Progress Report
on

JICA Technical Cooperation
"Capacity Development on Forest Resource Monitoring"

and

Grant Aid for Environment and Climate Change
"The Forest Preservation Program" (JICS)

March 4th, 2013
(based on material for JCC in September)

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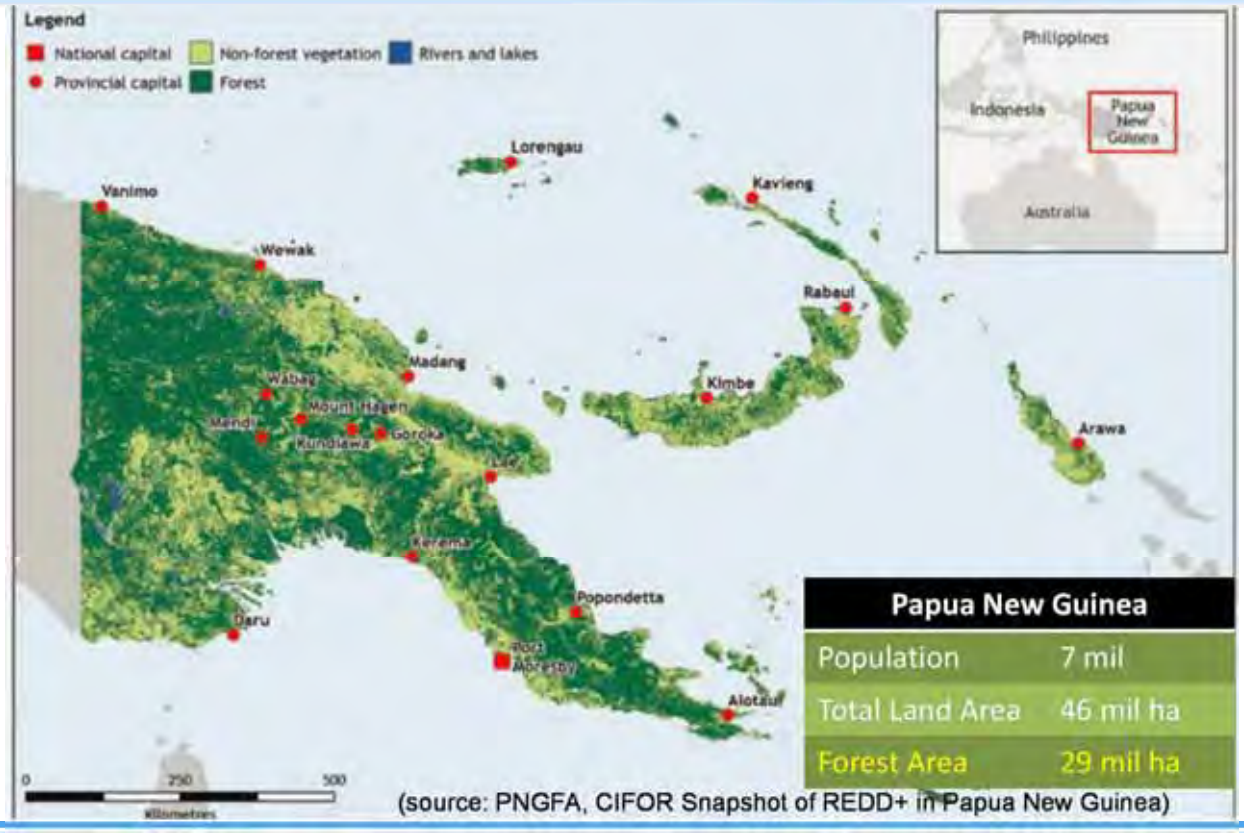
State of the Forest of PNG



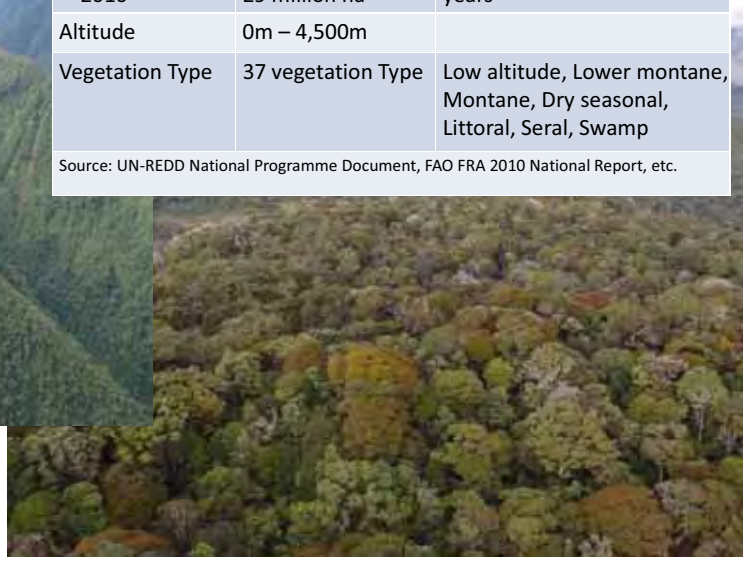
(source: PNGFA, CIFOR Snapshot of REDD+ in Papua New Guinea)

