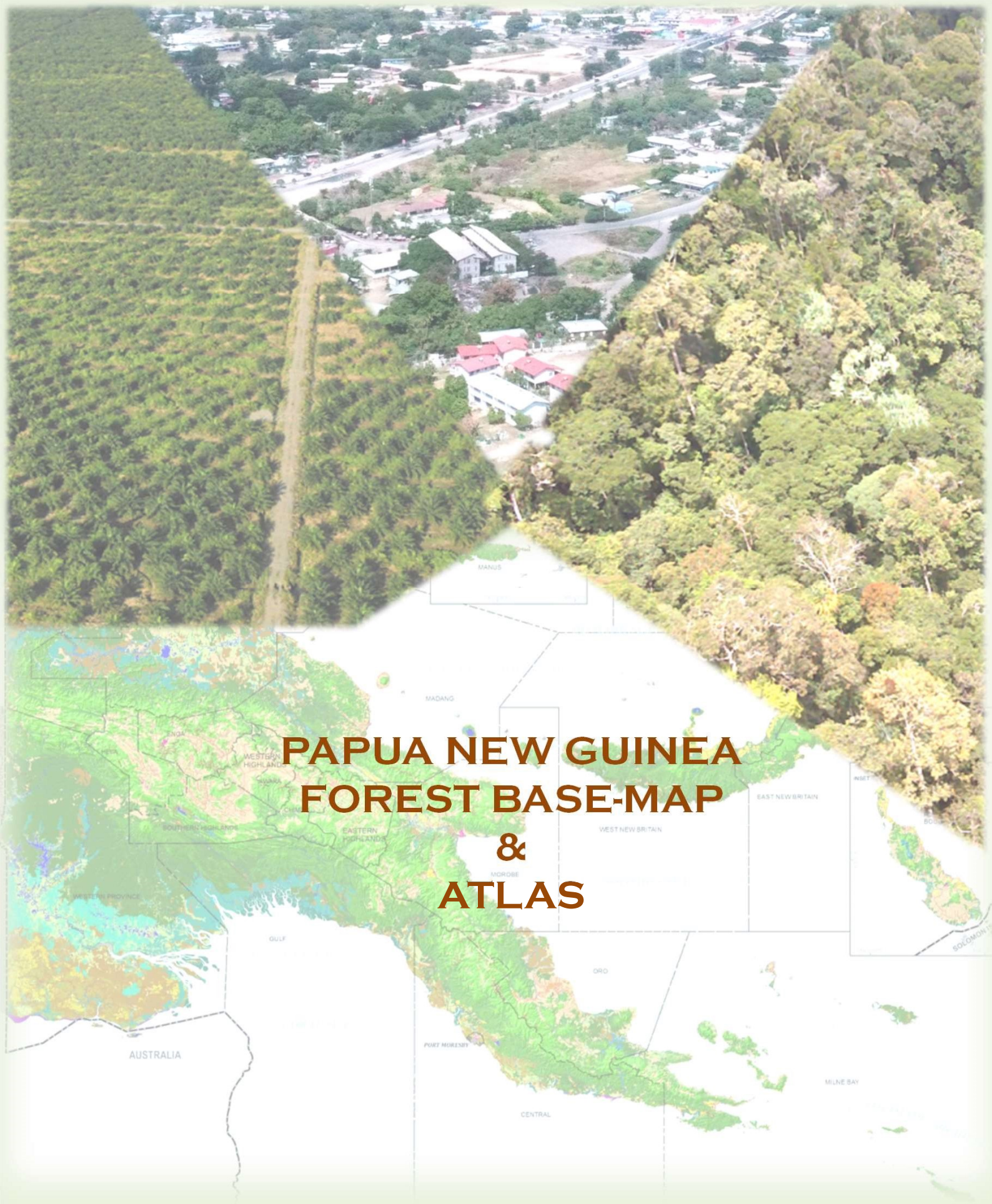

PAPUA NEW GUINEA FOREST BASE-MAP & ATLAS

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Papua New Guinea

Forest Base-Map and Atlas

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Table of Contents

I. Foreword

This very important publication documents the great collaboration that the people and government of Japan have provided to Papua New Guinea and, in particular to the Papua New Guinea Forest Authority (PNGFA) through the PNGFA/JICA Project – "Capacity Development on the Forest Resource Monitoring for Addressing Climate Change in Papua New Guinea". One cannot measure enough the value of the technology and the skills gained by the PNGFA Officers and those other Papua New Guineans that were involved in the project.

I also encourage the other government agencies, development partners and relevant stakeholders to work with my Ministry to collect appropriate information so to provide accurate and reliable data to assist the government chart the course for forestry management in PNG. This, will in the long run, assist in providing accurate reports on other emerging issues such as climate change.

It is my hope that the PNGFA officers continue on the good work that has been developed and challenge themselves to continue to update and improve the forest resource information for Papua New Guinea in the years to come.

Hon. Solan Mirisim, *MP*
Minister for Forests

II. Preface

As Papua New Guinea moves forward to address the challenges that global warming poses to its many natural resources; of which many are very poorly known, one agency of the Government has taken on the task to update its data on the forest resources of the country – The Papua New Guinea Forest Authority. This work has been 'thankfully' made possible through the generous support of the people and Government of Japan under its Forest Preservation Programme. This programme gave headway to the commencement of the project titled 'Capacity Development on Forest Resource Monitoring for Addressing Climate Change in Papua New Guinea'.

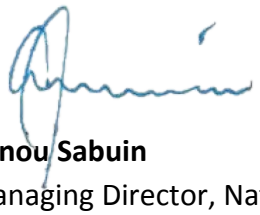
The Project has developed a Forest Base Map (herein referred to as 'FBM'), which has taken many long hours by both the Japanese experts and the Papua New Guinea experts. The various tasks included; interpreting satellite imageries and describing/classifying the various vegetation types and producing reports to come up with the current map and data, as will be presented in this Report. The Report will also include some work that has been undertaken under the second follow-on project titled 'Capacity Development Project for Operationalization of PNG Forest Resource Information Management System (PNG-FRIMS) for Addressing Climate Change'.

This Report has been put together by those that have been involved in the project; Japanese experts, PNG national counterparts and short-term PNG nationals attached with the Japanese experts, all of which whose names appear in the Acknowledgement section. Each of these persons have made a tremendous contribution to the interpretation of satellite imageries, conducting desk top and field-based research to confirm vegetation types and forest categories, preparing maps and writing up the specifics of how the FBM was developed as well as documenting the specific provincial trees of the 21 Provinces of Papua New Guinea, excluding the National Capital District.

The development of the FBM also took into account other work that has been developed and documented under the PNG Resource Information System series (PNGRIS). It is therefore believed to contain the latest data on the vegetation types and forest categories as presently known in PNG. It has contributed to the preparation of various reports relating to climate change, including the National REDD+ Strategy, Forest Reference Level, the Biennial Update Report and the Collect Earth Assessments on Forest and Land Use Change 2000-2015 Report.

Any inquiries on the FBM, can be directed to the PNG Forest Authority at –

P. O. Box 5055, Boroko, N.C.D., Papua New Guinea. Telephone: (675) 3277800 or email: infor_general@pngfa.gov.pg



Tunou Sabuin
Managing Director, National Forest Service,
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Ms Ayako Ochi (Expert on Forest Remote Sensing 2/ Forest GIS 2)

IV. Acknowledgement

The completion of the Papua New Guinea Forest Base-Map and Atlas book could not have been possible without the involvement, participation and support of so many people whose names may not all be mentioned. Their contributions are sincerely appreciated and gratefully acknowledged. However, the authors would like to express our deep appreciation and indebtedness particularly to the following-

The respected former JICA Experts, Mr Tatsuya Watanabe, Mr Kiyoshi Suzuki and Mr Masaya Nishimura and the ongoing support from Kokusai Kogyo Co., Ltd (KKC) Experts, Mr Masaki Kawai, Mr Kunihiro Ishii, Mr Yasuyuki Okada, Dr Ryota Kajiwara, Dr Takahiro Koide and Mr Hirokazu Takahashi who shared their knowledge with the Papua New Guinea Forest Authority (PNGFA) staff.

The PNGFA counterparts namely; Mr Patrick La'a, Mr Samuel Gibson, Ms Margaret Tongo, Mr Gewa Gamoga, Mr Dambis Kaip, Mr Ledino Saega, Mr Rabbie Lalo, Mr Kipiro Damas, Mr Goodwill Amos and Mr Constin Bigol;

The PNG national consultant; Mr Oala Iuda, and the JICA project casuals namely; Mr Benjamin Matambuai, Mr Joshua Turia, Ms Evelyn Paul, Ms Aida Kai and Ms Dika Davai who were privileged and fortunate to participate in this unique opportunity in working on this project.

All other PNG Forest Authority staff (from headquarters and provinces) that participated in the project activities, including the Administrative staff that coordinated logistics for duty travel and meetings relating to the Project, namely; Ms Matilda Kila, Ms Helen Bure and Mrs Ikimairi Wak.

The authors also would like to acknowledge the other relevant organizations which provided the data and information, such as the Mapping Agriculture Systems Project (MASP) under the Australian National University, the Papua New Guinea National Mapping Bureau which provided the Digital Elevation Model (DEM) data, the Mineral Resources Authority which provided the mining licences data and the Conservation and Environment Protection Authority (CEPA) which provided the protected area data.

It is a great pleasure and opportunity to work on this Book. For this, we are deeply indebted and sincerely thankful to everyone for their help, invaluable guidance and encouragement throughout the course of the JICA-PNGFA project.

V. Acronyms

AGD66	1966 Australian Geodetic Datum
AGD84	1984 Australian Geodetic Datum
ALOS	Advanced L-band Synthetic Aperture Radar
AMG	Australian Map Grid
AusAID	Australian Agency for International Development
CSIRO	Commonwealth Scientific and Industrial Organization
DEM	Digital Elevation Model
FAO	Food Agriculture Organization
FBM	Forest Base Map
FIMS	Forest Inventory Mapping System
FMU	Forest Mapping Unit
GeoSAR	Geographic Synthetic Aperture Radar
GIS	Geographic Information System
GPS	Global Positioning System
JICA	Japan International Cooperation Agency
KKC	Kokusai Kogyo Co., LTD.
LANDSAT	Land-Sensing Satellite (System)
NDVI	Normalized Difference Vegetation Index
NIR	Near Infra-Red
NMB	National Mapping Bureau
PALSAR	Phased Array type L-band Synthetic Aperture Radar
PNG	Papua New Guinea
FRIMS	Forest Resource Information Management System
PNGRIS	PNG Resource Information System
RMU's	Resource Mapping Units
RS	Remote Sensing
UN-REDD	United Nation - Reduced Emissions from Deforestation and forest Degradation
USGS	United States Geological Survey
UTM	Universal Transverse Mercator

1. Background:

Forest Resource Information in PNG

1.1 Before Forest Base Map

Many assessments and reports of the forest resources and land uses of Papua New Guinea have been conducted spanning many years; going back to the 1920s. In this Report, we will highlight some of those reports and provide some guidance as to how and what has changed up to the point of developing the FBM of Papua New Guinea.

1.1.1 Forest Resources of the Territories of Papua and New Guinea

The very first assessments of PNG's forest resources had been undertaken by Lane-Poole[1] from 1922-1924, unfortunately there is no record of that assessment report in PNG. In this assessment, Lane-Poole used the normal survey method of walking the forest along strip lines and taking measurements where he grouped his forest types as 'Forest Regions' and are as follows-

i) Lowland forests (0 - 1,000 feet) (0 - 305 m);
ii) Foothill forests (1,000 - 5,500 feet) (305 - 1,676 m);
iii) Mid-mountain forests (5,500 - 7,500 feet) (1,676 – 2,286 m);
iv) Mossy forests (7,500 - 11,000 feet) (2,286 – 3,353 m);
v) Alpine forests (over 11,000 feet) (over 3,353); and
vi) Savannah forests

1.1.2 Vegetation Map of Papua New Guinea

This vegetation map of PNG was developed by Paijmans (1975) of the Division of Land Use Research, Commonwealth Scientific and Industrial Organization (CSIRO) [2] which based its work on interpretations of aerial photographs, taking into consideration the features and floristics of the vegetation. This was complemented by field observations spanning over 20 years where topography, drainage and altitude were also considered in coming up with the nine (9) vegetation types, which are-

Table 1: Vegetation types of the map developed by CSIRO (1975)

Forest	Mixed herbaceous vegetation
Woodland	Pioneer vegetation
Scrub	Mangrove vegetation
Savanna	Garden
Grassland	

[1] Lane-Poole (1925). The Forest Resources of the Territories of Papua and New Guinea, Government of the Commonwealth of Australia, Victoria, Australia
[2] Paijmans (1975). Explanatory Notes to the Vegetation Map of Papua New Guinea. Land Research Series No. 35. Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia.

Paijmans (1975) has further mapped out the vegetation types into specific mapping types based on certain features such as tree crowns and the ecology and habitats where such vegetation type is available. For example, in the category of 'forest', he has established that you can identify the various types of forest as shown in Table 2 below.

