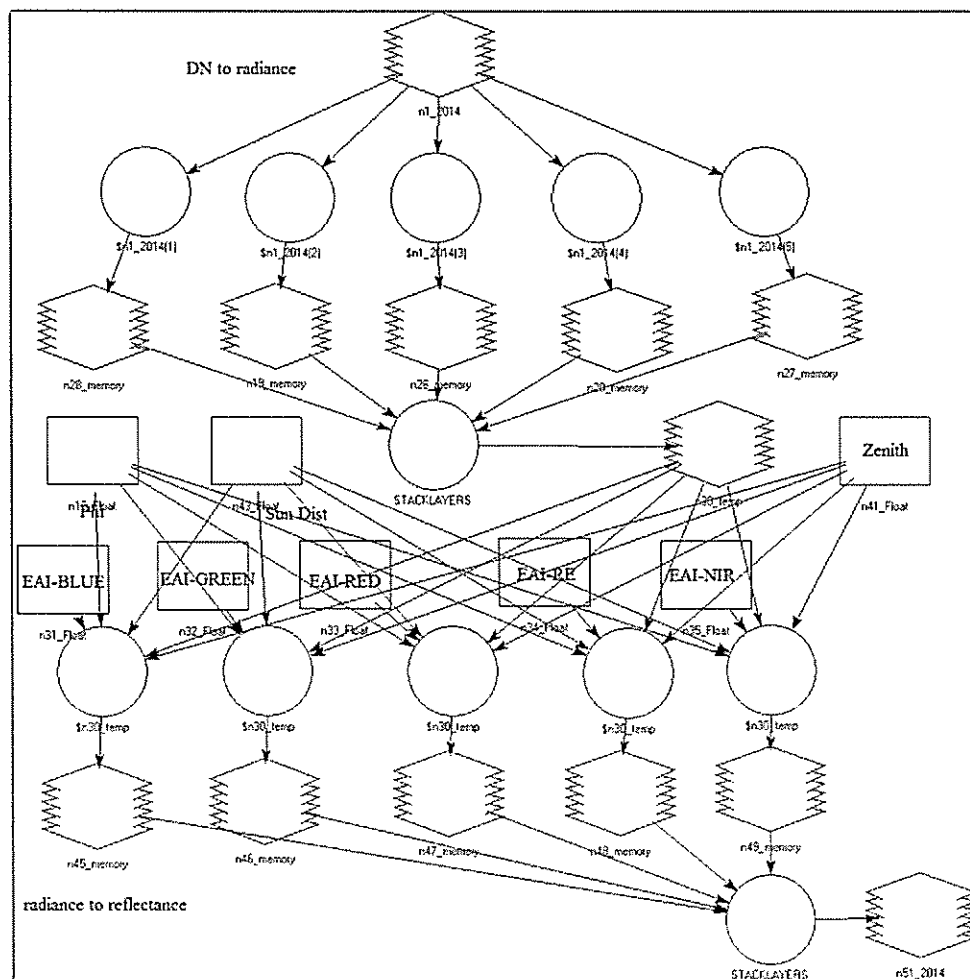
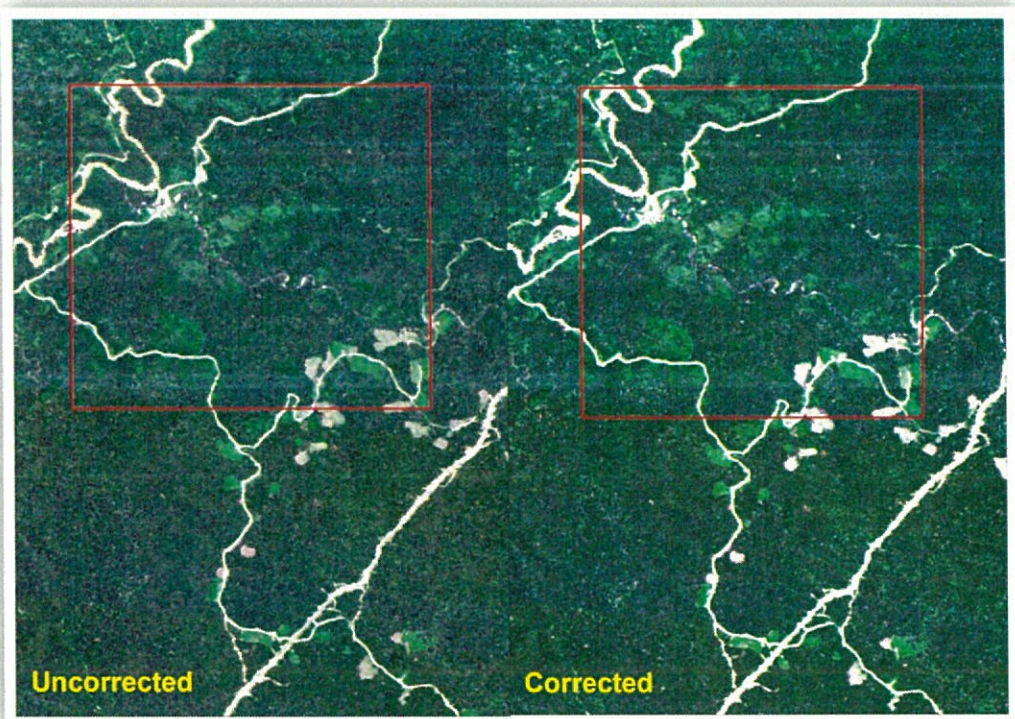