State of the Forest of PNG

More than 20% of GHG comes from Landuse-Change and Forestry

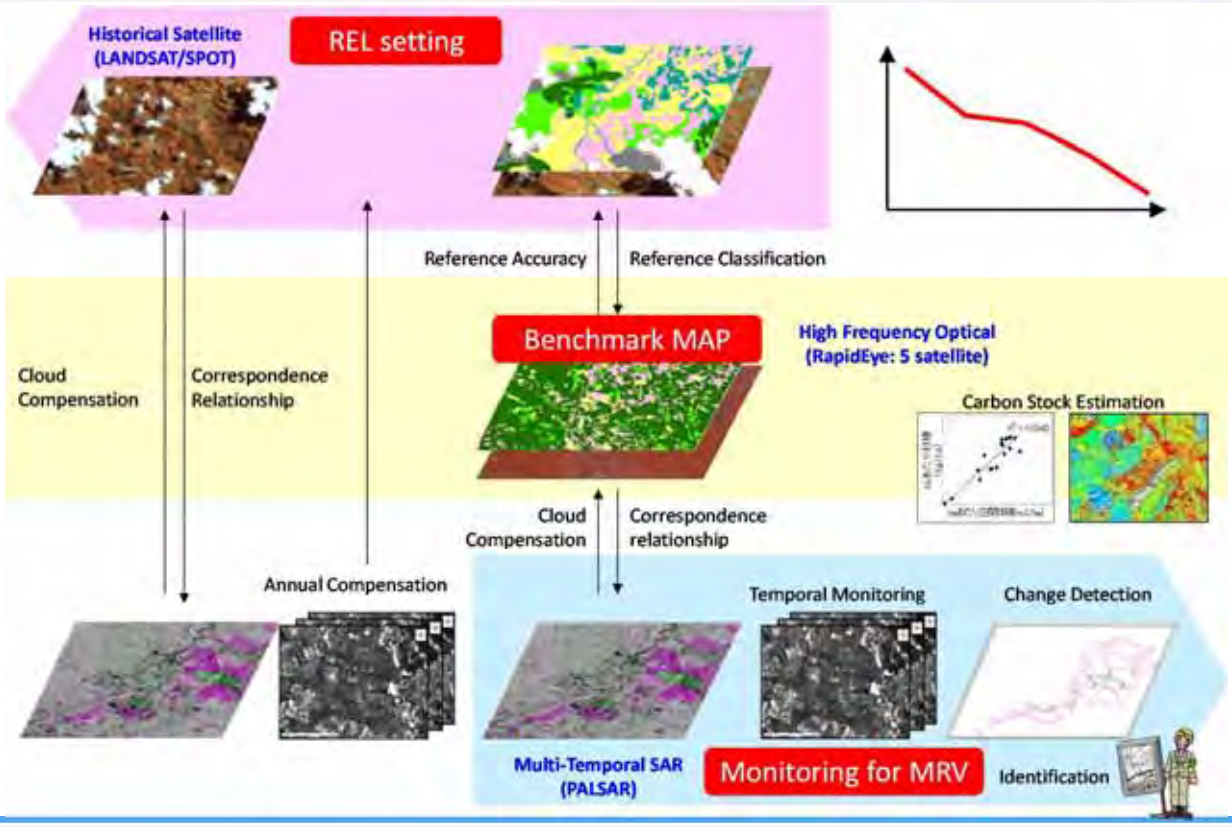
	Papua New Guinea	Remarks
Population	6.1 million	87% lives in rural area
Land Area	45 million ha	97% of the land is customary land
Forest Area 1990 2010	 32 million ha 29 million ha	 3 million ha decrease in 20 years
Altitude	0m – 4,500m	
Vegetation Type	37 vegetation Type	Low altitude, Lower montane, Montane, Dry seasonal, Littoral, Seral, Swamp

Source: UN-REDD National Programme Document, FAO FRA 2010 National Report, etc.



But…at the beginning the forest state is actually not so clear

What is Necessary for REDD+/SFM



Goals of JICA and Grant Aid for Forest Monitoring

JICA Technical Cooperation Project

Objective:

To enhance the capacity of relevant institutions in PNG for monitoring of nation-wide forest resource including carbon stock to address climate change

Expected Output

1. **Nation-wide forest base map**
2. **National level forest resource database**
3. **Monitoring system of forest resource including carbon stocks**

GoJ Grant Aid

- ☐ Equipment
  - ✓ Remote Sensing GIS facility
  - ✓ Satellite Images
  - ✓ Airborne data
  - ✓ Field survey equipment
- ☐ Training on usage of equipment
- ☐ Technical Assistance for usage of equipment
- ☐ Workbase Focus Training on RS/GIS software

Input of JICA and Grant-Aid for Forest Monitoring

Forest Preservation and Monitoring Project

JICA Technical Cooperation Project

- **Long-term Experts**
  - Forest Management
  - Inventory
- **Short-term Experts**
  - Remote Sensing,
  - Database,
  - Biomass survey (tbc)
- **Training in Japan**
- **Small Procurement and provision of equipments**

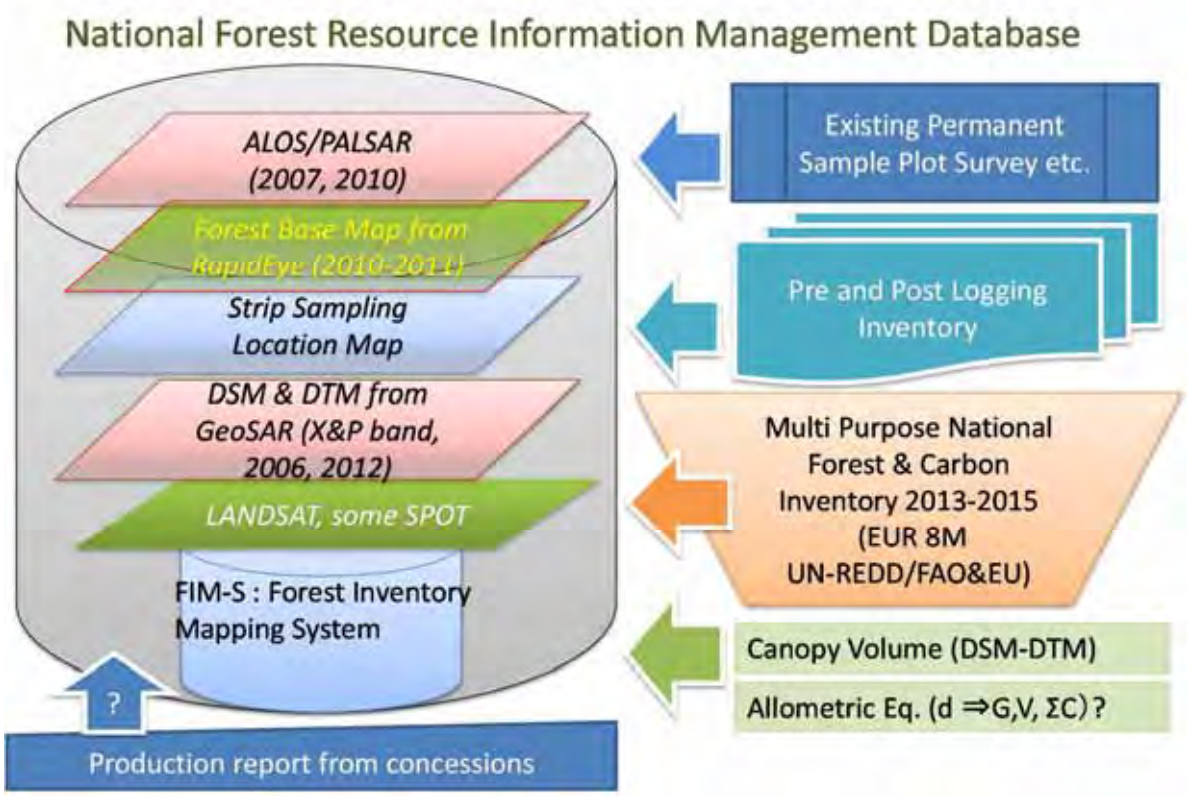
GOJ Grant Aid Programme

- **Procurement and provision of equipments**
- **"Soft component"**
  - Consultancy
  - Training in PNG (tbc)