Table 2: Forest types of the map developed by CSIRO (1975)

Forest Type	*Description*
Forest on plains and fans	Large-to medium crowned forest Open forest Small-crowned forest Littoral forest Swamp forest
Forest on hills and mountains Lowland hill forest zone (sea level to 1 400 m)	Medium-crowned forest Small-crowned forest Large-crowned forest
Lower montane forest zone (1 400 – 3 400 m)	Lower montane forest General type Coniferous lower montane forest Very small-crowned lower montane forest
Montane forest zone (3 400 m to the forest limit at 3 900 m)	Montane forest
Forest restricted to south-west Papua New Guinea	Dry evergreen forest

More specific details of these vegetation types, including Woodlands, Scrub, Savanna, Grassland, etc. are contained in his book as referred above.

1.1.3 Papua New Guinea Resource Information System (PNGRIS)

PNGRIS was developed by the CSIRO, based on interpretation of air photographs and is a continuation and improvement on the work by Paijmans (1975; 1976). In this work, CSIRO has developed maps that show the type and distribution of natural resources, land use and population distribution for the whole country.[3]

In effect, PNGRIS is a computerised mapping database based on a geographic information systems (GIS) that contains about 4,837 resource mapping units (RMU's) or land units covering PNG landmass by geology, topography and climate at a scale of 1: 500,000. The database contains a summary list of landform type, physical data, land-use information and population figures attached to each RMU. Since the promotion of PNGRIS, advancement of GIS and comparatively low-cost satellite derived data has enabled landscape features captured at original PNGRIS scale can now be reproduced at

[3] Saunders, J (1993). Forest Resources of Papua New Guinea. PNGRIS Publication No. 2. CSIRO, Brisbane, Australia

finer scale. Details are contained in "Papua New Guinea: Inventory of Natural Resources, Population Distribution and Land Use Handbook" 2nd edition.[4]

Consequently, PNGRIS has been updated using the advancements in technology utilizing GIS and satellite imageries but only looked at climate, geology, topography, population, soil and inundation to measure land use intensity. This work was undertaken by Bryan and Shearman in 2007 in partnership with the Department of Agriculture and Livestock[5].

The initial data from PNGRIS was used to undertake the Forestry Rapid Resource Appraisal[6] and is of a much broader scale than that of the Forest Inventory Mapping System (FIMS).

1.1.4 Forest Inventory Mapping System (FIMS)

FIMS has been developed to provide a consistent and country wide set of information on the type and extent of the forest resource and of its current use by the forest industry in PNG. FIMS was developed as a geographic information system, based on MapInfo 4.5 and Microsoft Access 97 to provide integrated information to assist in the effective management and planning of forest resource use. It was developed by John Quigley, a programmer under an AusAID project (1996)[7].

The FIMS focuses on a mapping of forest resources and vegetation at a scale of 1:100,000 and covers the entire country. The mapping is based on the 1972-75 SKAIPIKSA air photo interpretation coverage of a similar scale. This interpretation was based on data and experience gained in the earlier long-term mapping and field survey program of CSIRO and PNG Department of Forests (now National Forest Service). Details of the mapping procedures are contained in Hammermaster and Saunders (1995)[8].

The forest mapping of 1:100,000 was compiled on the same scale as standard PNG topographic series mapping using the Universal Transverse Mercator (UTM) projection with the Australian Map Grid (AMG) and the 1966 Australian Geodetic Datum (AGD66). This mapping is polygonised with the same projection and grid in MapInfo version 4.5, but with the later Australian Geodetic Datum of 1984 (AGD84). It was compiled as a series of film overlays at scale 1:250, 000 and stored at PNGFA.

The FMU; the basic mapping unit of FIMS, is an area of forest or other vegetation mapped as a polygon during the mapping process on a scale of 1:100,000. Each FMU is assigned a code describing the vegetation/forest type. There are total of 58 types of forest and other vegetation, of which 35 are forest types. A further four types deal with land use, urban areas, bare areas and lakes. The information is stored in the FIMS as a series of map layers in MapInfo software linked to a Microsoft Access database. Information can be accessed easily through a series of standard reports and maps in most common demand. The latter can be produced as either a single layer or any combination of layers. FIMS information includes; forest resource and vegetation mapping, FMU, disturbances and complexes, species composition and stocking rates, logged-over areas and land use change 1975-96, concession areas, logging constraints, protected areas and topographical maps.

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[4] Bellamy and McAlpine (1995). PNGRIS Publication No.6, 1995. AusAID, Canberra, Australia.

[5] Bryan and Shearman (2008). Papua New Guinea Resource Information System Handbook 3rd Edition, PNGRIS Publication No. 7. University of Papua New Guinea, Port Moresby, Papua New Guinea.

[6] Saunders (1993). Forest Resources of Papua New Guinea. PNGRIS Publication No. 2. CSIRO, Brisbane, Australia

[7] J. McAlpine and J. Quigley (1998). Forest Resources of Papua New Guinea. Summary Statistics From FIMS

[8] E. T. Hammermaster and J. C. Saunders (199). Forest Resources and Vegetation Mapping of Papua New Guinea. PNGRIS Publication No. 4. CSIRO, Brisbane, Australia

1.2 History of Forest Base Map

1.2.1 Status of Remote Sensing Data in FIMS

The aerial photographs used to prepare the FIMS were taken in the 1970s. The spatial resolution was high, but since they were taken in the analogue era, forest distribution and forest classification work were performed at a small scale with a digitizer board. Consequently, discrepancies were identified between the current forest distribution and forest classification, and deviations in the forest position. The map has been used widely and played an important role for PNGFA for a long time but certainly it is getting outdated based on legacy technology, and causing various practical difficulties to PNGFA recently, especially on forest planning and monitoring activities. Responding to this situation, the updating of the map used in FIMS was highly recommended to enable proper forest management planning in PNG.

1.2.2 Forest Base Map 2012(1.0) in JICA/PNGFA Project 2011-2014

JICA and PNGFA started a technical cooperation project "Capacity Development on Forest Resource Monitoring for Addressing Climate Change" (hereafter "the first JICA project") since 2011 to 2014. The first project was implemented with the "Forest Preservation Program" under the Japan Grant Aid that provided the Remote Sensing data (satellite imagery, GIS equipment and software tools) to the first JICA project.

15 years has passed since the FIMS was developed in 1996. Therefore, one of the outputs of the first JICA project was "Nation-wide forest base map is improved by using remote sensing technology". This enabled the FBM 2012 (1.0) to be developed at the end of the project.

The figure below shows existing FIMs GIS boundaries and latest procured satellite imagery.

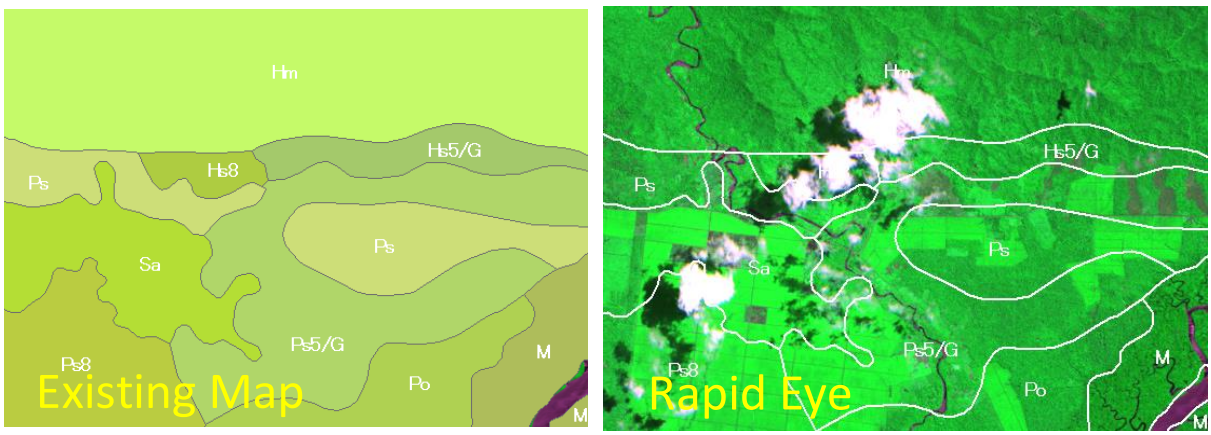


Figure 1: FIMS GIS boundaries overlaid onto latest procured satellite imagery

2. Development and Improvement of the Forest Base Map 2012 (1.1)

2.1 Data Input and Development Process

2.1.1 Defining Classification Items and the Codes

The land cover classification items and the code which were registered in the FIMS were extracted, reorganized and reviewed to take into consideration whether they are identifiable from the satellite imagery or not. A total of 21 classification items and codes were defined for PNGFA to perform their mapping tasks. Detailed classification items by canopy size and tree species of FIMS were omitted due to the limitation of satellite imagery that were planned to be used. The 21 Classification items include, other than forest, grasslands and cropland (agriculture land). In addition to existing FIMS classes, "Forest Plantation" and "Plantation other than Forest Plantation" were newly added to the FBM 2012 (1.0) because plantations are important for forest management and they can be classified by using the plantation boundaries which PNGFA had developed and managed.

Table 3: Classification item and its code of the Forest Base Map 2012

P	Low Altitude Forest on Plains and Fans (below 1000m)	G	Grassland and Herbland
H	Low Altitude Forest on Uplands (below 1000m)	Gi	Grassland (Sub-Alpine)
L	Lower Montane Forest (above 1000m)	Ga	Grassland (Alpine)
Mo	Montane Forest	Z	Bare areas
D	Dry Seasonal Forest	U	Larger Urban Centre
B	Littoral Forest	E	Lake and Larger Rivers
Fri	Seral Forest	O	Agriculture Land
Fsw	Swamp Forest	Qa	Plantation other than Forest Plantation
M	Mangrove Forest	Qf	Forest Plantation
W	Woodland		
Sa	Savanna		
Sc	Scrub		

Note: Light green items were classified as forest as per PNG forest definition.

National forest definition of PNG is "*Land spanning more than 1 hectare, with trees higher than 3 meters and the canopy cover of more than 10 percent (%)*". It was endorsed by the PNG National Executive Council # 256 of Meeting #07/2014.

This definition was developed under the PNGFA initiative toward preparation and implementation of NFI (National Forest Inventory) supported by UN-REDD/FAO. The JICA first project joined in the process and contributed to verify the definition by providing technical inputs as below;

- Minimum Area:
  -- 1 ha is adequately small by comparison with the FIMS vegetation boundary and satellite image spatial resolution (RapidEye: 5m, ALOS/PALSAR: 10m, LANDSAT: 30m)
- Canopy Cover:
  -- 10% is desirable to classify "Savanna" as forest (PNGFA needed to include this vegetation in forest as to properly manage forests in PNG).
  -- As it is challenging to classify "Savanna" and "Scrub" by remote sensing automatically (even with RapidEye), human interpretation is needed with considering the distribution of these vegetation.
- Tree Height:
  -- 3m is appropriate (to include Scrub as Forest) by verifying airborne data and RapidEye satellite imagery in Central Suau, Milne Bay (This value is the same as the definition in FIMS).

2.1.2 Data used for Forest Base Map Development

Satellite observation data used for developing the FBM 2012 (1.0) includes; RapidEye (optical sensor, captured mainly in 2011 and some in 2010) and ALOS-PALSAR (radar sensor, captured in 2010 and 2011). Airborne radar information was acquired from the PNG National Mapping Bureau (NMB) and utilized as data for elevation above sea level.

RapidEye (5 constellation satellites, which have the most frequent observation opportunities among the satellites with the same level of resolution) was utilized as the main base information because of the high resolution (5m) with multi-band (5 bands). ALOS/PALSAR was used as alternative source for cloud cover area. NMB Digital Elevation Model (DEM) was used for segmentation process and decision tree classification.

Table 4: Data used for Forest Base Map Development

Data (Satellite etc.)	Sensor type	Resolution	Years	Remarks
RapidEye	Optical (5 bands)	5 m	2011 (some are 2010)	Main base information
ALOS/PALSAR	Radar (L-band)	10m	2010-2011	For cloud covered area
NMB DEM	Radar (P & X band)	5 m	2006	Slope, and watershed

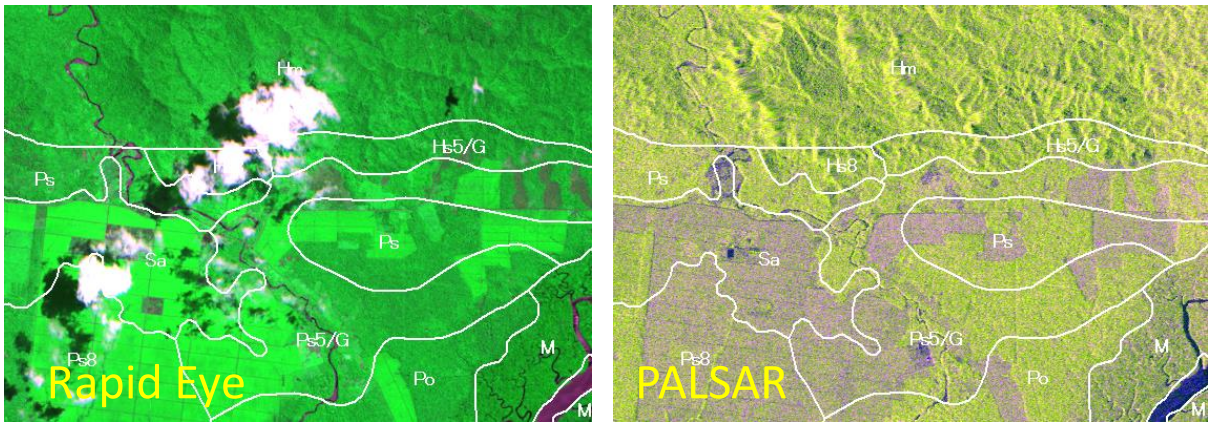


Figure 2: RapidEye (optical sensor) and ALOS/PALSAR (radar sensor)

2.1.3 Examination of Classification Items and Flow

Satellite imagery by optical sensor (RapidEye) and radar senor (ALOS/PALSAR) of the existing vegetation types in PNG were compared and examined; then existing GIS data in the FIMS was overlaid onto the satellite imagery to confirm how the 21 discernible classes/items can be interpreted with respect to discrepancies between elements such as tone/colour, size, shape, pattern, texture, shadow, and association.