Figure 8: Sample of TOA Result on the Vegetation Comparison



**Figure 9: Sample of TOA Result on the Normalised Difference Vegetation Index (NDVI)
Value Range**

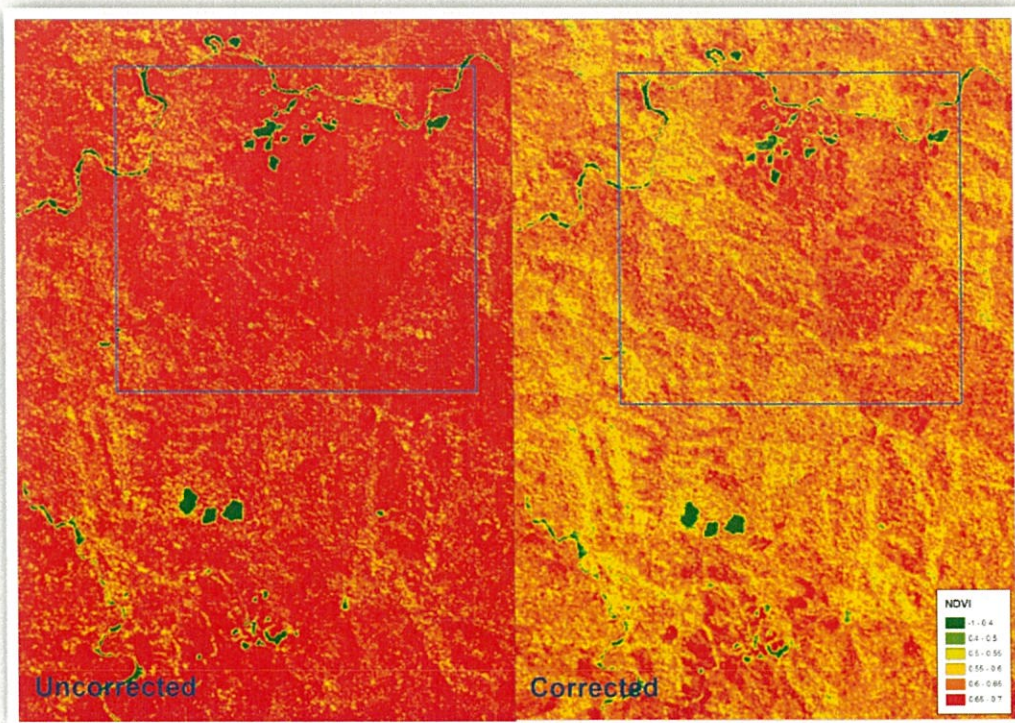
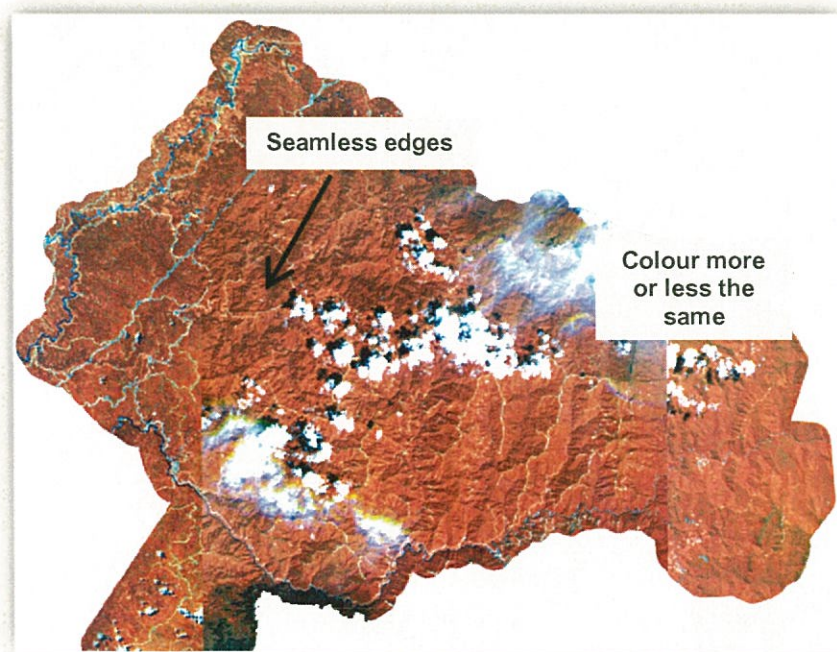
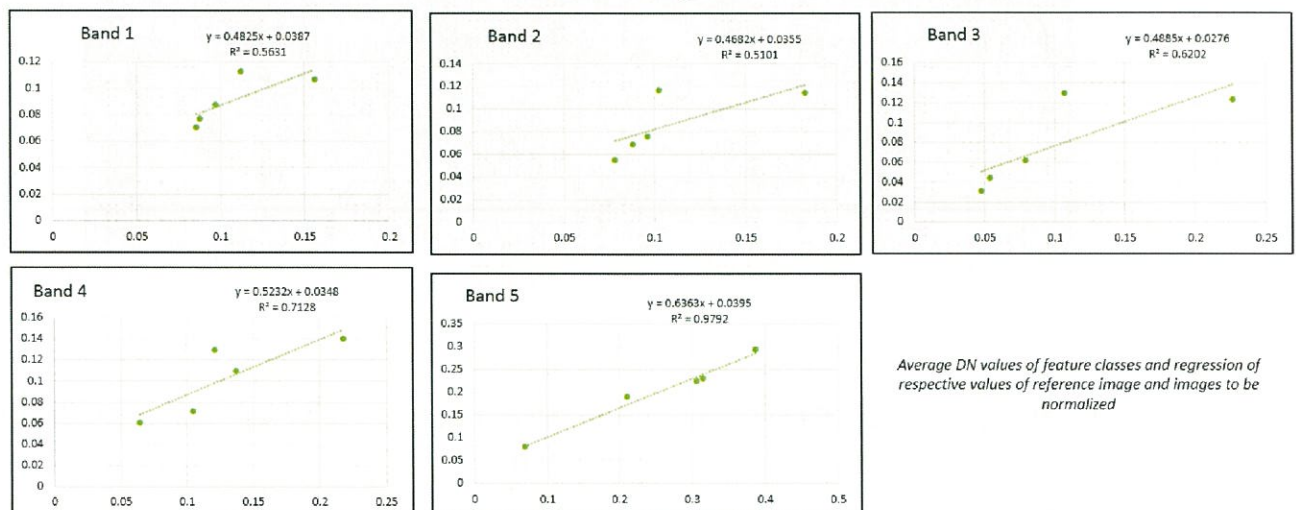


Image Normalisation

Satellite imagery must be normalised to a reference image to ensure that the atmospheric and seasonal effects among the images are minimised. This is to ensure that the atmospheric conditions among the images are more or less the same.

The DN values were later averaged based on the feature classes. The DN values of each of the feature classes of the reference image were regressed to the corresponding values of the other images to be normalised. Equation regression has been applied to perform image normalisation as shown in **Figure 10**.

Figure 10: Result for Image Normalisation Producing Seamless Edge and Average Colour Range