JICA Group Training Course

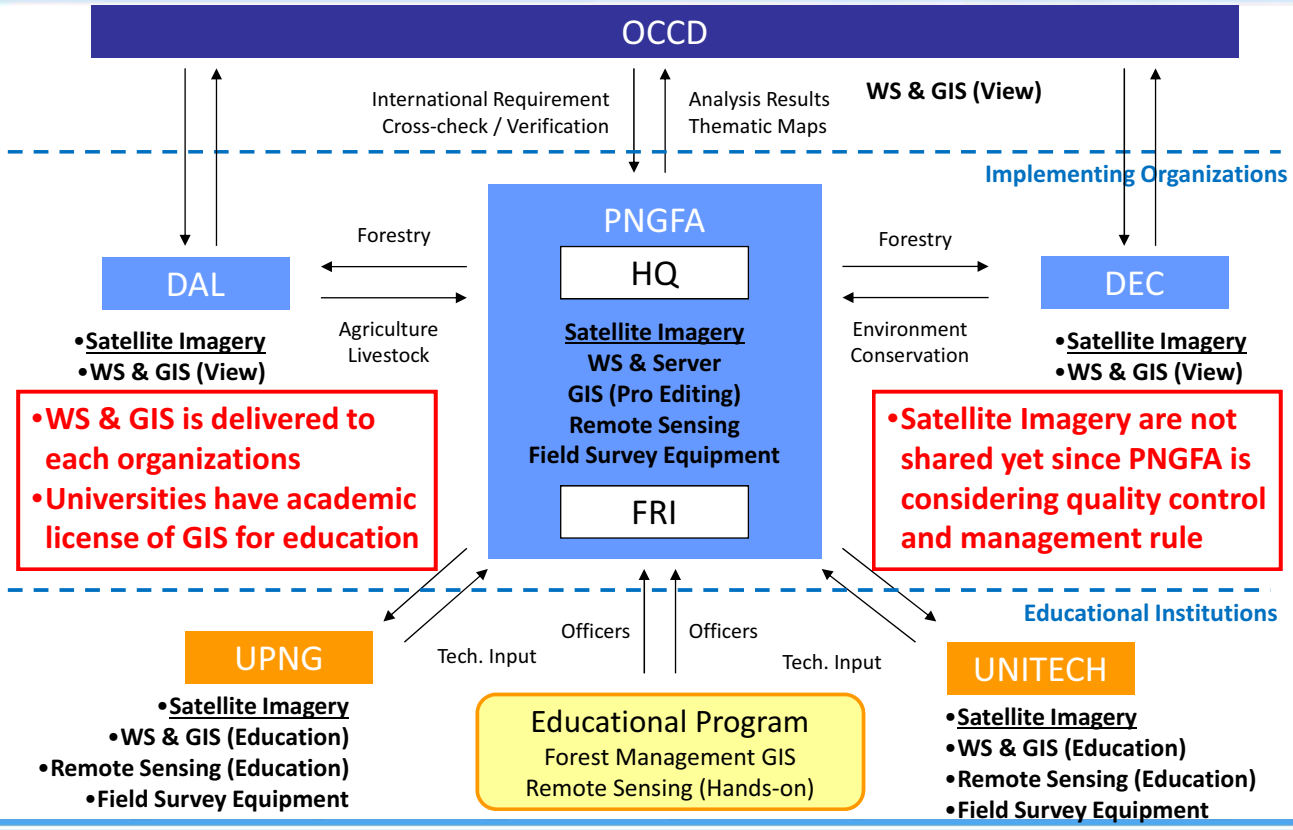
- Biomass Survey in Forest
- Remote Sensing on Forest
- Climate Change Mitigation etc.