Based on the results from comparison and examination of the satellite imagery and classification items, the draft classification flow-chart was prepared and this flow-chart has been kept updated and improved based on the results of consecutive trial and error.

The final classification flow-chart used for the FBM 2012 (1.0) development is shown in Figure 3.

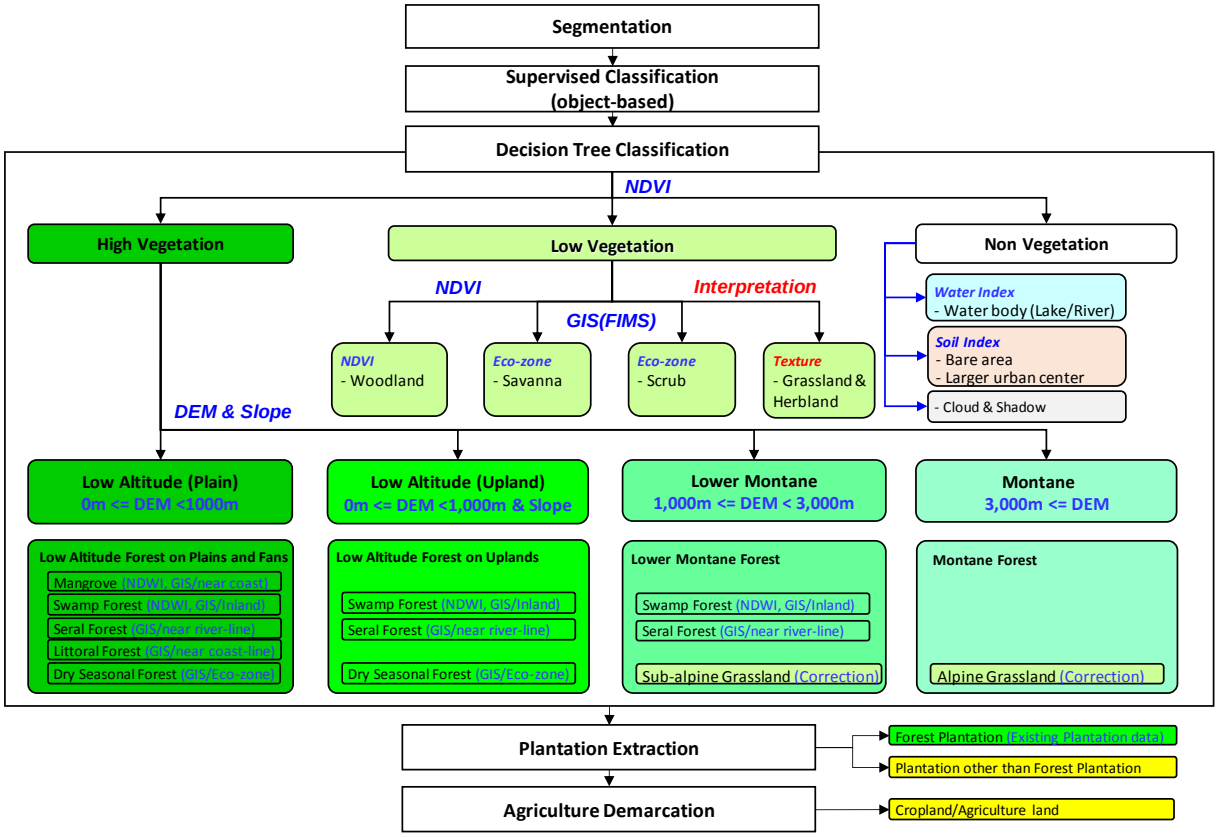
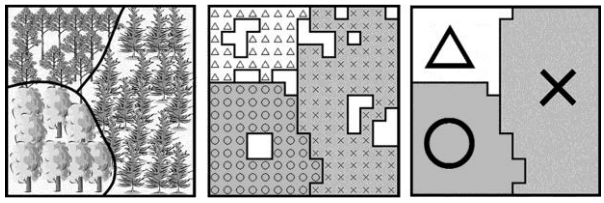


Figure 3: Classification Flow-chart for Forest Base Map Development

2.1.4 Segmentation and Object-based Classification

Segmentation and object-based classification of the land cover, as well as satellite imagery analysis was done using the software 'eCognition'. Another software called 'R' was used for statistical analysis of the segments. For this analysis, we utilized RapidEye satellite imagery (5 bands), Normalized Differential Vegetation Index (NDVI) generated from analysis on RapidEye data, elevation data acquired from NMB (5m mesh), and slope and watershed data (or catchment boundaries) generated from analysis on NMB elevation data.



(a) Forest (b) Pixel based classification (c) Object based classification

Figure 4: Pixel based Classification and Object based Classification

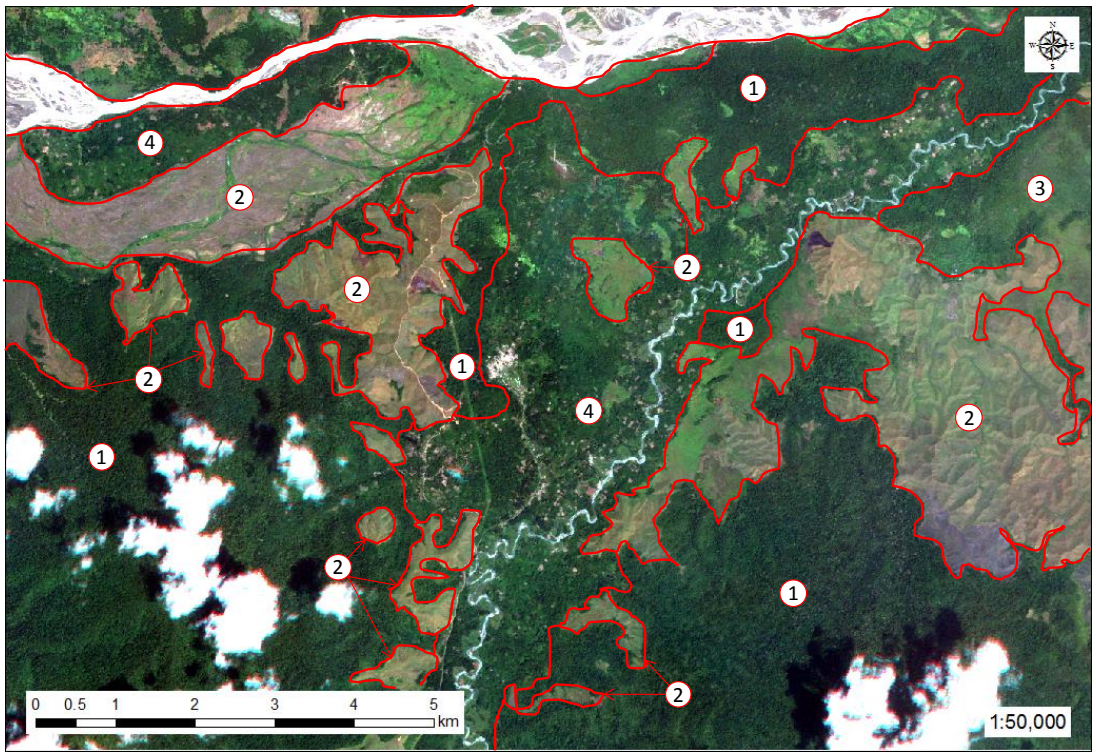
Automated classification of the segments was done for forest and other vegetation by 'eCognition' and 'R' after calculating 'feature parameters' of each segment. This was done by using statistical values including average and standard deviation of various parameters of all pixels in each segment. The classification was done by multi-stage classification, following a forest classification flowchart tailored (Figure 3) for this work by using parameters including Brightness, Green, Near Infra-Red (NIR), NDVI, elevation from DEM and slope etc.

2.1.5 Correction Process by Human Interpretation

Correction by human interpretation was made where we found automated classification difficult, for instance, in classes such as Larger Urban Centres, Bare Areas, Cropland/ Agriculture land, Woodland, Savanna, and Scrub, or if the error in classification made by automated process was obvious. Human interpretation was supported by photographs taken by digital camera on hand-held GPS terminals from a helicopter, verification by ground truth surveys, mobilization of existing knowledge, and literature study.

Interpretation cards were prepared for 21 vegetation types as a common understanding and standardizing method for interpretation to obtain the same results regardless of interpreters. The interpretation cards were overlaid with interpreted polygons describing the vegetation type and interpretation features (e.g. colour, tone, size, shape, texture, etc.), topographic and social background, classification codes based on knowledge of PNGFA, FIMS class, and high resolution images obtained from Google Earth.

True color	Morobe	Wampar	Tile 5536013	Percent Clip Min: 0.5 Max: 4.5



No.	Vegetation type	Color/Texture viewed from the RapidEye tile		Note	Reference	
		True color (RGB 3:2:1)	False color (RGB 3:5:2)		FIMS	Other images
1	Forest	Dark green Rough	Green with black dots Rough		Hm, Po, Fsw	
2	Grassland	Light green to light Very smooth	Reddish purple Very smooth		G, Gf	
3	Swamp Woodland	Brownish green Relatively smooth	Light green Relatively smooth	Sparse tree crown can be seen.	Wsw, Fsw, Po,	
4	Gardening Settlement	Green with small brown patches	Light green with small purple patches	Generally gardening and settlement are occurred along river and road.	Po, Fsw, G	
5	Burned grassland	Dark purple to Very smooth	Purple to black Very smooth			

Figure 5: Sample of Image Interpretation Card for Forest Base Map

2.1.6 Plantation Extraction / Agriculture Demarcation

'Forest Plantation' class was distinguished from 'Plantation other than forest plantation' by referring to plantation boundary data taken from PNGFA. 'Forest Plantation' indicated on the FBM 2012 (1.0) is not necessarily corresponding to the actual distribution of forest plantations, as PNGFA does not have all boundary information of forest plantations, as this data is normally managed by private sectors.

Cropland/Agriculture land, Forest Plantation, and Plantations other than forest plantation are delineated by human interpretation relying on local knowledge of PNGFA officers, including staff of Area and Provincial Offices, RapidEye imagery and geo-referenced photographs. The PNGFA officers used high resolution imagery taken from Google Earth and Bing Map, existing information on cropland (Mapping Agriculture Systems of PNG [MASP] and PNGRIS) and DEM.

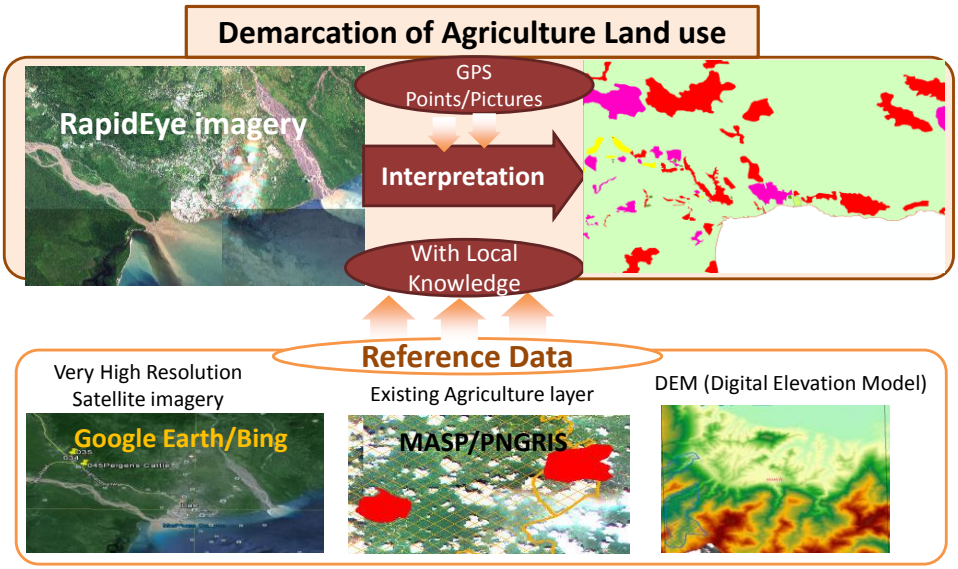


Figure 6: Demarcation of Agriculture Land Use and Reference Data

Subsistence (SUB)–Agricultural Land-use which has the following attributes: Located closer to rural settings (place) where the produce is mainly for consumption and smaller in size. Usually subsistence gardening are scattered, with irregular shapes, pattern and rough textures on a satellite image. Subsistence Land use activities include fallow areas as well.