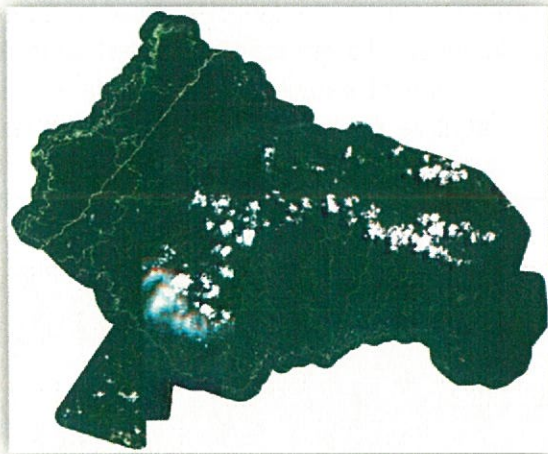


Colour Enhancement

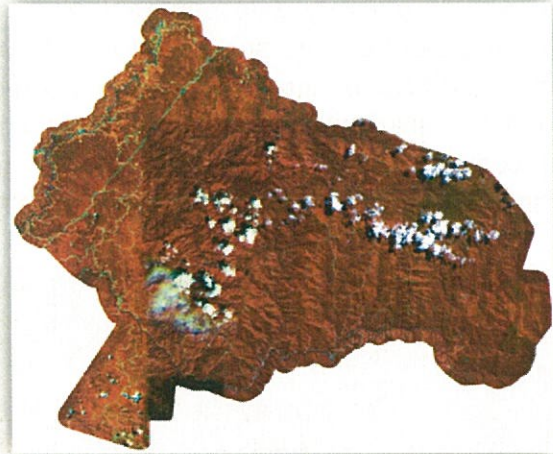
The RapidEye imagery was reprocessed, to create a 5-m resolution colour-balanced image mosaic. Image-processing was carried out to perform colour-balancing and radiometric remodeling. Additional processing has been mosaic between the nominated scenes to minimize cloud cover. The mosaicing has addressed major areas of cloud coverage, but could not reduce it totally. The imagery has been procured from different dates, so on-ground and atmospheric conditions and sun-sensor-ground geometry varied between the images. There would be some differences visible between adjacent images acquired at different times.

Figure 11(a) to (d) show the overview of the final mosaic for the AOI using different band colours.

Figure 11: The Overview of the Final Mosaic of the Area of Interest



(a) Kubaan Puak FMU Area with Band 321



(b) Kubaan Puak FMU Area with Band 542



(c) KTN FMU Area with Band 321



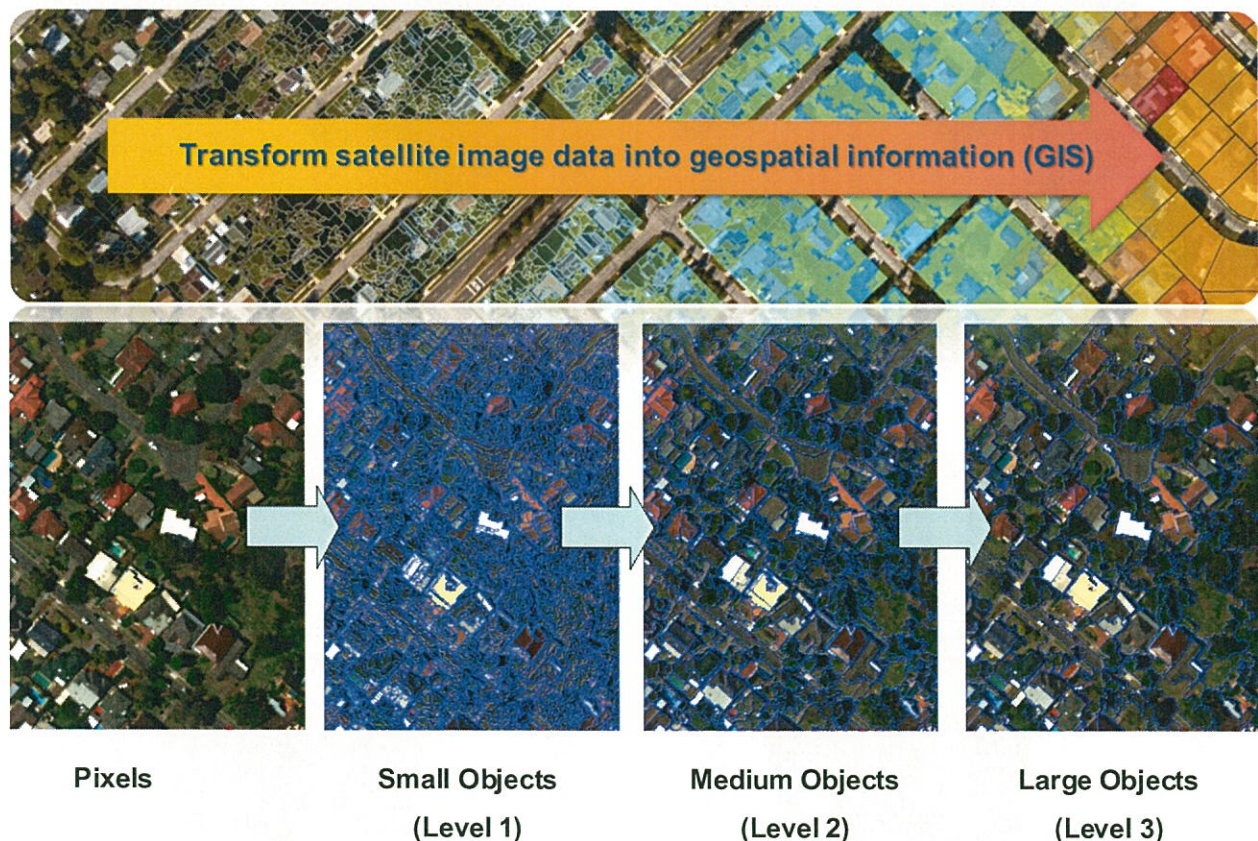
(d) KTN FMU Area with Band 542

Geometry Correction

Geometric accuracy of the imagery will be enhanced with Ground Control Points (GCPs) derived from GPS points, road network data, a processed Landsat 8 basemap, in-house archived aerial orthophoto dataset as well as ortho-correction using our SRTM 30 m Digital Elevation Model. This data is held in-house, and is made available for use towards optimising the RapidEye image.

3.2.2 Object-base Image Analysis (OBIA)

The analysis of satellite imagery has evolved from simple pixel-based supervised/ unsupervised classification of regional-scale imagery such as Landsat 8, to intelligent object-oriented classification systems that can be applied to increasingly higher-resolution imagery by mimicking cognitive ability to visually interpret and understand objects and their context. The object-driven approach allowed consideration of shape, colour (reflectance), texture, proximal relationships, as well as ancillary datasets such as terrain information. In this way, classification artifacts ('noise') can be more successfully dealt with and classified. To standardise target separation and classification, input images are incorporated into a set of knowledge-based classification rules that are applied to image objects (segments) that have been generated during the earlier processing and transformation of the imagery from a collection of individual pixels. The rules base is refined for different vegetation or climatic zones to produce more accurate results.



Underlying an eCognition-based image classification is the segmentation of input data into distinct image objects using user-defined spectral, spatial, and contextual parameters. The generation of Image Segments, consisting of GIS-ready polygons that can be tuned towards a cognitive (visually-based) delineation of target boundaries facilitates rapid manual editing of output classification layers when required.

Spectral indicators can be highly mixed between targets in RapidEye satellite imagery. Traditional classification techniques fail in this environment. eCognition software uses 'Object-Oriented' classification techniques. These techniques are different from traditional classification methodologies in that it divides the image into homogeneous regions - image objects – for processing, rather than a pixel-based approach. These Objects convey more information than pixels, such as: Shape, Texture, Context, Average Reflectance, etc. An expert user can create a durable rules base using fuzzy logic-based membership functions to classify objects into distinct target features. This enables classes to be assigned according to degrees of compliance with the rule base. This in turn creates a much more consistent and scientific application of classification rules, creating a classification methodology that can be applied consistently across multiple images and improving consistency of results.