What to be Done by 2014



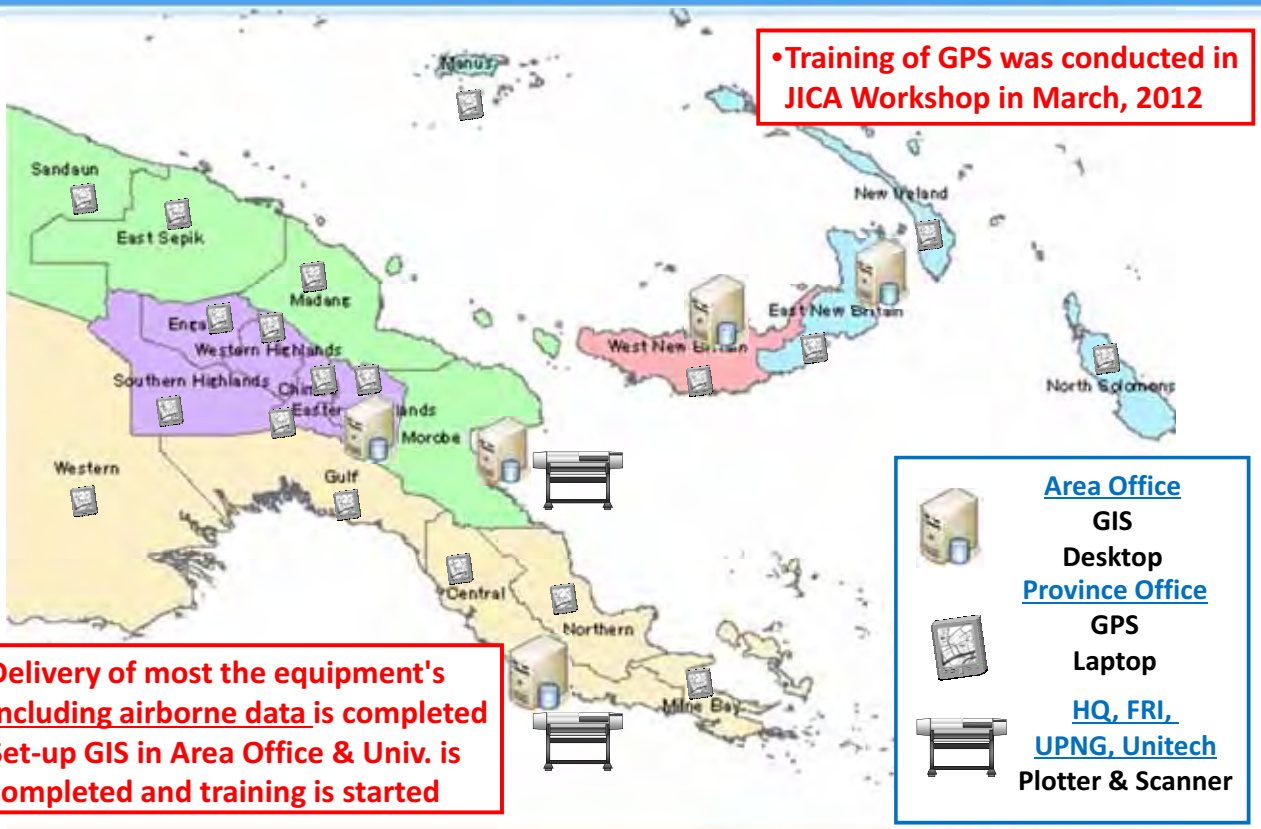
Equipment Procurement

Distribution Plan & Cooperation with Organizations



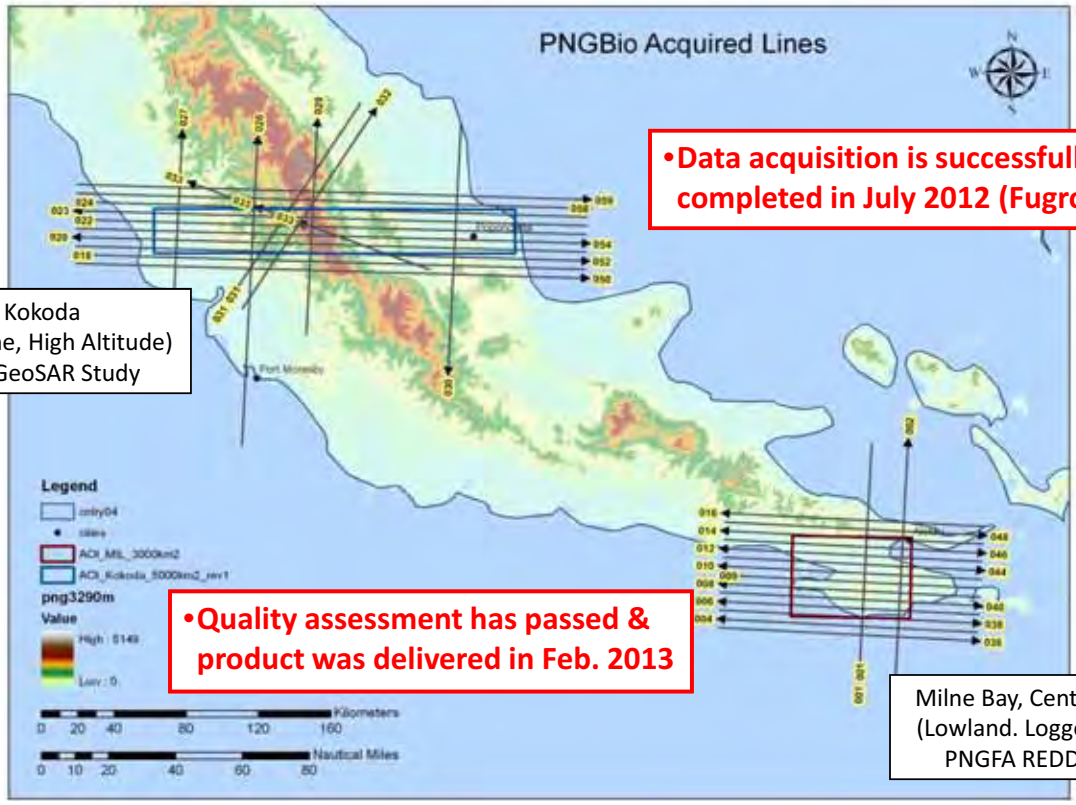
Equipment Procurement

Equipment Delivery, Setting-up and Training



Equipment Procurement

Airborne Radar (GeoSAR) Data Collection



- Data acquisition is successfully completed in July 2012 (Fugro)

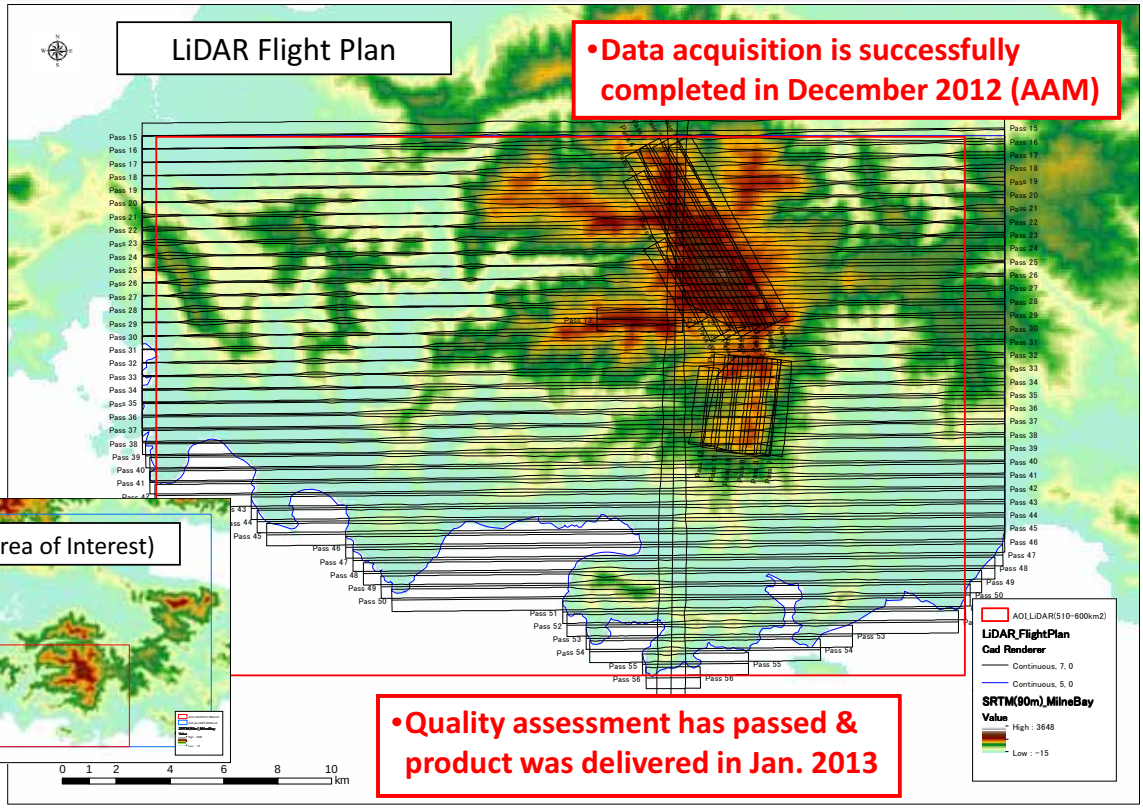
Kokoda
(Montane, High Altitude)
DEC GeoSAR Study

- Quality assessment has passed & product was delivered in Feb. 2013

Milne Bay, Central Suau
(Lowland. Logged over)
PNGFA REDD+ Pilot

Equipment Procurement

Airborne LiDAR Data Collection

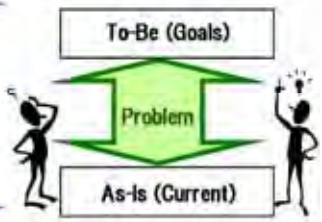


- Data acquisition is successfully completed in December 2012 (AAM)