Commercial (COM) – Agricultural Land use areas that are manage by small holders (Block owners) mostly for monetary benefits (coffee, cocoa, banana..) as identified thru MASP and confirm by local knowledge. Such land uses cover a smaller area and may have smooth/rough texture and irregular patterns in a satellite image.

Mixed (MIX) – Agricultural Land use areas which have both subsistence and commercial activities coexisting. These Land use types are identified thru local knowledge. Mixed Agricultural Land use activities have irregular shapes and pattern and a rough texture on satellite images.

Uncertain (AUN) – Uncertain Agricultural land use has the following attributes: Agricultural Land use areas where the types of agricultural activities are not clearly identifiable.
Agricultural Land use areas which cannot be identified in Google Maps, Bing Maps and RapidEye Images due to heavy cloud cover or poor image resolution. Local knowledge about area of interest is limited thus cannot confirm.

Grazing (GRZ) – Agricultural Land use areas that have extensive grassland which are used for cattle grazing. Grazing areas usually have regular patterns and smooth texture on a satellite image.

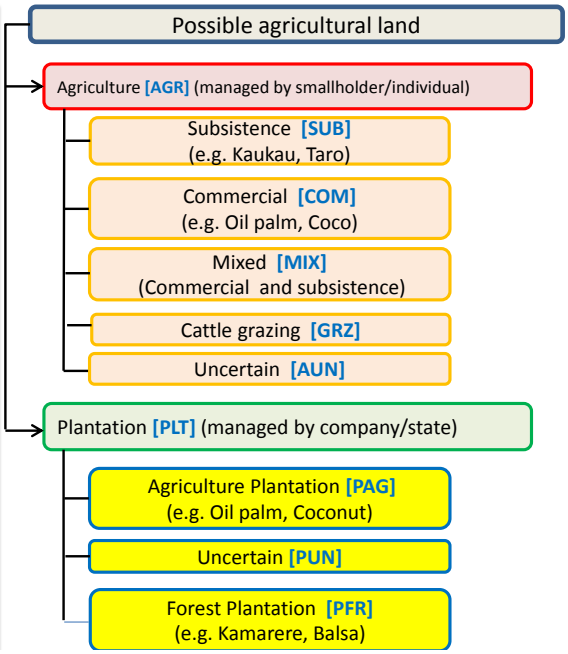


Figure 7: Definition of Agriculture Land Use and Classification Groups/Codes

2.2 Identified Issues and Improvement

After the first project finished in March 2014, JICA and PNGFA started the 2nd Technical Cooperation Project, "Capacity Development for Operationalization of PNG Forest Resource Information Management System (PNG-FRIMS) for Addressing Climate Change" (hereinafter referred to as the second project). The second project commenced in August 2014 and ended in August 2019. It aimed to enhance the capacity of PNGFA in its ability to continuously update forest information, and to fully operationalize and utilize PNG-FRIMS for promoting sustainable forest management and for addressing climate change.

Under the second Project, the FBM 2012 (1.0) was updated to the FBM 2012 (1.1) with small modifications made on polygons of coastlines. The quality and accuracy of the FBM 2012 (1.1) was also assessed by comparing the data taken from the Collect Earth Assessment (supported by UN-REDD/FAO). Issues that rose during the JICA first and second project were analysed for future updating.

2.2.1 Classification among Woodland, Savanna, and Scrub:

The accurate delineation, verification and monitoring of boundaries of Woodland, Savanna, and Scrub cannot be done by relying on interpretation and classification solely from satellite imagery. The Savanna, particularly in PNG, only occurs in the Southern region with specific vegetation that is confined by specific climatic and ecological conditions. Three types of vegetation can be distinguished, and they are Eucalyptus Savanna, Maleulecca Savanna and Mixed Savanna. However, it is challenging to distinguish with RS. The Scrub land in PNG is also specifically defined as low-rise forest vegetation comprised of specific tree species. Taking these conditions into account, these three classes are identified on the FBM 2012 (1.1) by referring to FIMS and localities.

2.2.2 Subdividing codes of land use (missing codes of FIMS)

In the process of developing the FBM 2012 (1.0), based on the FIMS, more precise land cover information was simplified into rough information in the FBM (1.0); this was due to reasons such as limitation in interpretation using satellite imagery. For example, the definition of land cover in FIMS includes not only swamp in forest but also swamp in woodland and in grass land. The FBM does not have these classes.

As the information is useful for PNGFA, to enable them to judge the possibility of forestry operation in its planning stage, some codes in the FIMS which related to swamp distribution was added back. Other detail codes were also revived in terms of usefulness for calculating forest timber volume with more accuracy based on forest type.

2.2.3 Distinction between P (Plain Forest) and H (Hill Forest)

The distinction between 'P' and 'H' type forest are made according to incline (or slope) in the FBM 2012 (1.1). As plains are dominant and topography is relatively gentle in Western Province, it was recognized that the distribution of 'P' and 'H' are significantly different between the FBM 2012 (1.0) and FIMS. This difference occurred mainly because the FIMS development process took into account the composition of tree species as well.

After consultations within the JICA Project Team (comprised of PNGFA officers and JICA experts), it was decided to keep the methodology for the FBM 2012 (1.1), as slope is important and useful

information for forest management operations. The slope is often a main determinant of efficiency and practicability of the logging operations as it determines manoeuvrability of heavy machineries in the field.

2.2.4 Examining RS methodology to detect wetland-forest

In addition to the wetland distribution issue due to simplification of original land cover codes, the deviation of distribution of swamp forests between the FIMS and current actual distribution was apparent. Therefore, for future updating of the FBM 2012 (1.1), the methodology to detect wetland-forest was examined in the Second project.

For the examination, GeoSAR data with its P-band microwave and a false colour composite of LANDSAT-8 were used to detect peatland located around April Salumei in East Sepik province. The P-band of GeoSAR was expected to observe forest floor by penetrating the tree crown. However, it could not detect peat land which was likely considered to exist in the targeted area.

On the other hand, a false colour composite of LANDSAT-8 (R: Band 6, G: Band5, B: Band 4) looks capable for helping estimate peat distribution. Note that NDWI (Normalized difference water index) calculated from LANDSAT-8 imagery could not show significant difference between inside and outside of peatland.

This suggests that digitizing work or objected-based segmentation using LANDSAT-8 imagery is an option to detect wetland forest using remote sensing data. However, ground survey is necessary to ensure accuracy of information derived from RS method in general. Therefore, it is necessary to conduct ground survey to establish this method.

2.2.5 Improving forest plantation data (collecting the data)

There were gaps identified of forest plantation area between the value calculated on the FBM 2012 (1.1) and the value from the Plantation branch of PNGFA. This was caused by the difficulty in distinguishing between forest plantation and agricultural plantation, such as oil palm plantation with satellite imagery, and limitation of local knowledge of field staff. Upon discovering this, it was found necessary to update plantation data held by PNGFA. Forestry plantations in PNG are managed by communities, private companies and PNGFA. Companies should manage their plantation(s) with GIS software; however, most of the state-owned plantations and community plantations do not use GIS software.

Based on the situation, it was decided that PNGFA request private companies to share their GIS data on their plantation(s), and conduct ground surveys on state-own plantation and community plantations to acquire data of actual plantations. The acquired data would then be inputted into one of the thematic layers within PNG-FRIMS. As a result, more accurate maps could be prepared by overlying FBM 2012 (1.1) and the thematic layers.

2.3 Quality and Accuracy Assessment

The quality and accuracy of the FBM 2012 (1.1) was assessed using an error matrix. This assessment ideally should be done with ground truth data as a reference data which is collected by appropriate sampling design. However, the national level comprehensive ground truth data whose sample size is statistically sufficient is not available in PNG yet. Therefore, the assessment was implemented by comparing the land use classes in the FBM with the land use classes of Collect Earth assessment 2013 (which was supported by UN-REDD/FAO), as the reference data. The correspondence of land use classes in the FBM and Collect Earth Assessment are shown in the table below.

Table 5: Correspondence of land use classes in Forest Base Map and Collect Earth Assessment

IPCC Category	Forest Base Map			Collect Earth Assessment
	No	Code	Class	Land use class
Forest	1	P	Low Altitude Forest on Plains and Fans	low_altitude_forest_on_plains and
	2	H	Low Altitude Forest on Upland	low_altitude_forest_on_upland
	3	L	Lower Montane Forest	lower_montane_forest
	4	Mo	Montane Forest	montane_forest
	4	Mo	Montane Forest	montane_coniferous_forest
	5	D	Dry Seasonal Forest	dry_seasonal_forest
	6	B	Littoral Forest	littoral_forest
	7	Fri	Seral Forest	seral_forest
	8	Fsw	Swamp Forest	swamp_forest
	15	M	Mangrove	mangrove
	20	Qf	Forest Plantation	acacia_plantation
				balsa_plantation
				eucalyptus_plantation
				hoop_plantation
				klinki_plantation
				pine_plantation
				rubber_plantation
				teak_plantation
				terminalia_plantation
				undetermined_plantation
Woodland	9	W	Woodland	woodland
Savanna	10	Sa	Savanna	savanna
Scrub	11	Sc	Scrub	scrub
Grassland	12	G	Grassland and Herbland	herbland
				meadows
	13	Ga	Alpine grassland	alpine_grassland
	14	Gi	Subalpine grassland	-

IPCC Category	Forest Base Map			Collect Earth Assessment
	No	Code	Class	Land use class
Cropland	16	O	Agricultural Land Use	irrigated_perennial_crops
				non_irrigated_perennial_crops
				other_crop
				subsistence_agriculture
				subsistence_agriculture_not_sure
				subsistence_agriculture_permanen
				subsistence_agriculture_shifting
	21	Qa	Plantation other than forest plantation	palm_oil
				cocoa
				coconut
				coffee
				tea
Wetlands	-	-	-	freshwater_swamp
				lowland_freshwater_swamp
				montane_swamp
				saline_brackish_swamp
	17	E	Lakes and larger rivers	lake
				river
Other land	18	Z	Bare areas	barrein_soil
				land_slides
				rock
				sand_soil
Settlements	19	U	Larger urban centres	large_settlement
				infrastructure
				village
-	22	Es	Sea	sea
	-	-	-	clouds
	-	-	-	other_reason

2.3.1 The results of the assessment

Table 6: The result of the Quality and Accuracy Assessment of Forest Base Map

				Collect Earth Assessment																					
				Forest										Woo	Savanna/Sc		Grassland		Cropland		Wetlands	Other land	Settlements	Total	U.A.
				P	H	L	Mo	D	B	Fri	Fsw	M	Qf	W	Sa	Sc	G	Ga/G	O	Qa	E	Z	U		
Forest Base Map	Forest	P	Low Altitude Forest on Plai	2446	1138	4		40	21	70	309	31	16	65	9	18	41		184	26	80		31	4529	54%
		H	Low Altitude Forest on Upl	1122	4820	109			9	47	18		4	17	6	17	41		225	21	23	4	22	6505	74%
		L	Lower Montane Forest		58	4208	74						2			16	56	18	165	7	6	1	13	4624	91%
		Mo	Montane Forest			19	186									6	2	26						239	78%
		D	Dry Seasonal Forest	121	8			207	1	5	47			65	3	3	13				7			480	43%
		B	Littoral Forest	8					6		3	1		7			1			1				27	22%
		Fri	Seral Forest	17	18	11			1	4	11	1		5			3		2	3	6			82	5%
		Fsw	Swamp Forest	297	38			48	6	22	314	11		90	15	11	33		13	1	116		6	1021	31%
		M	Mangrove	17				2	11	2	34	104		5	2		1		3	2	62		2	247	42%
		Qf	Forest Plantation	3	3	1			1				7	1		2	1	1	11	2				33	21%
	Woodland	W	Woodland	267	33	1		326	5	16	247	7		307	115	40	51		36	5	104		2	1562	20%
	Savanna /Scrub	Sa	Savanna	5	1	1		34			8	3		77	132	8	27		11		9	1	6	323	41%
		Sc	Scrub	2	1	1	1	33			3			58	85	11	8		1		2			206	5%
	Grassland	G	Grassland and Herbland	83	44	45		53	3	7	72	4	1	98	24	36	689	20	162	15	303	7	19	1685	41%
		Ga/G	Alpine grassland/Subalpine			7	12									2	23	70	2				1	117	60%
	Cropland	O	Agricultural Land Use	225	299	363	4	7	12	16	45	6	7	21	9	24	233	30	1211	132	47	2	165	2858	42%
		Qa	Plantation other than forest	13	6				1		1		2			2	10		66	132			9	242	55%
	Wetlands	E	Lakes and larger rivers	13	18	3		2		4	6	3		1	2	1	19		2		209		2	285	73%
	Other land	Z	Bare areas	2	1	1										1	4				3	2	1	15	13%
	Settlements	U	Larger urban centres														1		1				14	16	88%
			Total	4641	6486	4774	277	752	77	193	1118	171	39	817	402	198	1257	165	2095	347	977	17	293	25096	
			P.A.	53%	74%	88%	67%	28%	8%	2%	28%	61%	18%	38%	33%	6%	55%	42%	58%	38%	21%	12%	5%		

O.A.	60%

U.A. (User Accuracy) is used for accuracy assessment for land classification. It shows how much percentage of land classification is correctly done (matching classification result and reference class).
P.A. (Producer Accuracy) is used for assessment of classification by showing how much percentage of the reference classes are matching classification results.
O.A. (Overall Accuracy) of classification of forest and non-forest and of six land class as per Intergovernmental Panel on Climate Change (IPCC) are 87 % and 83 % respectively. These values show high accuracy. On the other hand, O.A. of the most detailed land classes is 60 % (refer to the Table 6).