It should be noted that classifications are models and will not represent 100% of the reality on the ground. Confusion between land cover classes will occur due to mixed pixels or strong similarity in spectral characteristics. The steep terrain of the AOI, in particular of some area, added to these difficulties as some valleys sides were shaded and thus did not show the spectral characteristic of the landcover that was present. To reduce shadows the imagery was taken around midday, yet by this time of day there is considerable cloud cover. However, as described in the following sections, several analyses were performed and several actions were undertaken to ensure that the maps are as accurate as possible given the resources available.

Producing the Cloud and Shadow Mask

Initial segmentation of the imagery was conducted at a scale of 150. This segmented layer was then exported as a shapefile and added to ArcGIS. Objects containing cloud cover and shadow were manually selected in ArcGIS. A buffer of 10 m was added to these objects, and then exported as a new shapefile. This shapefile was added to the Definens project and used as a mask.

Masking Cloud and Shadow

To remove cloud and shadow from the classification, it was pre-classified using the mask. The function 'assign class' was used with the threshold condition equal to the value of the mask.

Feature Selection

The input features for the formulas were selected partly on the basis of their characteristics, discovered empirically by observing the properties of image objects, and partly more or less randomly. Together customised arithmetic features were created and tested. Since they all worked with a limited number of input features and all were based on a combination of just 4 image layers (RED, GRN, BLU & NIR) from RapidEye Imagery, naturally there was a degree of correlation between these derived arithmetical features. The list of customised arithmetic feature used for the feature space for knowledge-based classification is tabulated in **Table 5**.

Table 5: Customised Arithmetic Feature used for Feature Space for Knowledge-Based Classification

Arithmetic Features	Description or Equation
Red_medianfilter	Median filter with 3 2D kernel size
NDVI	Normalized Difference Vegetation Index, calculated as $([\text{Mean NIR}] - [\text{Mean RED}] / ([\text{Mean NIR}] + [\text{Mean RED}]))$
Mean NDVI	Mean Value of NDVI
Mean rededge	Mean Value of rededge
Mean nir	Mean Value of Near Infra-red
Mean red_medianfilter	Mean Value of red_medianfilter layer
B5+B4+B3	$[\text{Mean Rededge}] + [\text{Mean Near Infra-red}] + [\text{Mean red}]$
Ratio Blue	$([\text{Mean blue}]) / ([\text{Mean blue}] + [\text{Mean green}] + [\text{Mean nir}] + [\text{Mean red}])$
SUM	$[\text{Mean blue}] + [\text{Mean green}] + [\text{Mean nir}] + [\text{Mean red}]$
Brightness	Average image brightness
GNDVI	Green Normalised Difference Vegetation Index
SAVI	Soil-Adjusted Vegetation Index

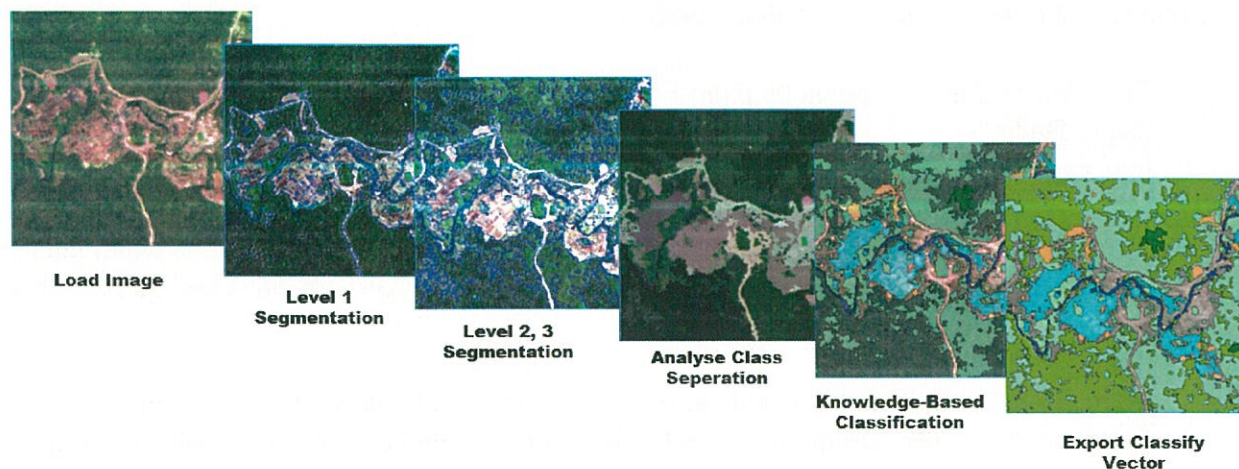
Knowledge Base Classification

a) *Pre-Classification*

The satellite data has been processed with multi-scale segmentation method. Firstly, a rough classification is done on Normalised Difference Vegetation Index (NDVI) value. This has led to the classification of Pervious (Forest) and Impervious (Non-Forest) based on contrast spit segmentation. The homogeneity criteria were defined from 0.02-0.3 value of NDVI and were well-distinguished between these major classes. Those mainly empirically gained parameters were ensured, and further classification processing of detailed class were carried out with a combination of NN classification and rule set approach.

The object-oriented classification used, based on image segmentation and knowledge-based rules are optimal for classification of satellite imagery. The steps and methodology for the object oriented classification is shown in **Figure 12**.

Figure 12: Steps and Methodology for Object-Oriented Classification



b) Land Cover Definition

For the land cover definition, the general landcover class label and description used for the AOI is tabulated in **Table 6**.

Table 6: Land Cover Class Label and Description of the AOI

Land cover class	Land cover sub-class	Definitions
Vegetation Types	High Density	<ul style="list-style-type: none"> • Logged over forest with intact forest structure • Replanted Forest (mature)
	Medium Density	<ul style="list-style-type: none"> • Secondary Forest • Heavily logged over forest, with no intact forest structure and broken canopy
	Low Density	<ul style="list-style-type: none"> • Bushes, Grass & Fern • Newly Replanted Forest • Harvested Forest
	Mixed Crop	<ul style="list-style-type: none"> • Other Cultivation Crop
Paddy Field		<ul style="list-style-type: none"> • Paddy Cultivation
Exposed Ground		<ul style="list-style-type: none"> • Cleared / Bareland
Manmade Features / Logging Road		<ul style="list-style-type: none"> • Built up area • Road
Waterbody		<ul style="list-style-type: none"> • River • Pond

c) Classification

Eight land-cover classes could be defined from major classes of Pervious and Impervious. Definition of every classes are defined below:

1. From Major Class: Impervious (Non-Forest)

Water Body

It is assumed that the most common Near Infra-Red band is strongly absorbed by water reflectance. This assumption was made due to higher value in comparison to other objects. Compared to NDVI, the absorption is lower for water. In order to differentiate water classes, combination of high value from NIR and lower value from NDVI are classified as water body.