- Quality assessment has passed & product was delivered in Jan. 2013

Overview of Technical Cooperation/Assistance

【To-Be】 1. National forest resource basemap is developed & utilized	【To-Be】 2. National level forest resource GIS/Database is developed & utilized	【To-Be】 3. Carbon/Biomass stock is estimated.
【Problem】 ・PNGFA does not have data and facility to develop ・Need time to develop national level map	【Problem】 ・The work flow does not fit with FIMS any more ・Existing data are not well compiled into the system	【Problem】 ・More than 90 % of PNG land is customary land ・No access road to do field survey for whole country
【As-Is】 1. National level forest basemap is not developed since 1972	【As-Is】 2. FIMS (Forest Inventory Mapping System) is not updated since 1998	【As-Is】 3. Carbon stock estimation is necessary but no good data for it



Contents of Technical Cooperation & Technical Assistance

TC3. Monitoring system of forest resource including carbon stocks

TA1: Creation of national forest base maps using remote sensing technologies

TC1: Nation-wide forest base map

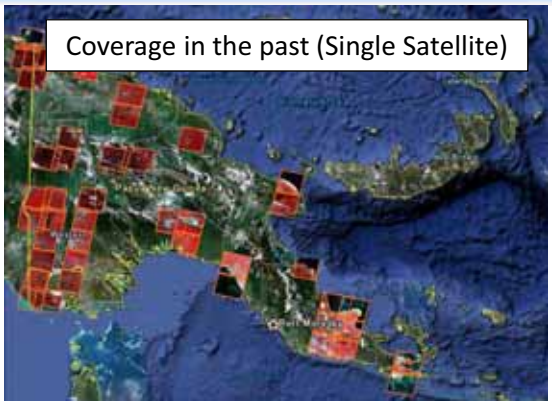
TA2: Development/construction of a national-level forest GIS/Database

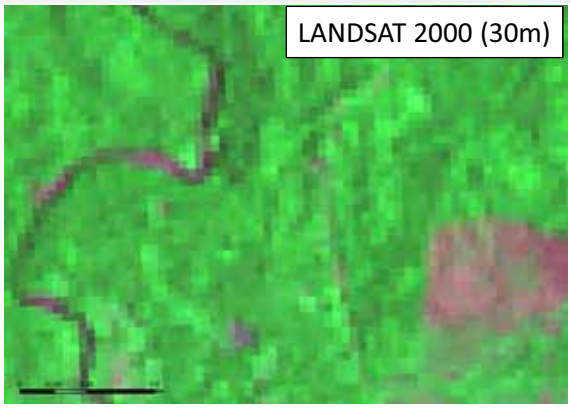
TC2:National level forest resource database

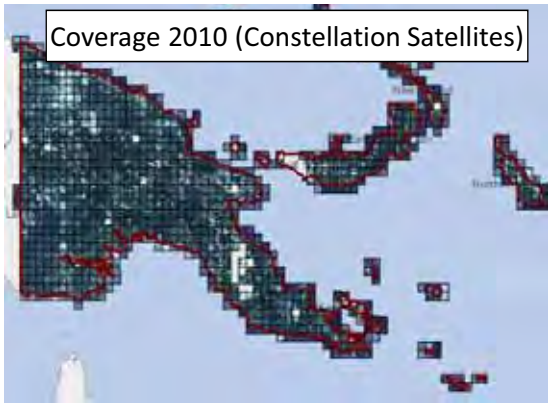
TA3: Estimation of carbon stock which would be essential information for the forest resource monitoring

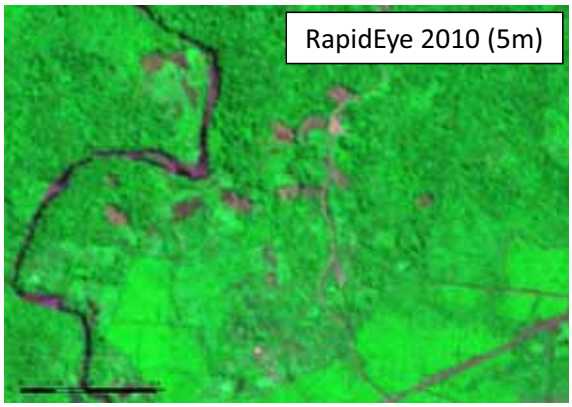
TA4: Formulation of a program to strengthen implementation capacity and to support educational institutions

Satellite Image for Forest Classification (Start from Optical)

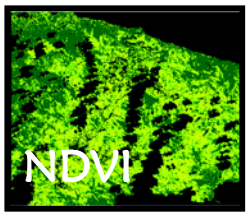


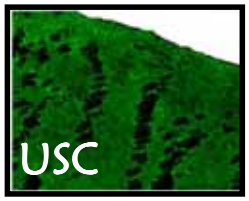


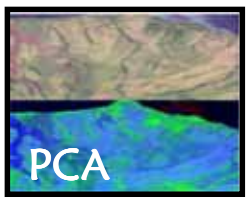




Fundamental Study for Classification (Training in Japan)

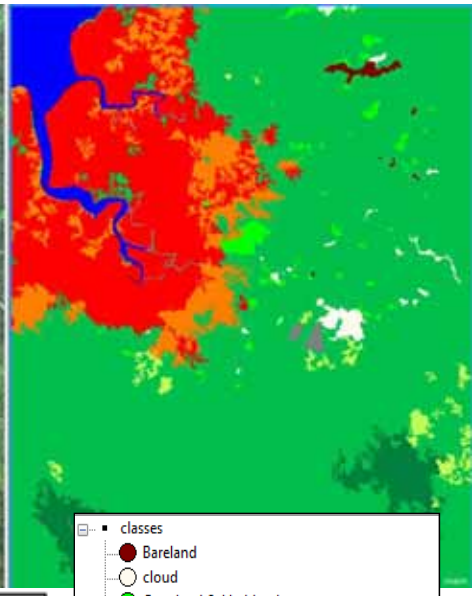


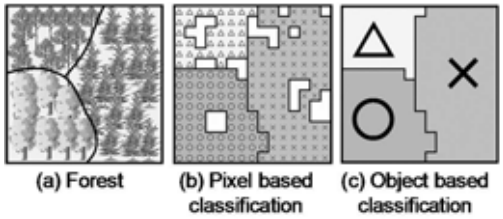


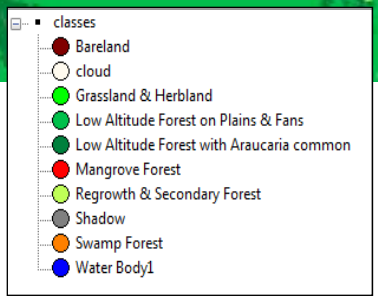


No.	Vegetation or Forest Types	RS & GIS techniques Used to detect forest types									
		NDVI	Unsupervised Classification	PCA	True Imag	Red Edge Band	Watershed polygons	Contour lines	Slope	DEM	Tree Canopy height
	Evergreen Broadleaf Forests										
1	Mangrove Forest										
2	Litoral Forest										
3	Swamp Forest										
4	Seral Forest										
5	Dry Seasonal Forest										
6	Low Altitude Forests on Plains & Fans										
7	Low Altitude Forests on Uplands										
8	Lower Montane Forests										
9	Mid Montane Forests										
10	Montane Forests										
	Evergreen Mixed Conifer Forests										
11	Low Altitude Forest with Araucaria common										
12	Lower Montane Forests with Araucaria common										
13	Mid Montane Forests with Conifers										
14	Montane Forests with Conifers										
	Other Wood Lands										
15	Woodland										
16	Savanna										
17	Scrub										
18	Grassland & Herbland										
*	Bareland,waterbodies,clouds, shadows etc…										
*	Watershed (catchment)										
*	Degraded areas										
*	Ridges & terrains										
*	Young & matured forests										
*	Canopy height										