2.3.2 Main findings from the assessment

i) **Wetlands**: U.A. of Wetland is high, 73 %; however, P.A. is low, 21 %. This means much of the Wetlands categorized in the FBM 2012 (1.1) are also categorized as Wetland in the Collect Earth Assessment 2013, but many Wetlands picked out of the Collect Earth Assessment cannot be categorized in the FBM.

ii) **Settlement**: U.A. of Settlement is high, 88 %, however, P.A. is significantly low, only 5 %. This is caused by the difference in the classification approach used between the FBM 2012 (1.1) and the Collect Earth Assessment 2013. In fact, the Collect Earth Assessment picked out small scale settlements, such as villages, while the FBM did not pick out the same small-scale settlements.

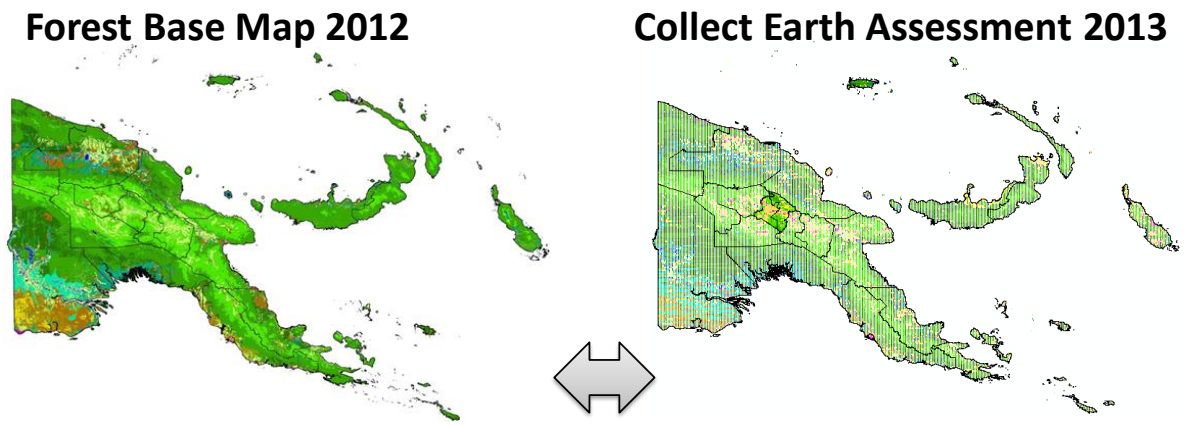
iii) **Seral Forest** (Fri): Both U.A. and P.A. are very low. It is assumed that the results were caused by the difficulty of interpreting Fri from remotely sensed images; especially for the systematic point sampling method used in the Collect Earth assessment. This is because Fri is usually located along rivers, and its shape is long and thin.

vi) **Woodland** (W): Most of the Woodland in the FBM 2012 (1.1) is classified as Dry Seasonal Forest (D) in the Collect Earth Assessment. It is assumed that separating W and D would be challenging.

2.3.3 Points to be noted in comparison

Overall accuracy (matching) of forest and non-forest and IPCC 6 land use classes between the FBM 2012 (1.1) and Collect Earth Assessment 2013, are good, but for detailed classes only; as only a few mismatches were observed by comparing the classification between the FBM and the Collect Earth Assessment. However, since the data of Collect Earth was used as the reference data, and not data taken from a ground truth survey, the result does not mean that the accuracy of the FBM is entirely correct. These mismatches are mainly caused by the difference in data capture methods used between the FBM and the Collect Earth. Points to be noted in comparing the result of assessment are below;

i) **Difference of the methods** (recognition of land use classes in Collect Earth Assessment 2013 and the FBM 2012 (1.1))**:** The method used in classification of the FBM recognizes land covers as collective groups of polygons which have similar features. Collect Earth recognizes land uses by 25 check points in 1 hectare of land area which is a grid point of about 4km mesh in most cases except for Provinces with less land mass, a grid point of 2km mesh is used.



	Basemap	Point Sampling
Spatial Coverage	**Wall-to-Wall by Polygons** Segmentation: minimum mapping unit 1ha (100x100m)	**Systematic sampling point** Points every 4x4km (2x 2km for 2 provinces) 1ha unit with 25 check points
Satellite	RapidEye (ALOS/PALSAR)	LANDSAT, Digital Globe, RapidEye, SPOT, etc.
Land cover class	21 classes based on PNGRIS including agricultural land and plantations (referring to IPCC category)	6 IPCC categories (Forest, Grassland, Cropland, Wetland, Settlement, Other), with 54 detailed subdivision (including disturbance)

Figure 8: Comparing features of the Forest Base Map and Collect Earth

ii) **Measure the area directly**; the FBM can show the extent of vegetation/land covers by wall to wall mapping and the area of vegetation/land covers can be calculated by polygon basis against Collect Earth Assessment. It enables PNGFA staff to conduct various analysis by comparing the FBM and other maps used in planning, implementing and the monitoring stage of forest management.

iii) **High cost of satellite imagery;** procurement of high-resolution satellite imagery was very costly and was a disadvantage of the FBM.

iv) **Necessity of High GIS skills;** More GIS skills were needed to interpret the satellite imageries in the Forest Base Map compared to Collect Earth as the analysis by Collect Earth can be done with open source software and satellite imagery provided for free through the internet. High skill GIS staff is not needed for analysis and therefore the Collect Earth is suited for analysis which needs to be updated annually.

By the difference in methods of the FBM 2012 (1.1) and Collect Earth 2013, each method has different features. Both methods should be properly understood and used based on its features.

2.4 Appropriate Scale of Map Utilization

The ground resolution of the RapidEye imageries used for the development of the FBM 2012 (1.1) is five (5) meters (re-sampled from original six-point five (6.5) meters) meanwhile, PALSAR imagery uses a ten (10) meter resolution for interpolating data over cloud cover area. The mapping scale is between 1:25,000 and 1:50,000 for the data development while minimum mapping polygon size is 1 hectare. Therefore, this map should be used at a scale between 1:25,000 and 1:50,000, taking note of the constraint of location accuracy described in the sub-section 2.5 below.

2.5 Limitations of Geographical Accuracy and Coverage

Geographical Accuracy: The location accuracy of the FBM 2012 (1.1) is equal to that of the ortho-rectified dataset of LANDSAT (Land Satellite) developed by United States Geological Survey (USGS); this being because the specification was designed in accordance with LANDSAT taking into account the conditions of reference data available for PNG and future updating of the data. According to the limitation of the resolution of LANDSAT, location error of plus or minus thirty (30) meters may have been included. Due to this limitation, it should be noted that the ground-based positioning by GPS has higher location accuracy than that of this map.

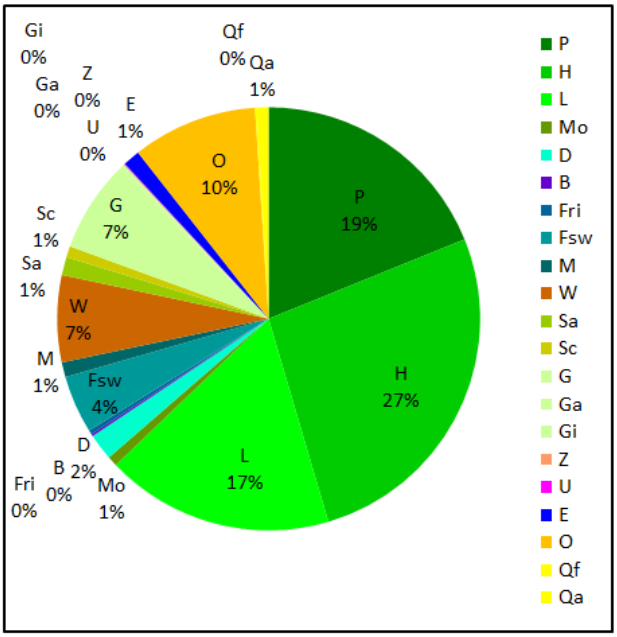
Geographical Coverage: This map is developed for utilizing on purpose of forest management by the PNGFA. Therefore, the map does not exhaustively cover some small islands and other areas where forest management operation by PNGFA are not currently conducted.

Delineation of Cropland/Agriculture land: Since conditions of crop land varies depending on applied practice and cropping cycle, local knowledge and supplementary information is prerequisite for the interpretation and classification at a localized level. According to that nature, the map does not exhaustively cover all cropland and agriculture land.

3. Contents of the Forest Base Map 2012 (1.1)

3.1 Forest Base Map 2012 (1.1) at National Level

	VEG	VEGNAME	Area (ha)
	P	Low Altitude Forest on Plains & Fans	8,707,393
	H	Low Altitude Forest on Uplands	12,264,035
	L	Lower Montane Forest	8,042,001
	Mo	Montane Forest	355,513
	D	Dry Seasonal Forest	935,368
	B	Littoral Forest	70,358
	Fri	Seral Forest	158,719
	Fsw	Swamp Forest	2,035,431
	M	Mangrove Forest	521,933
	W	Woodland	3,062,749
	Sa	Savanna	639,969
	Sc	Scrub	392,078
	G	Grassland and Herbland	3,231,935
	Ga	Grassland (Alpine)	110,602
	Gi	Grassland (Subalpine)	86,979
	Z	Bare areas	23,874
	U	Larger Urban Centres	23,896
	E	Lake & Larger Rivers	600,105
	O	Cropland/Agriculture land	4,413,543
	Qf	Forest Plantation	66,670
	Qa	Plantation other than Qf	411,614
		SUM	46,154,764



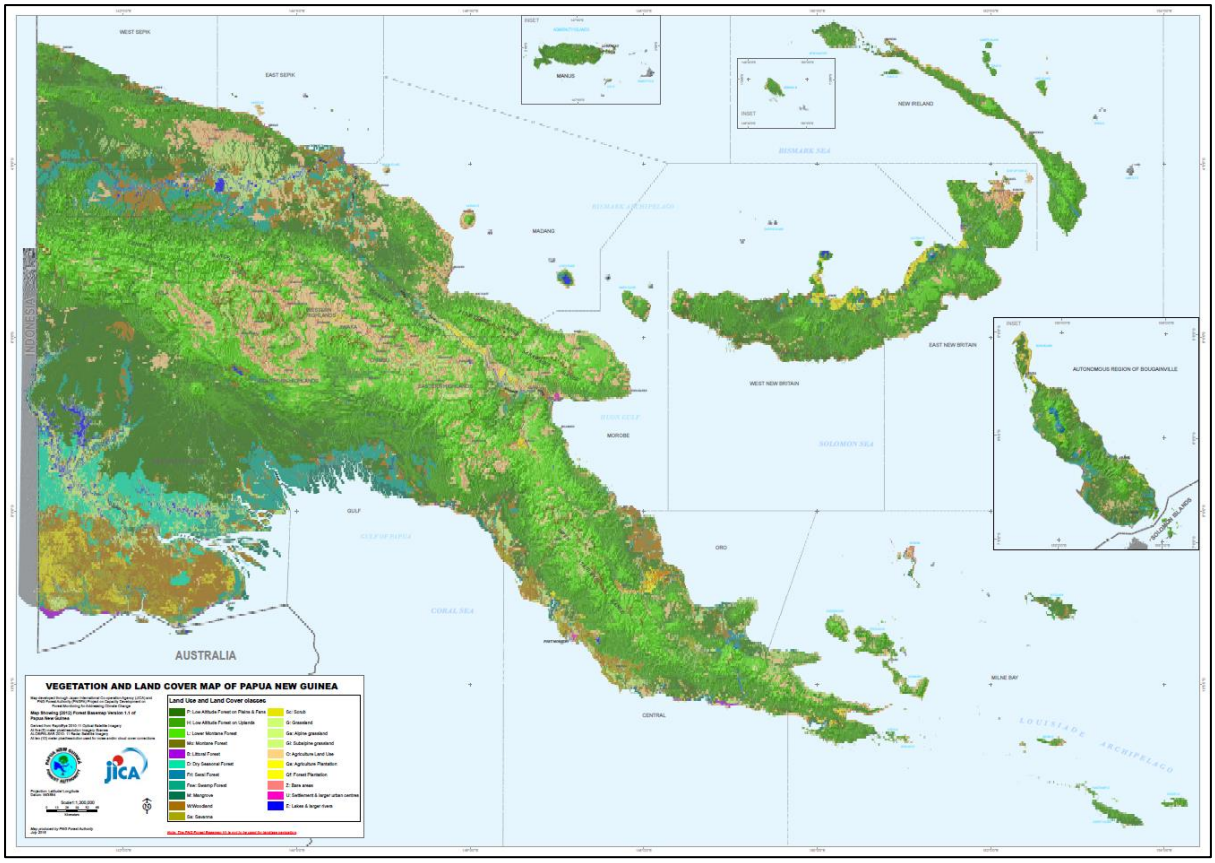


Figure 9: Sample of the Forest Base Map (Not to Scale)

4. Forest Concession and Land Management Layers in PNG-FRIMS

4.1 Timber Concession Areas

Timber concessions refer to the permits or licences to perform logging operations in an area which PNGFA has acquired and/or allocated. Currently there are three concession types; Timber Rights Purchase (TRP), Local Forest Area (LFA) and Forest Management Agreement (FMA). LFA's and TRP's are no longer being issued under the Forestry Act, 1991 (as amended), however they are still in use as they were saved under the Forestry Act, 1991 (as amended). FMA's are the only type of concession allowed under the Forestry Act, 1991 (as amended).