Paddy Field

Paddy field features is most likely to have same range of value with water body, but paddy field has their own structures. Paddy field can be easily determined with manageable structure with high value water range together with estimation of value for Vegetation Index (VI) and Enhanced Vegetation Index (EVI).

Exposed Ground

Exposed ground in this study is described as cleared/ abandoned area, bare/ soil area. This class is defined in lower value in arithmetic band Ratio Blue. Ratio Blue shows a very bright contrast to differentiate exposed ground.

Mixed Crop

Mixed crop is described as planted area that consists of different structure of vegetation. The structures derived from different texture cultivated crop compared to forest texture. The value of Green Normalized Difference Vegetation Index (GNDVI) shows in between high and low density forest. This class is a bit mixed up with medium density forest due to the GNDVI value, but the comparison is made based on visual interpretation.

Manmade Features/ Logging Road

This class is analysed by human made features rather than those occurred in nature, which includes buildings of settlements, built-up infrastructure, tarmac road and logging tracks.

2. From Major Class: Pervious (Forest)

Low Density Vegetation Area

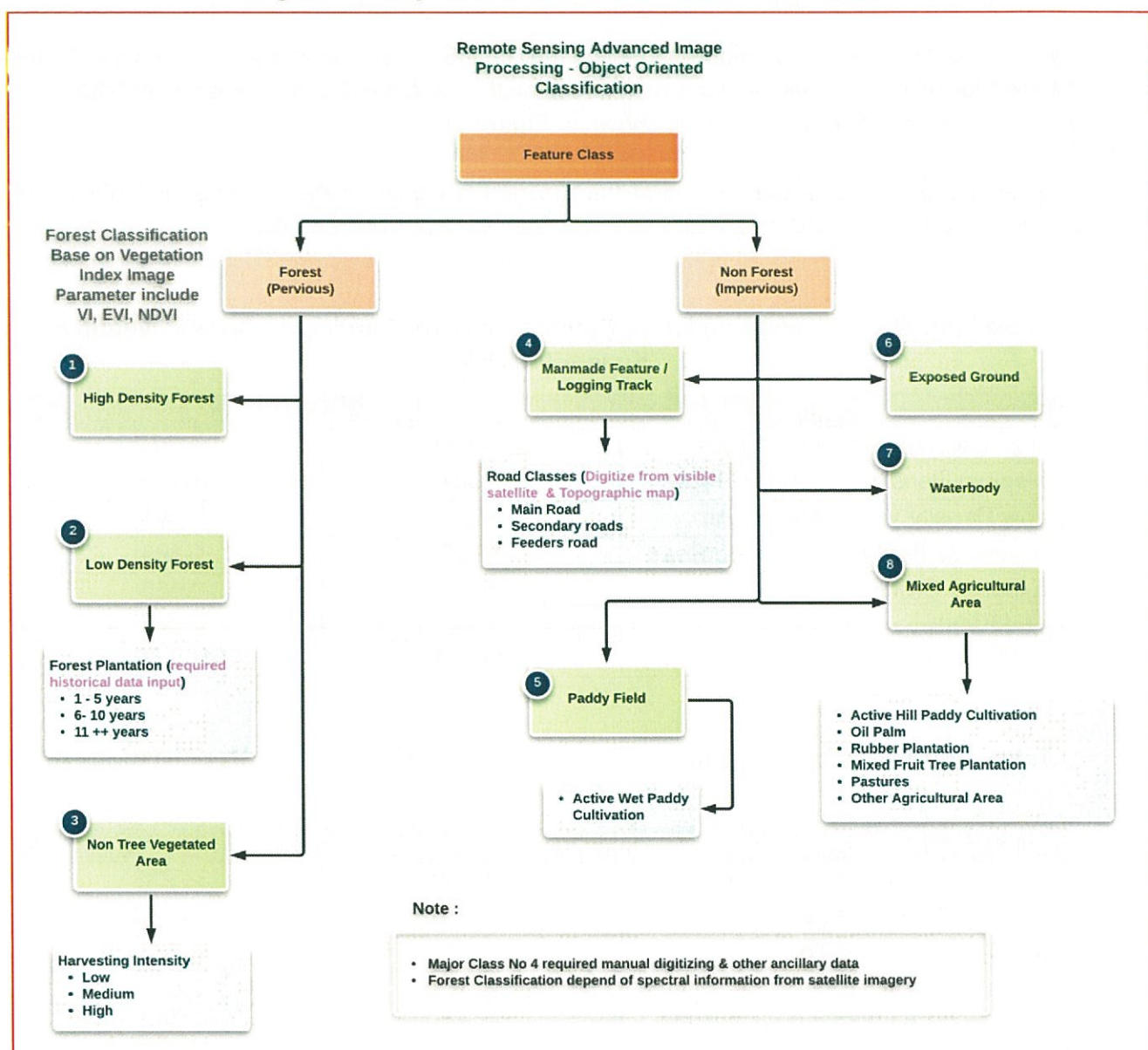
Low density vegetation area are known as bushes, grass, fern, newly planted forest or harvested forest. The light green colour in natural combination can be clearly seen in the satellite imagery for visual interpretation. This class is classified using high mean value of NIR.

Medium Density Forest and High Density Forest

Medium density is classified using medium range of NIR band layer. This feature is a bit dark than non-tree vegetated area. High density forest class totally relies on image brightness. High density forest is darker compared to other features in pervious major class. These two (2) classes are slightly mixed up due to the inconsistency of forest boundary in the AOI.

The process for the object-oriented classification is shown in the flow chart (**Figure 13**).

Figure 13: Object-Oriented Classification Flow Chart



3.3 VISUAL INTERPRETATION OF GOOGLE EARTH IMAGERY

Cloud cover remaining on RapidEye after the use of both the In-house SPOT 5 (2.5 m) and Google Earth images were used for classification. This remaining area was manually classified from visual interpretation of Google Earth Imagery & SPOT 5 captured.

3.4 COMPARISON WITH OTHER PUBLISHED MAP SOURCES

Comparison and verification has been made using other published maps held in-house. The maps that has been used are the 1:250,000-scale landuse map from Land and Survey Department Sarawak, Sarawak Series No. 22, 1:50,000-scale topography map from Land and Survey Department, T735 series, and 1:50,000-scale topography map from JUPEM, T738 series.

3.5 RESULTS

The land cover classification output based on the RapidEye satellite Imagery is shown in **Figure 13** and **Figure 14**; while the land use map based on the Land and Survey Department 1:250,000-scale landuse and vegetation map is shown in **Figure 15**.