Object-based (eCognition) Classification (Training in Japan)

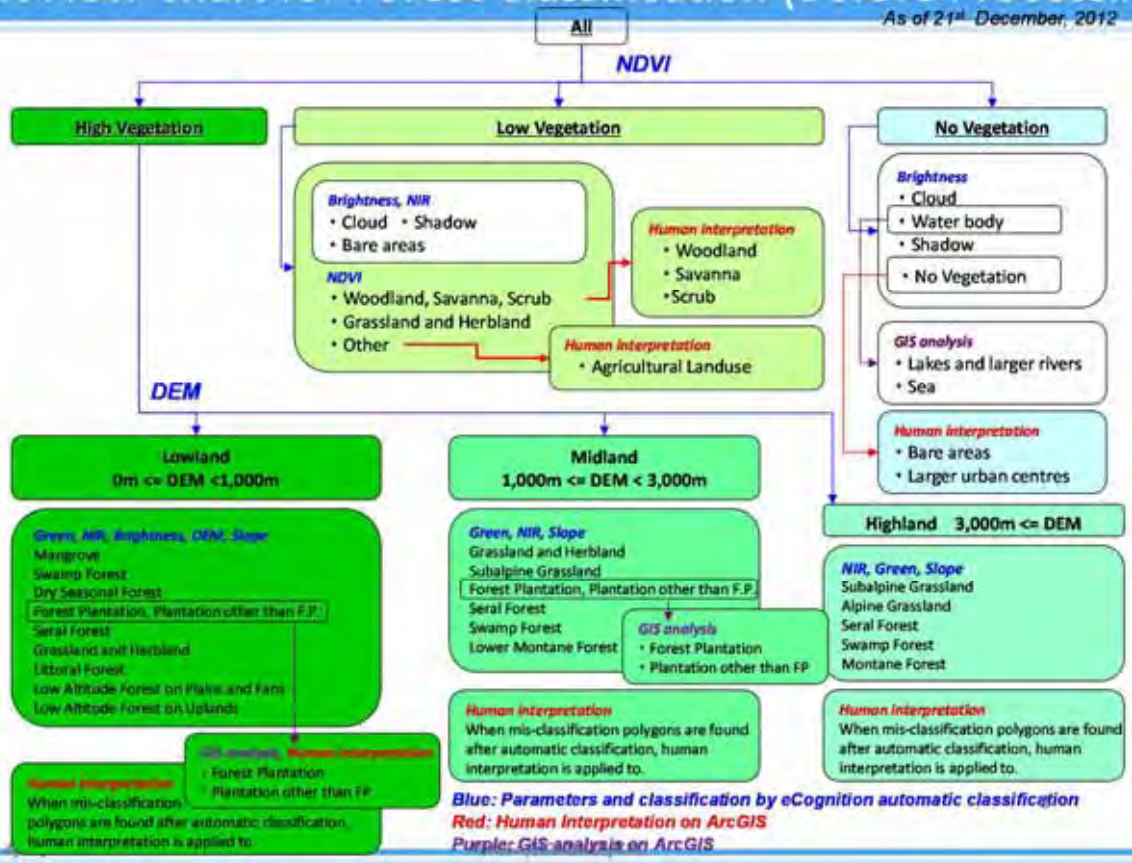




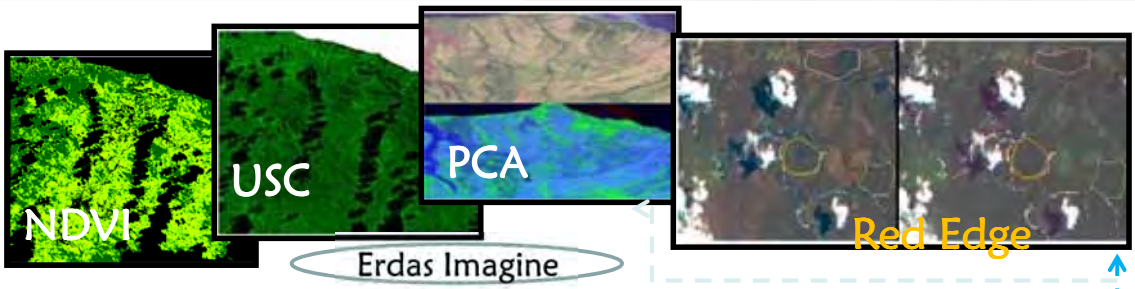


- **Create classes**
- **Input data (images)**
- **<u>Threshold of parameters</u>**
- **Procedure of processing**

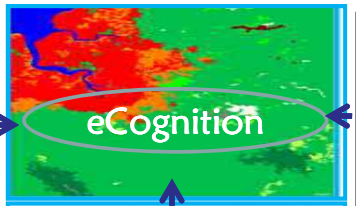
Draft Flow Chart for Forest Classification (Before Processing)

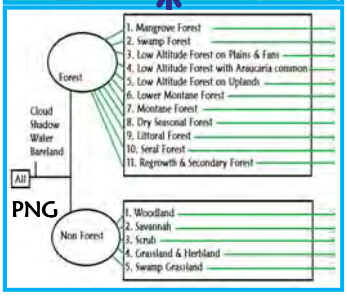


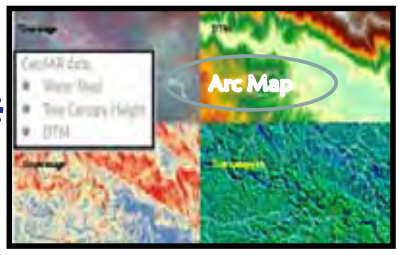
Summary & Gaps of Forest Classification (Training in Japan)