4.2 Constraints to Commercial Timber Production

The Constraints to Commercial Timber Production encompasses a range of aspects of an area that limits the logging activity in that area. There are socio-economic factors, regarding licensing processes, government regulation or demographics that do affect logging operations and timber production, however, the constraints that are presented in this publication are only focused on the topographical and environmental aspects. These aspects are classified below:

Table 7: The Logging Constraints

Constraint	Description
Extreme Altitude:	land over 2400m altitude
Extreme Slope:	land with over 30-degree dominant slope
Serious Slope:	land with dominant slope of 20-30 degrees and sub-dominant slope over 30 degrees and with high to very high relief
Extreme Karst:	land with polygonal karst landform
Extreme Inundation:	land permanently or near permanently inundated extending over more 80% of the area of that land
Serious Inundation:	50-80% permanent or near permanent inundation
Mangrove:	land covered by mangroves

4.3 Terrestrial Protected Areas

Terrestrial protected areas are totally or partially protected areas that are designated by national authorities as scientific reserves with limited public access, national parks, natural monuments, nature reserves or wildlife sanctuaries, protected landscapes, conservation areas, and areas managed mainly for sustainable use.

In Papua New Guinea, there are nine (9) types of protected areas.

1. Conservation Areas
2. Protected Areas
3. Memorial Parks
4. Wildlife Management Areas
5. National Parks
6. Protected Parks
7. Reserve Areas
8. Wildlife Sanctuaries
9. National Reserve

Currently, there are a total of sixty-one (61) protected areas throughout the country.[9]

[9] Terrestrial protected areas data was obtained from the Conservation and Environment Protection Authority (CEPA).

5. Map Atlas and Provincial Profiles

This section contains the map atlases of the Forest Base Map (2012) and the Forest Concession and Land Management layers in PNG-FRIMS at the National Level and the Provincial Level (Provincial Profiles and Provincial Trees).

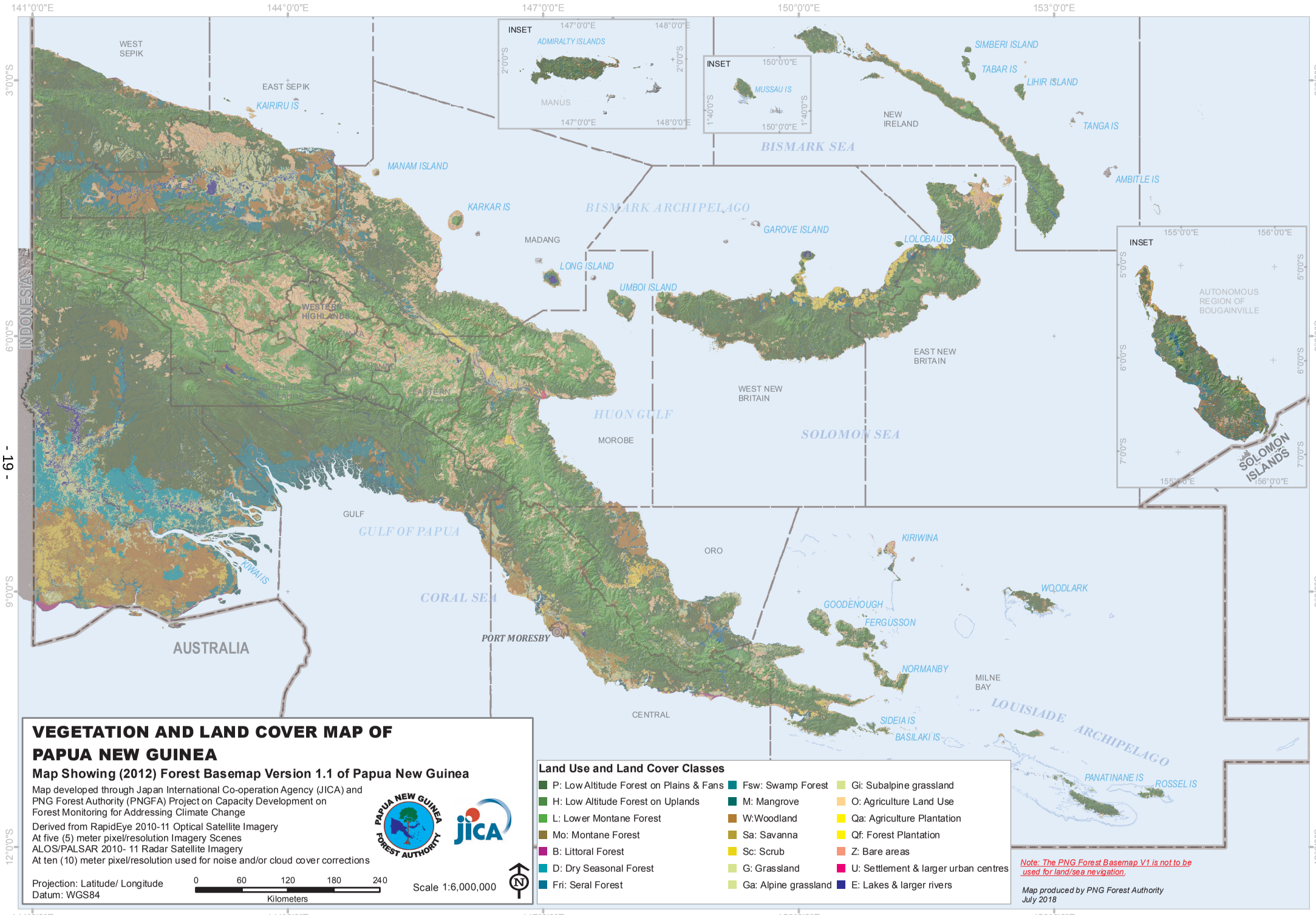
The Provincial Trees were not part of the JICA/PNGFA Project but were part of the International Year of Forests activities that took place in 2011 and have been included to give some added value to the Provinces and its forest base.

National Level Maps:

1. Vegetation and Land Cover Map of Papua New Guinea (FBM 2012)
2. Timber Concession Areas in Papua New Guinea
3. Constraints to Commercial Timber Production in Papua New Guinea
4. Terrestrial Protected Areas in Papua New Guinea

Provincial Profiles:

1. Western Province
2. Gulf Province
3. Central Province
4. Milne Bay Province
5. Northern (Oro) Province
6. Southern Highlands Province
7. Eastern Highlands Province
8. Chimbu (Simbu) Province
9. Western Highlands Province
10. West Sepik (Saundaun) Province
11. East Sepik Province
12. Madang Province
13. Morobe Province
14. West New Britain Province
15. East New Britain Province
16. New Ireland Province
17. Autonomous Region of Bougainville
18. Manus Province
19. Enga Province
20. National Capital District
21. Jiwaka Province
22. Hela Province



VEGETATION AND LAND COVER MAP OF PAPUA NEW GUINEA

Map Showing (2012) Forest Basemap Version 1.1 of Papua New Guinea

Map developed through Japan International Co-operation Agency (JICA) and PNG Forest Authority (PNGFA) Project on Capacity Development on Forest Monitoring for Addressing Climate Change

Derived from RapidEye 2010-11 Optical Satellite Imagery
At five (5) meter pixel/resolution Imagery Scenes
ALOS/PALSAR 2010- 11 Radar Satellite Imagery
At ten (10) meter pixel/resolution used for noise and/or cloud cover corrections

Projection: Latitude/ Longitude
Datum: WGS84

0 60 120 180 240
Kilometers

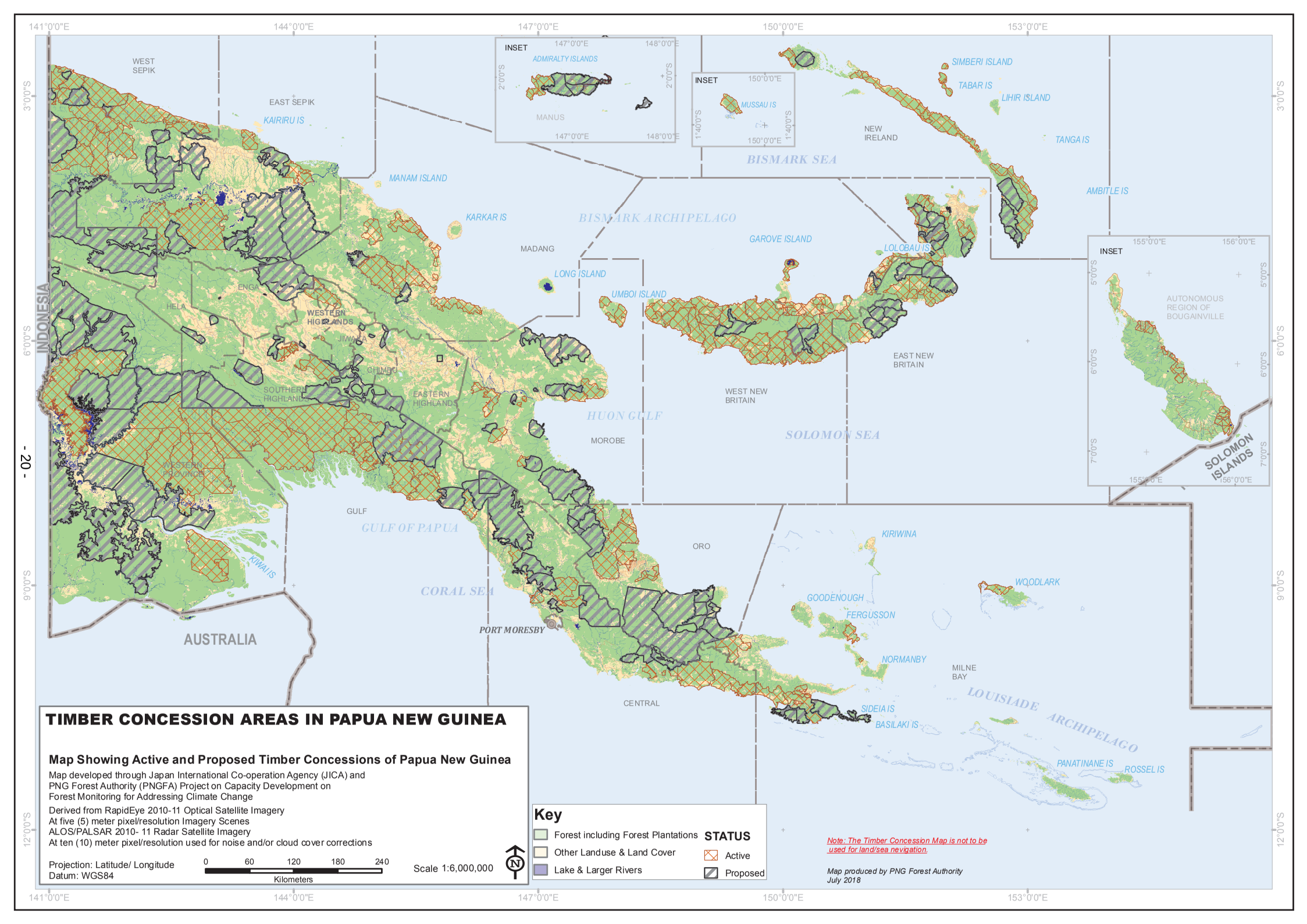
Scale 1:6,000,000

Land Use and Land Cover Classes

- P: Low Altitude Forest on Plains & Fans
- H: Low Altitude Forest on Uplands
- L: Lower Montane Forest
- Mo: Montane Forest
- B: Littoral Forest
- D: Dry Seasonal Forest
- Fri: Seral Forest
- Fsw: Swamp Forest
- M: Mangrove
- W:Woodland
- Sa: Savanna
- Sc: Scrub
- G: Grassland
- Ga: Alpine grassland
- Gi: Subalpine grassland
- O: Agriculture Land Use
- Qa: Agriculture Plantation
- Qf: Forest Plantation
- Z: Bare areas
- U: Settlement & larger urban centres
- E: Lakes & larger rivers

Note: The PNG Forest Basemap V1 is not to be used for land/sea nevigation.