The hectareage and area percentage of the different landcover classifications for the Kubaan-Puak FMU and KTN FMU areas are in summarised in **Table 7(a)** and **(b)**.

Table 7(a): The Hectarage and Area Percentage of the Landcover Classifications for Kubaan-Puak FMU

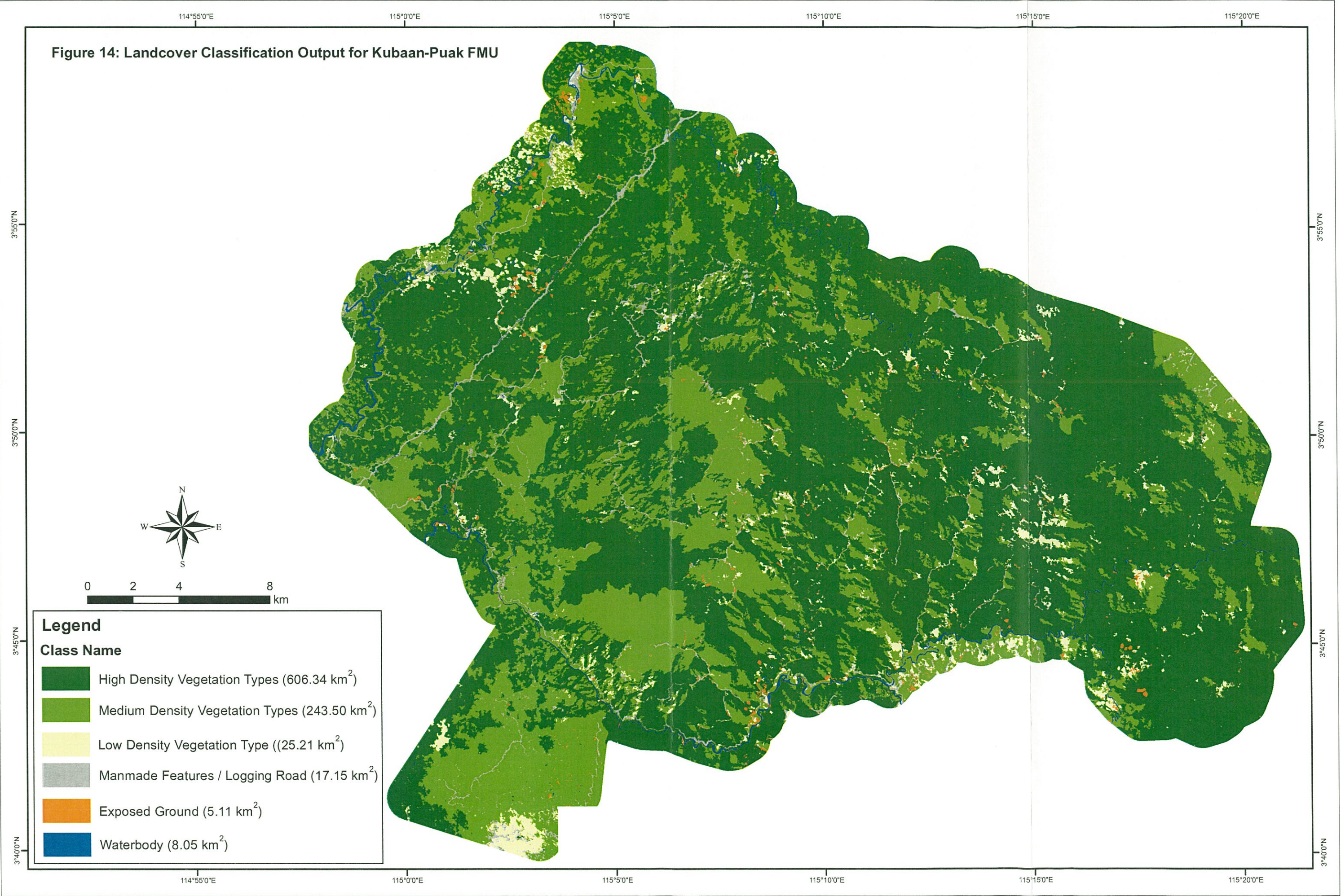
Class Name	Total Area (km ²)	Percentage (%)
High Density Vegetation Types	606.34	66.972
Medium Density Vegetation Types	243.50	26.895
Low Density Vegetation Types	25.21	2.784
Manmade Features / Logging Road	17.15	1.895
Exposed Ground	5.11	0.565
Waterbody	8.05	0.889
Total Area	905.36	100.00

Table 7(b): The Hectarage and Area Percentage of the Landcover Classifications for KTN FMU

Class Name	Total Area (km ²)	Percentage (%)
High Density Vegetation Types	316.30	39.233
Medium Density Vegetation Types	372.36	46.188
Low Density Vegetation Types	71.10	8.820
Mixed Crop	0.01	0.001
Manmade Features/ Logging Road	20.48	2.540
Paddy Field	4.33	0.537
Exposed Ground	18.10	2.245
Waterbody	3.52	0.436
Total Area	806.20	100.00

3.6 CONCLUSION

Several image analysis are developed for target detection in different field. It is very difficult to compare every image analysis due to lack of standardized data and environment condition. The main problem for the designed algorithm is mixed pixel due to resolution and algorithm assigned. As a result, the automated algorithm still have mixed information and manual editing and visual interpretation would be required for better result.