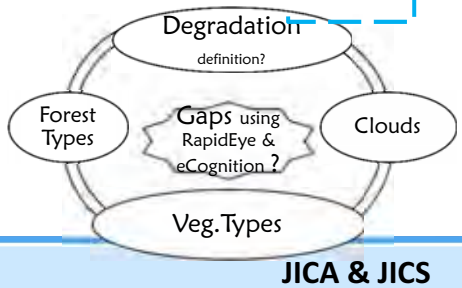


	Classes	Milne Bay	Highlands	April Salumei
	Forests			
1	Mangrove Forest	Green,DTM	n.a	n.a
2	Swamp Forest	Green,DTM	n.a	DTM,Green
3	Low Altitude Forest on Plains & Fans	DTM	n.a	DTM
4	Low Altitude Forest with Araucaria common	DTM	n.a	n.a
5	Low Altitude Forest on Updlands	n.a	DTM	DTM
6	Lower Montane Forest	n.a	DTM	n.a
7	Montane Forest	n.a	DTM	n.a
8	Dry Seasonal Forest			
9	Litoral Forest			
10	Seral Forest	n.a	n.a	NIR
11	Regrowth & Secondary Forest	NIR	NIR,DTM	RE
	Non Forests			
1	Woodland			
2	Savannah			
3	Scrub			
4	Grassland &Herbland	NDVI	NDVI,NIR	n.a
5	Swamp Grassland	n.a	n.a	NDVI,DTM
	Other Classes			
	Cloud	Green, Bright, NDVI	Bright	Bright
	Shadow	Bright,NIR	Bright	Bright
	Water	NDVI	NDVI	NDVI
	Bareland	NDVI	NDVI	n.a
	Degraded Forest ?	n.a = not available in this file/image or very difficult to detect		



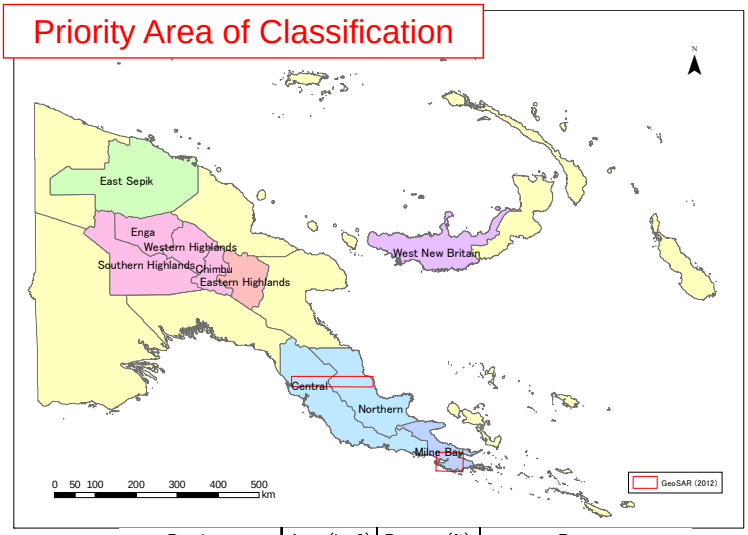




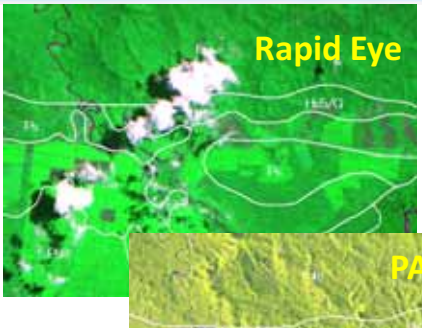


Priority Area & PALSAR Change Analysis

Priority Area of Classification



Province	Area (km2)	Percent (%)	Reason
PNG (All)	465,501	100.0%	
MilneBay (Mainland)	8,102	1.7%	REDD+ Pilot Project
East Sepick	43,834	9.4%	REDD+ Pilot Project
West New Britain	20,422	4.4%	REDD+ Pilot Project
Eastern Highlands	11,143	2.4%	REDD+ Pilot Project
Chimbu	6,145	1.3%	Heli/Chopper Survey
Western Highlands	9,129	2.0%	Heli/Chopper Survey
Soutern Highlands	25,799	5.5%	Heli/Chopper Survey
Enga	11,768	2.5%	Heli/Chopper Survey
Central	29,684	6.4%	Kokoda GeoSAR Sample
Nortnern	22,701	4.9%	Kokoda GeoSAR Sample
SUM	188,727	40.5%	



Change Analysis by PALSAR

PNGFA New Database: Scope of Integration of Existing DBs

The forest resource information management DB shall be made accessible from other applications including those for image analysis

A GIS application which expands the functions of FIMS and FIPS

GIS

To be used as the basis of the information management in the forestry administration in PNG

Forest resource information management database

Data sharing with administrative institutions, such as PNGFA, and other donors

Storage

Integration/adoption of GUI

Integration

Data on forest cover maps, ground surveys, carbon accumulation, etc.

FIMS

FIPS

PNGFA New Database: System/Hardware Composition

[Data Server]

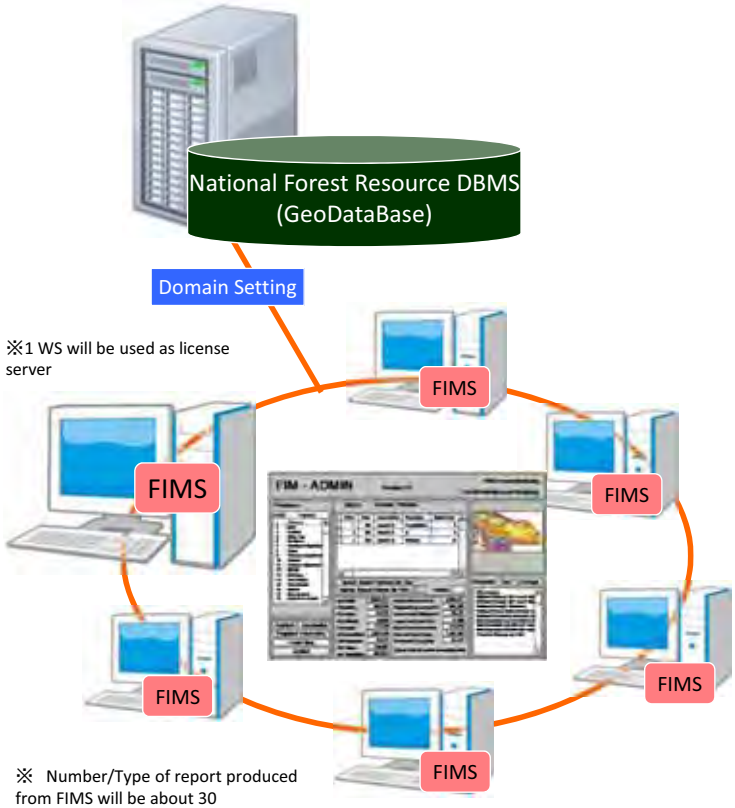
■ArcGISServer10.0
Standard/Enterprise

■SQL Server 2008
Standard Edition(English)

[Desktop PC]