Map produced by PNG Forest Authority
July 2018



TIMBER CONCESSION AREAS IN PAPUA NEW GUINEA

Map Showing Active and Proposed Timber Concessions of Papua New Guinea

Map developed through Japan International Co-operation Agency (JICA) and
PNG Forest Authority (PNGFA) Project on Capacity Development on
Forest Monitoring for Addressing Climate Change

Derived from RapidEye 2010-11 Optical Satellite Imagery
At five (5) meter pixel/resolution Imagery Scenes
ALOS/PALSAR 2010- 11 Radar Satellite Imagery
At ten (10) meter pixel/resolution used for noise and/or cloud cover corrections

Projection: Latitude/ Longitude
Datum: WGS84

0 60 120 180 240
Kilometers

Scale 1:6,000,000

Key

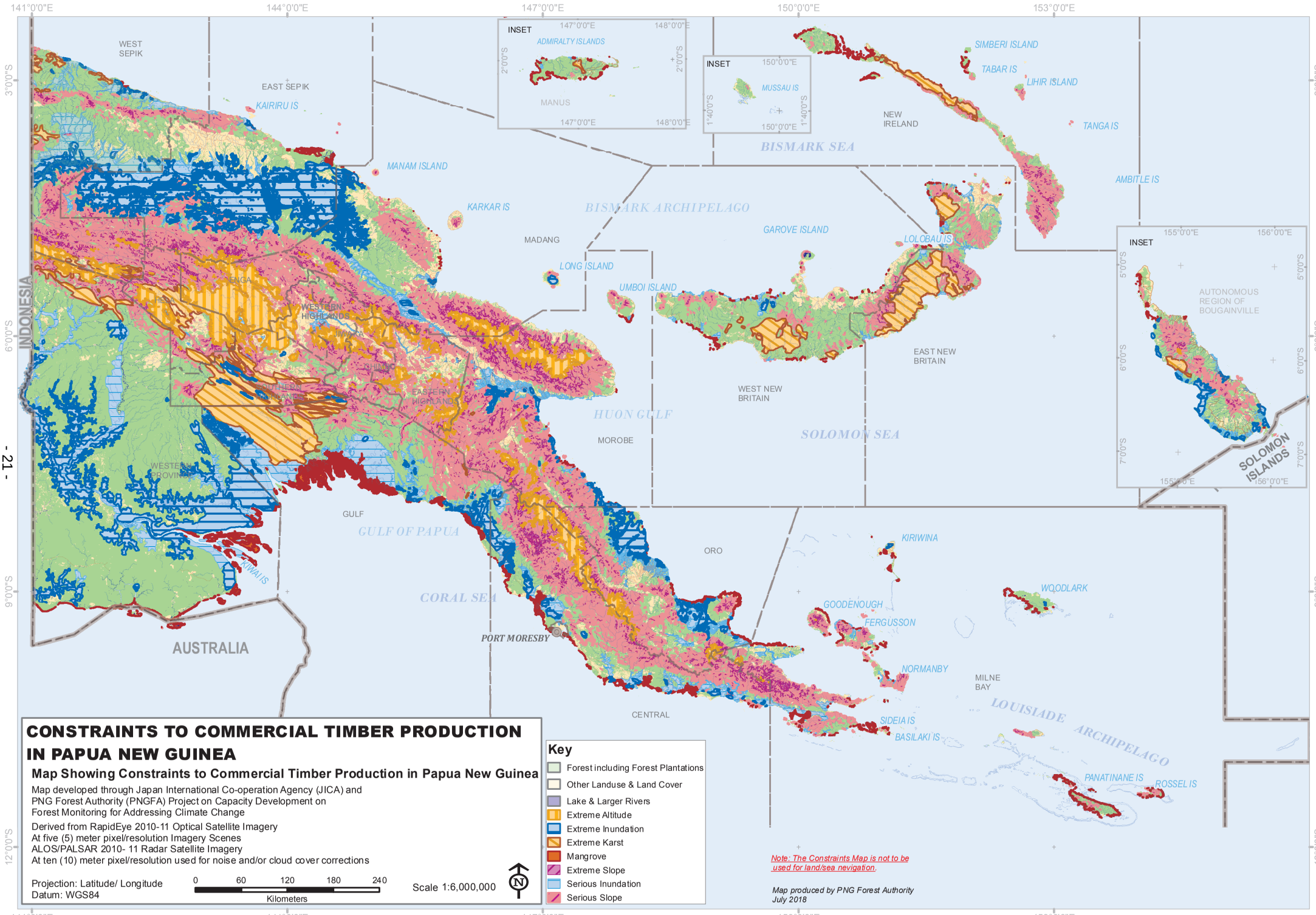
- Forest including Forest Plantations
- Other Landuse & Land Cover
- Lake & Larger Rivers

STATUS

- Active
- Proposed

Note: The Timber Concession Map is not to be used for land/sea nevigation.

Map produced by PNG Forest Authority
July 2018



CONSTRAINTS TO COMMERCIAL TIMBER PRODUCTION IN PAPUA NEW GUINEA

Map Showing Constraints to Commercial Timber Production in Papua New Guinea

Map developed through Japan International Co-operation Agency (JICA) and
PNG Forest Authority (PNGFA) Project on Capacity Development on
Forest Monitoring for Addressing Climate Change

Derived from RapidEye 2010-11 Optical Satellite Imagery
At five (5) meter pixel/resolution Imagery Scenes
ALOS/PALSAR 2010- 11 Radar Satellite Imagery
At ten (10) meter pixel/resolution used for noise and/or cloud cover corrections

Projection: Latitude/ Longitude
Datum: WGS84

0 60 120 180 240
Kilometers

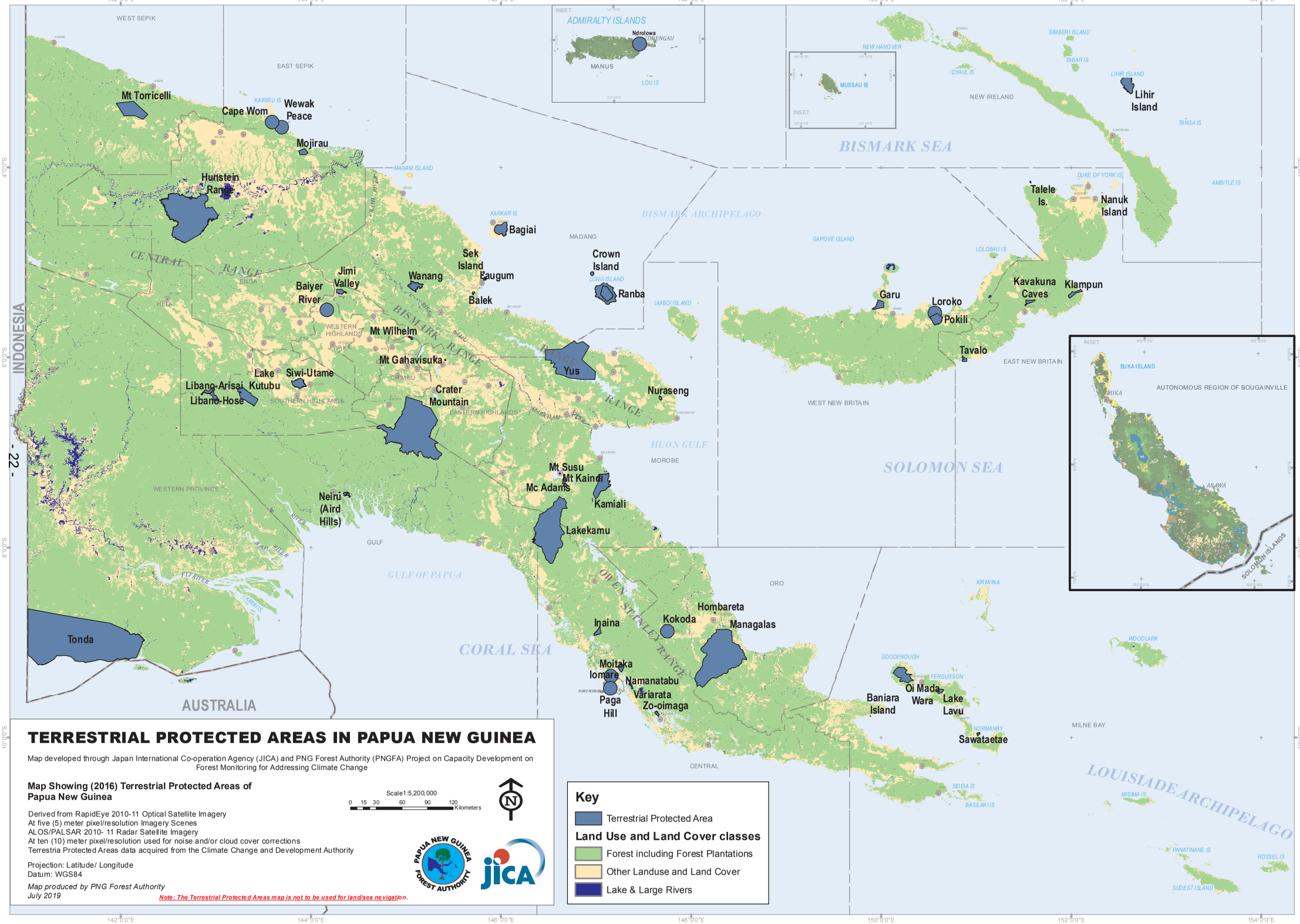
Scale 1:6,000,000

Key

- Forest including Forest Plantations
- Other Landuse & Land Cover
- Lake & Larger Rivers
- Extreme Altitude
- Extreme Inundation
- Extreme Karst
- Mangrove
- Extreme Slope
- Serious Inundation
- Serious Slope

Note: The Constraints Map is not to be used for land/sea nevigation.

Map produced by PNG Forest Authority
July 2018



TERRESTRIAL PROTECTED AREAS IN PAPUA NEW GUINEA

Map developed through Japan International Co-operation Agency (JICA) and PNG Forest Authority (PNGFA) Project on Capacity Development on Forest Monitoring for Addressing Climate Change

Map Showing (2016) Terrestrial Protected Areas of Papua New Guinea

Scale1:5,200,000

0 15 30 60 90 120 Kilometers

Derived from RapidEye 2010-11 Optical Satellite Imagery
At five (5) meter pixel/resolution Imagery Scenes
ALOS/PALSAR 2010- 11 Radar Satellite Imagery
At ten (10) meter pixel/resolution used for noise and/or cloud cover corrections
Terrestria Protected Areas data acquired from the Climate Change and Development Authority

Projection: Latitude/ Longitude
Datum: WGS84

Map produced by PNG Forest Authority
July 2019

Note: The Terrestrial Protected Areas map is not to be used for land/sea nevigation.

Key

- Terrestrial Protected Area

Land Use and Land Cover classes

- Forest including Forest Plantations
- Other Landuse and Land Cover
- Lake & Large Rivers

1. Western Province

General information/Overview

1. Location

Western Province is located in the southwest of mainland of PNG and it's the largest province in terms of land mass. It shares its borders with Indonesia (western) and Australia (south) and the province has some of the unique flora, fauna, landforms and estuarine that is restricted to this part of the province.

Provincial Administration Centre:	Daru
Land area:	9, 797, 778 ha
Population:	201, 351 (2011)
Number of District:	3 (North Fly, Middle Fly, South Fly)
Number of Local Level Governments (LLGs):	14 LLGs

2. Forest Information

Forest Area:	8, 345, 275 ha

Provincial Tree

The provincial tree is Vatica (scientifically known as *Vatica papuana) and is* commonly found in Low Altitude Forest on Plains and Fans, and Low Altitude Forest on Uplands.

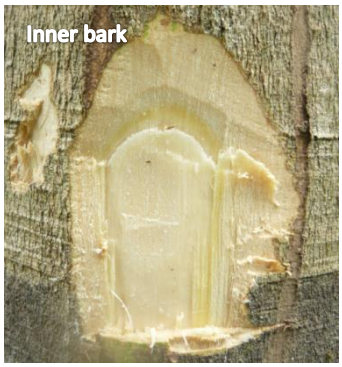
Significance of Provincial tree:

It is a hard wood species and is one of the species exported in round log form. Traditionally, Vatica is an important tree species to Western because of its long association with the people before the introduction of torch and lamps. The bark produces/releases the sap which becomes solid when exposed to air which the locals collect and attach it to a piece of stick or wood and light it up. It burns continuously like a candle and gives light to the people in their homes/ houses. This can be used as a torch even today in the absence of torch or lamp at night. In the absence of the solid sap, dry wood splinters are normally used as torch to give light.