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77. Editorial Manuscripts

78. Editorial Manuscript

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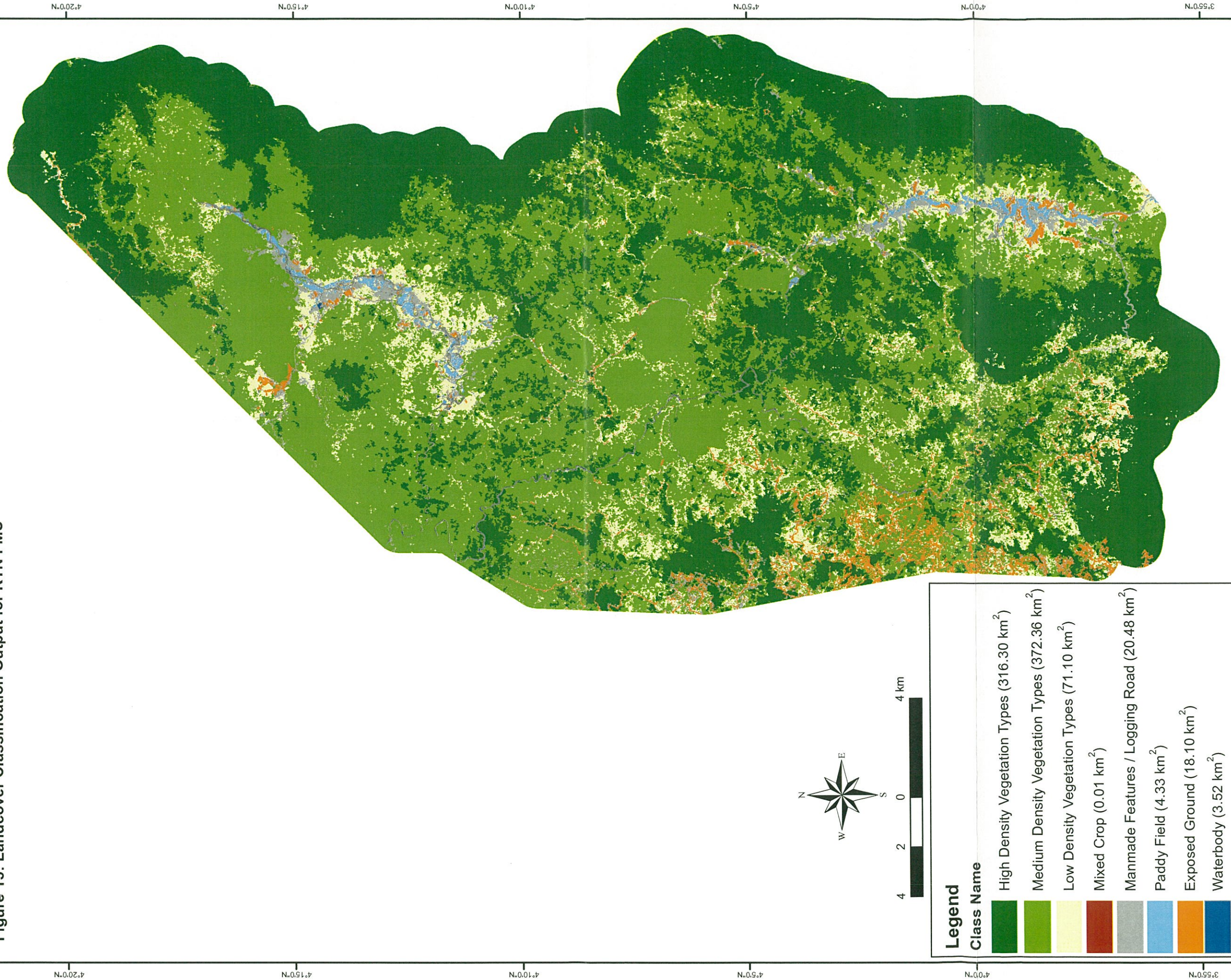
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Figure 15: Landcover Classification Output for KTN FMU



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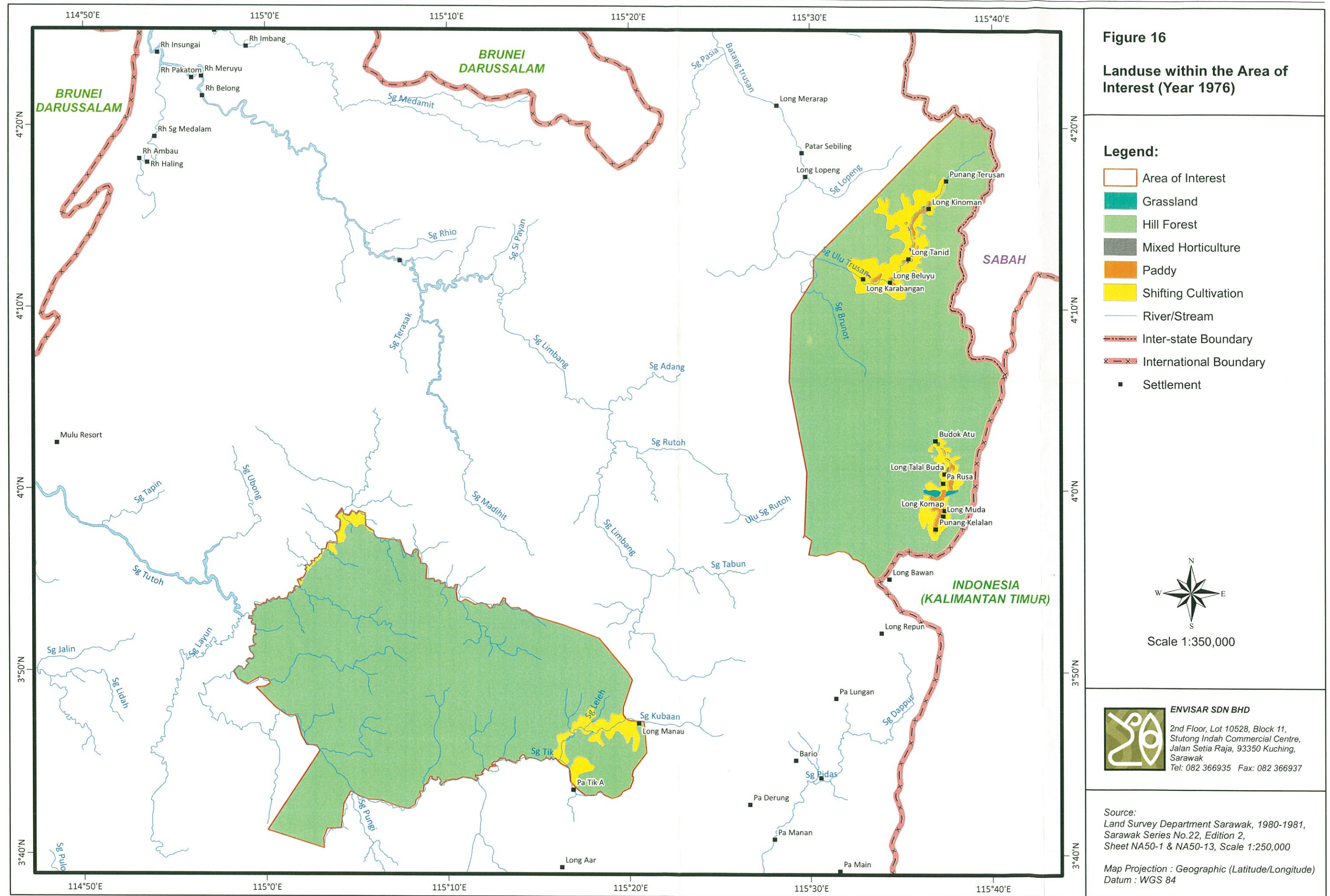
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1. The first part of the document is a list of the names of the members of the committee who have been appointed to study the problem of the shortage of housing in the city of New York.

4.0 GAP ANALYSIS

The gap analysis appraised the availability of information required for the assessment of the forest condition, biodiversity and ecosystem services relevant to the areas of interest. Outcome of the information gap analysis is shown in **Table 8**.