Scientific name:	Family:	Common Name/Trade name:
Vatica papuana/V. rassak	***Diptercarpaceae***	***Vatica***

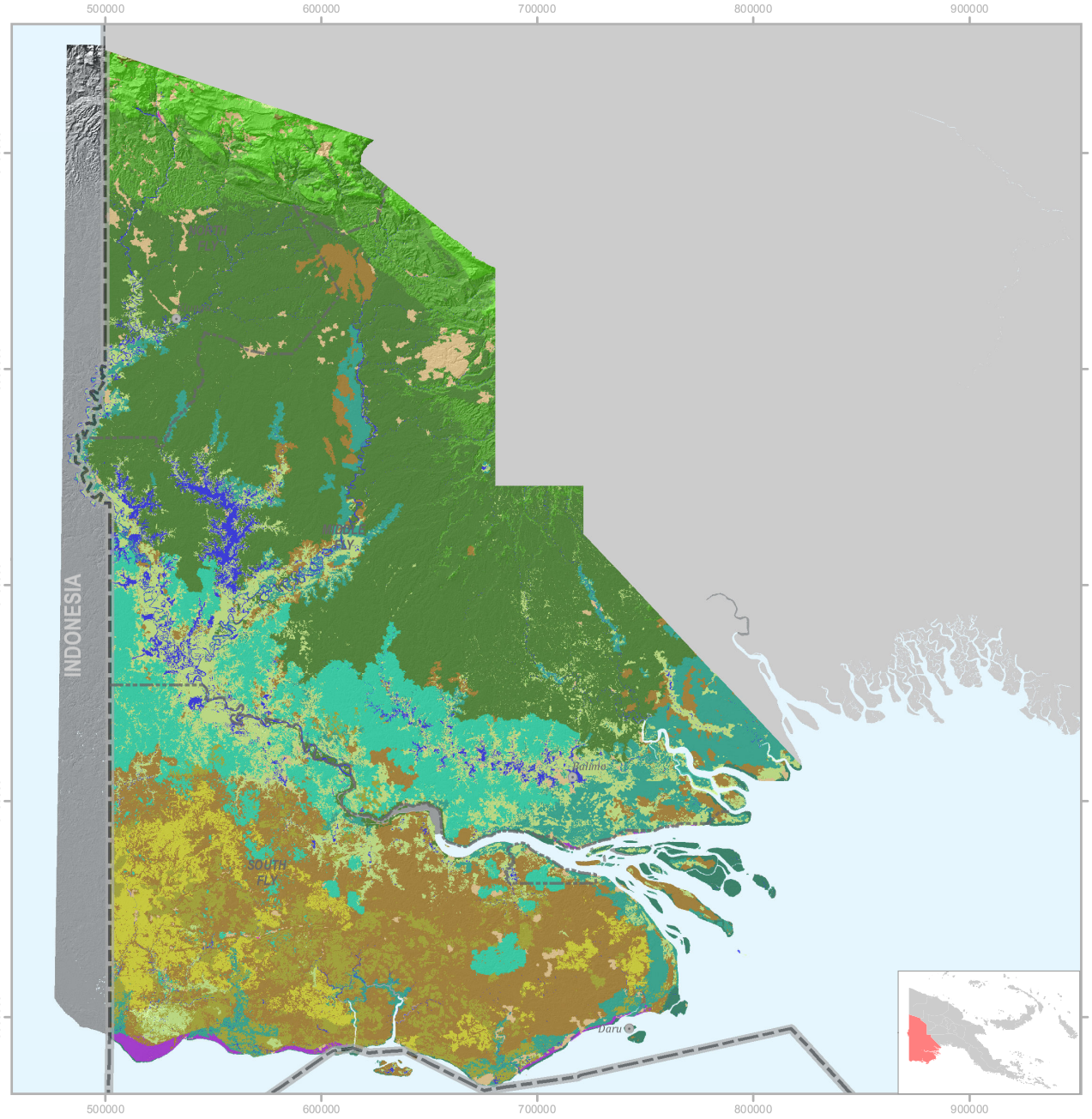
Description

Vatica a large canopy tree with crooked or straight cylindrical bole less buttressed. Outer bark is grey - black, rough, scaly or flaky and inner bark blaze pale brown or pale brown, fibrous. Exudate: colourless and non-sticky. Leaves: spiral, simple, broad, upper surface f is green and underneath is pale green. Flowers: small yellow flowers with distinct sepals and petal whorls. Fruit/Seed; narrow (ovoid), brown in colour, fleshy and contains one seed.

Tree	Bark	Leaf/Leaves
	 	

Note:	Flower	Fruit/Seed
Short description was from the PNG Plant database website (link below) http://www.pngplants.org/PNGtrees/Tree Descriptions Photo source: (tree, bark, leaves and flowers): KDamas, Senior Botanist, FRI, Lae, Morobe Province		 Source: https://www.mybis.gov.my/sp/43945

VEGETATION AND LAND COVER MAP OF WESTERN PROVINCE (2012 FOREST BASEMAP VERSION 1.1)



Land Use and Land Cover Classes

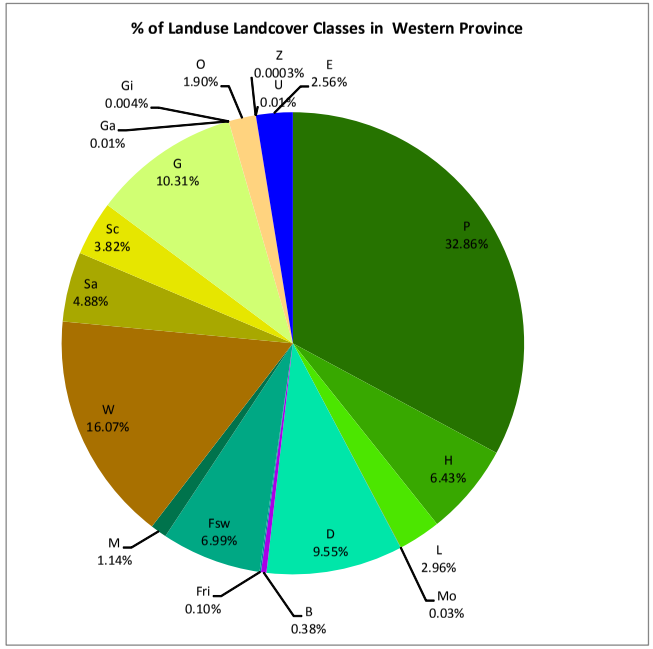
P: Low Altitude Forest on Plains & Fans	D: Dry Seasonal Forest	Sa: Savanna	O: Agriculture Land Use
H: Low Altitude Forest on Uplands	Fri: Seral Forest	Sc: Scrub	Z: Bare areas
L: Lower Montane Forest	Fsw: Swamp Forest	G: Grassland	U: Settlement & larger urban centres
Mo: Montane Forest	M: Mangrove	Ga: Alpine grassland	E: Lakes & larger rivers
B: Littoral Forest	W:Woodland	Gi: Subalpine grassland	

N

1 cm = 30 km

0 30 60 90

Kilometers

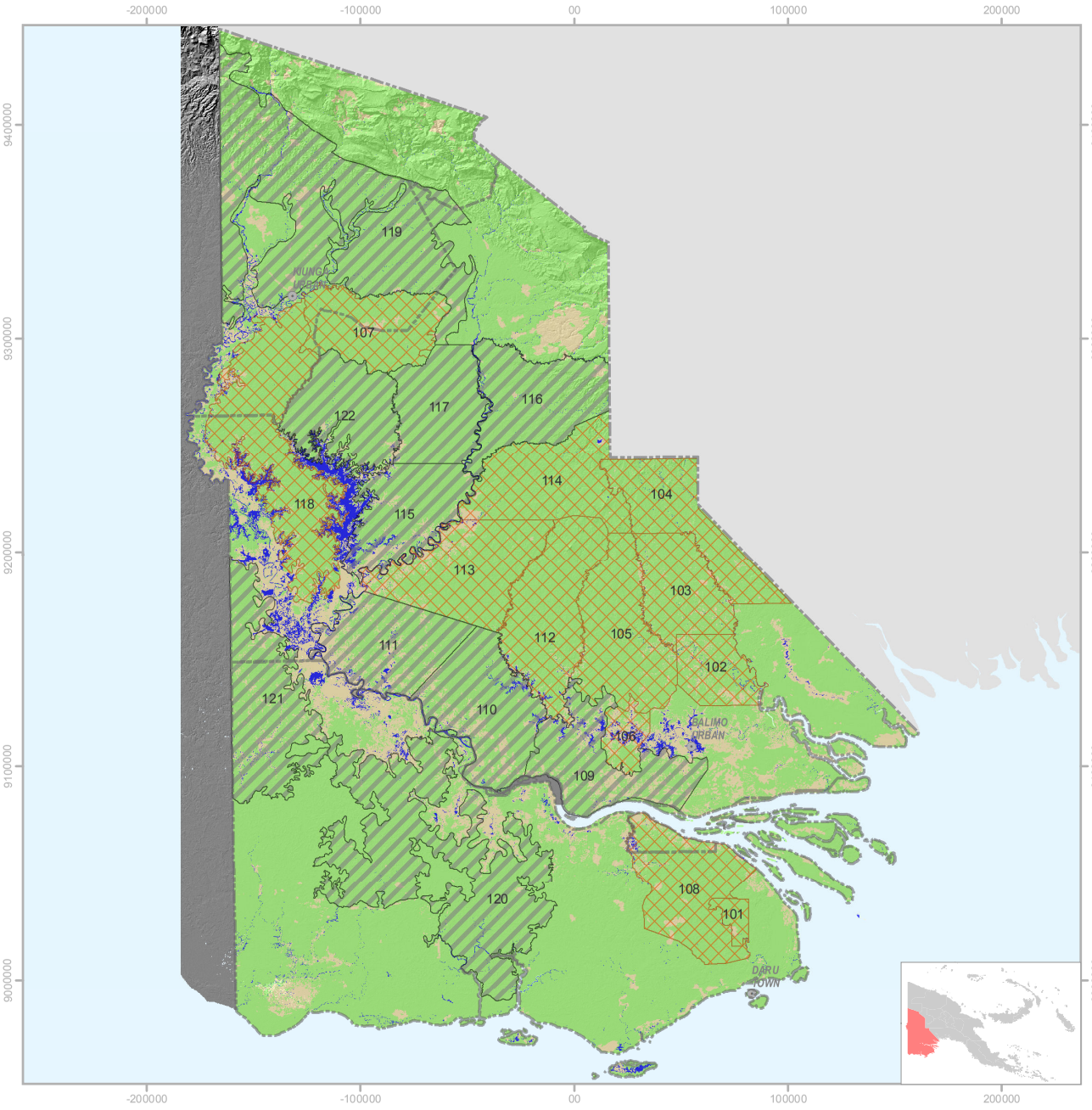


Pie Chart showing percentage in Landuse, Landcover of Western Province.

% of Landuse Lancover			
Code	Middle Fly	North Fly	South Fly
P	48.27%	48.31%	0.34%
H	5.73%	22.30%	0.01%
L	0.72%	16.88%	
Mo		0.18%	
D	12.15%		9.92%
B	0.02%		1.15%
Fri	0.19%		0.01%
Fsw	9.43%	2.40%	5.17%
M	0.26%		2.66%
W	4.61%	0.44%	42.52%
Sa	0.24%		14.89%
Sc			11.96%
G	13.15%	3.31%	9.00%
Ga		0.06%	
Gi		0.02%	
O	1.55%	4.34%	1.30%
Qf			
Z			0.001%
U		0.02%	0.01%
E	3.70%	1.75%	1.06%
Land Area (ha)	5,143,184.50	1,499,777.58	3,129,175.46

Table showing percentage in Landuse, Landcover of Districts in Western Province. Percentage calculated from area in hectares.

TIMBER CONCESSION MAP OF WESTERN PROVINCE



PLAN_ID	NAME	AREA	CONSTYPE	STATUS
105	Makapa	255748.53	TRP	Concession
101	Waimare (Oriomo)	24834.81	TRP	Concession
104	Wawoi Guavi Block 3	207180.80	TRP	Concession
102	Wawoi Guavi Block 1	108665.22	TRP	Concession
103	Wawoi Guavi Block 2	172364.77	TRP	Concession
106	SEMABO	54222.18	FMA	Concession
108	Wipim Tapila FMA	243851.36	FMA	Concession
107	EAST AWIN	202294.67	FMA	Concession
113	KAMULA DOSO Block 2	265906.92	FMA	Concession
112	KAMULA DOSO Block 1	268785.97	FMA	Concession
114	KAMULA DOSO Block 3	257962.38	FMA	Concession
116	Nomad Strickland	238571.85	PFD	Proposed
111	Fly Block 2	227278.20	PFD	Proposed
115	Lake Murray Block 1	202639.10	PFD	Proposed
117	Lake Murray Block 2	197683.51	PFD	Proposed
110	Fly Block 1	263291.40	PFD	Proposed
109	Balimo Fly	237716.29	PFD	Proposed
120	Morehead / Suki Block 1	589211.95	PFD	Proposed
121	Morehead / Suki Block 2	297385.42	PFD	Proposed
119	Ningerum	723666.12	PFD	Proposed
122	East Awin Extension	211003.41		Proposed
118	Kiunga-Aiambak TA	394751.45	TA	Concession

Table showing Timber Concession for Western Province.
Information updated as at 2016.