Table 8: Outcome of Information Gap Analysis

No.	Subject Matters	Information Required	Availability of Information	Remarks	Commends / Recommendations
1	Forest condition	Forest cover and types	<p>The forest cover and forest types are depicted in the Forest Type Map as appended in the respective forest timber licences.</p> <p>Descriptions of the forest cover and types are available in the EIA Reports prepared for logging operations under the respective forest timber licences. The EIA Reports are available at the NREB Sarawak and with the respective timber licence holders.</p> <p>Descriptions of the forest cover and types within T/0342 are available in the HCVF assessment report.</p>	<p>Photocopies of the Forest Type Maps (in AO size) have been acquired.</p> <p>EIA Reports of T/0280, T/0294 and T/0342 are provided by the respective timber licence holders. The reports only provide generic descriptions of the forest cover within the timber licence areas.</p> <p>Copy of the HCVF assessment report for T/0342 is provided by WWF.</p>	<p>Digital maps depicting the prevailing forest cover and types should be prepared /compiled.</p> <p>EIA Reports of T/0285 and T/0405 should be acquired. The relevant information should be reconciled for the AOI.</p>
		Protection of the forest	<p>The forest areas are largely gazetted /proposed as PFEs. Information regarding the PFEs is available in the GIS database of Forest Dept. Sarawak and the Sarawak Government Gazettes.</p> <p>Areas of Terrain Class IV (steep terrain >35° slopes) are identified and delineated in the Forest Type Maps of the relevant forest timber licences.</p>	<p>Map depicting the relevant PFEs is provided by Forest Dept. Sarawak.</p> <p>Photocopies of the Forest Type Maps (in AO size) which also include information on the terrain classes have been acquired.</p>	<p>-</p> <p>Further information (e.g. gazette notification, boundary & coverage) regarding the relevant PFEs should be compiled.</p> <p>Digital maps depicting the areas of Terrain Class IV should be prepared /compiled. Terrain mapping and/or slope analysis may be considered as this will give more information on the viability and connectivity of the corridor.</p>

No.	Subject Matters	Information Required	Availability of Information	Remarks	Commends / Recommendations
2	Biodiversity	Documentation on biological diversity	Flora and fauna species that could be found within the AOI are documented in the respective EIA Reports, as well as the HCVF and PSP assessment reports for T/0342.	The HCVF and PSP assessment reports for T/0342 outlined flora and fauna species that could be found within the site. The EIA Reports provided lists of tree enumerated and protected fauna species that may be found within the assessment sites. Apart from T/0342, the tree enumerations conducted within the other timber licenced areas were not conducted within the AOI.	The information should be compiled and reconciled for the AOI.
			The Botany Unit of the Forest Dept. Sarawak and Sarawak Biodiversity Centre had conducted botanical collections and documentation of traditional medicinal plants in parts of the AOI. Information is not published.	The information is kept as herbarium specimens in the Botany Unit and in the travelling reports of SBC. These are proprietary database of the respective agencies.	
		Conservation activities	ITTO is undertaking a buffer zone conservation project within and adjacent to the AOI.	Information is available as project documents of ITTO and is not published.	Further information (e.g. project objective, coverage, scope & activities) regarding the buffer zone project, as well as other similar undertaking by other parties, should be compiled.

No.	Subject Matters	Information Required	Availability of Information	Remarks	Commends / Recommendations
3	Ecosystem services	Land uses	<p>Land use within the PFEs is largely timber production as prescribed in the forest timber licences. Information on coupe layout, forest roads network and the progress of logging activities are available at the offices of the respective timber licence holders and the Sarawak Forestry Corporation Miri Regional Office.</p> <p>Land uses such as settlement area, paddy and rubber etc. are depicted in the Sarawak Land and Survey Department 1:250,000-scale Landuse Map, Sarawak Series No. 22, Edition 2, Sheet NB50-13 and Sheet NA50-1.</p> <p>Brief descriptions of land uses within and surrounding the timber licenced areas are available in the EIA Reports.</p>	<p>Information has not been acquired.</p> <p>The information is not up-to-date.</p> <p>The information is generalised statements; and the actual coverage and localities are not provided.</p> <p>The Penan Reserve is administratively agreed between the respective timber licence holders and the Forest Dept. Sarawak. The reserve has not been officially gazetted.</p>	<p>Further information on prevailing logging activities (e.g. coupe & blocks, boundary & road networks) within the AOI should be compiled.</p> <p>Up-to-date land use map should be prepared.</p> <p>The types and spatial distribution of existing land uses should be identified and the information compiled. This may requires ground surveys to ascertain the information on shifting cultivation, farming/ cropping, existence of pulau and pemakai benua (rights for forest resources gathering and hunting), gravity-feed water supply catchments and etc.</p> <p>Further information regarding the Penan Reserve (e.g. beneficiary community, location, boundary & coverage) should be compiled.</p>

No.	Subject Matters	Information Required	Availability of Information	Remarks	Commends / Recommendations
	Defined land use boundary		Boundaries of the forest timber licenced areas are described in the respective forest timber licences.	Boundaries of the respective timber licence areas are depicted on the Forest Type Maps.	-
			Boundaries of the PFEs where the AOI are located are described in the respective gazette notifications and in the GIS database of the Forest Dept. Sarawak.	Map depicting the relevant PFE is provided by Forest Dept. Sarawak.	Further information (e.g. gazette notification, boundary & coverage) regarding the relevant PFEs should be compiled.
			Activities pertaining to other land uses (e.g. Tagang system, irrigation dams and catchments, collection of minor forest produces) are mentioned in the EIA reports.	Actual location and boundary of the reported land uses are not clearly defined /described in the EIA reports.	Further information (e.g. location, boundary, community involved) regarding the other land uses should be compiled.
	Community project		ITTO and APFNeT are undertaking a watershed management project that involve community development within and adjacent to the AOI.	Detailed information regarding these projects are not published.	Further information regarding the watershed management project, as well as other similar undertaking by other parties, should be compiled. Official requisition should be submitted to the respective organisations.
	Temporal use by wildlife		Wildlife temporal use of the forest ecosystem within T/0342 is documented in the HCVF assessment report.	Wildlife temporal use of the forest ecosystem within the other timber licenced areas covering the AOI has not been assessed and documented.	Temporal use, and other conservation values, of the forest ecosystem within the other forest timber licenced areas (particularly covering the AOI) should be assessed and documented.

No.	Subject Matters	Information Required	Availability of Information	Remarks	Commends / Recommendations
4	GIS	Landcover mapping	RapidEye data with different series of level (Level 3a), and product (RapidEye 3 and RapidEye 5).	The images have been pre-processed and have affected the quality of the images.	The results were affected depending on the level of the product, image pre-processing and the quality of image. Therefore it is recommended to have in-house pre-processing for quality control.
				The resolution of the images have limited the landcover mapping outcome.	Image quality will also affect the results. It is recommended to have higher resolution images for further landcover studies. Images to be considered could involve information from Worldview 8 bands or SPOT 6/7 with a range of 0.5-0.6 resolution for better comparison between features.