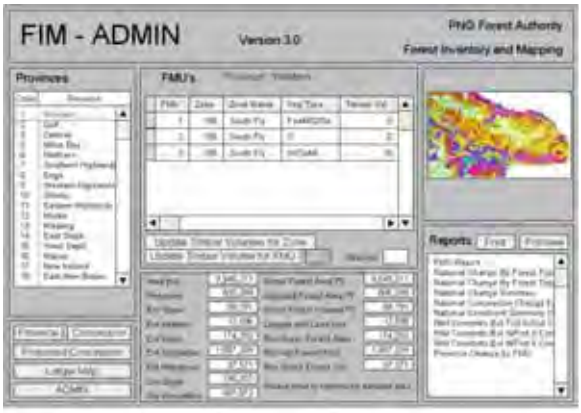
■ArcGIS Desktop10.0
ArcInfo 2
ArcEditor 2
ArcView 2

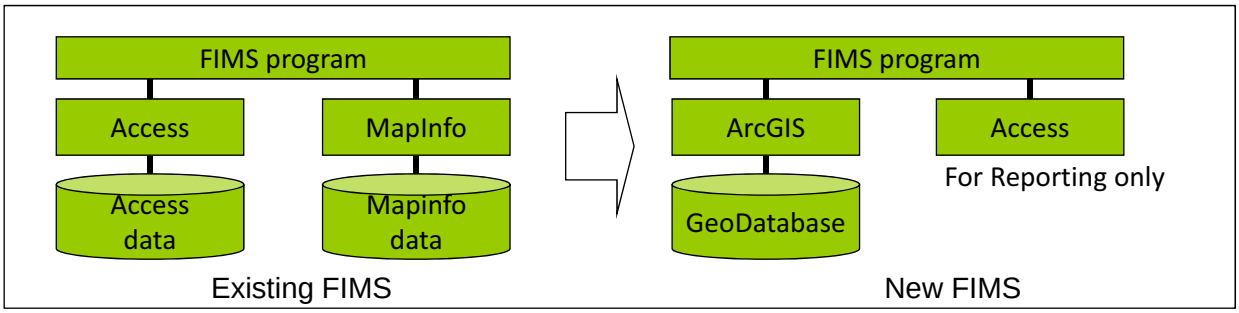
■Microsoft Office 2010
Professional(English)



New FIMS (ArcGIS version): Screen Image

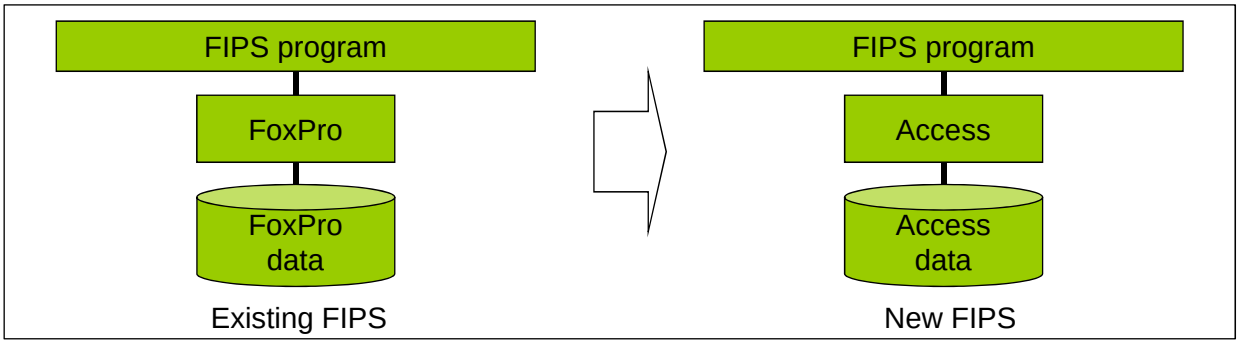
- GUI and the functions of the existing FIMS have been incorporated



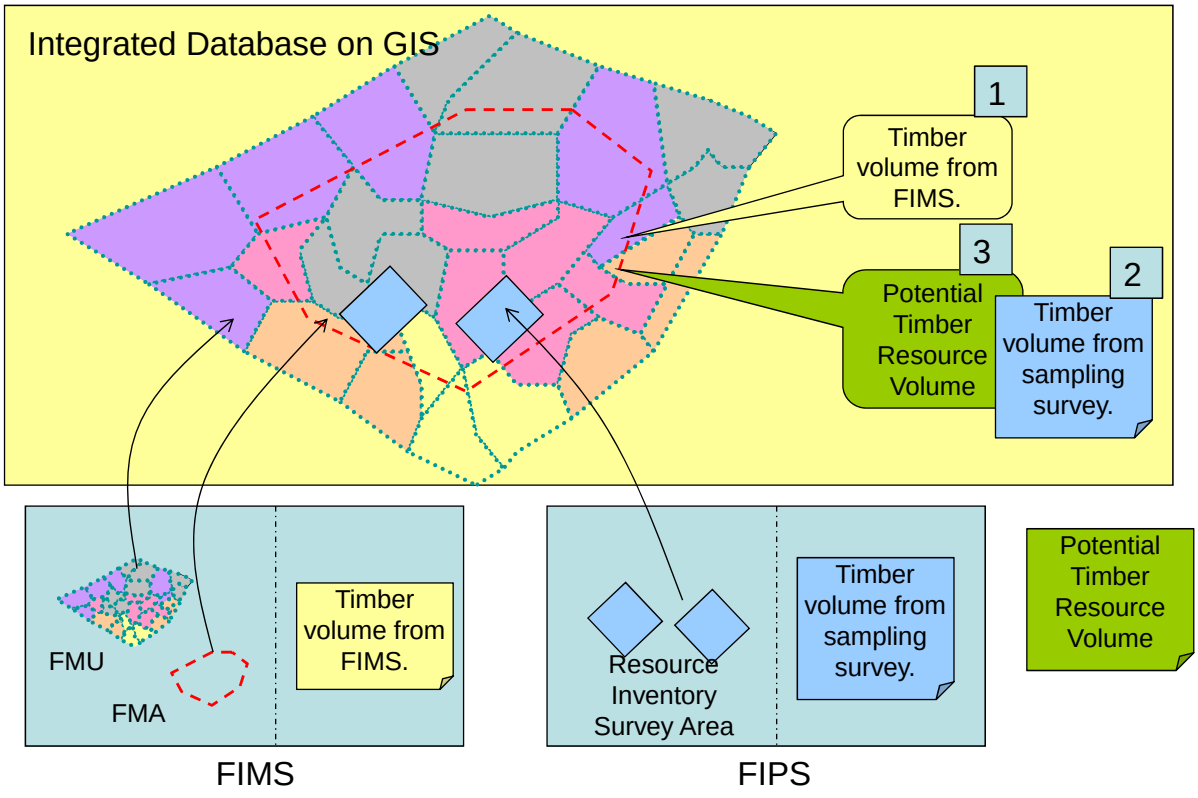


Replacement of FIPS (Access version)

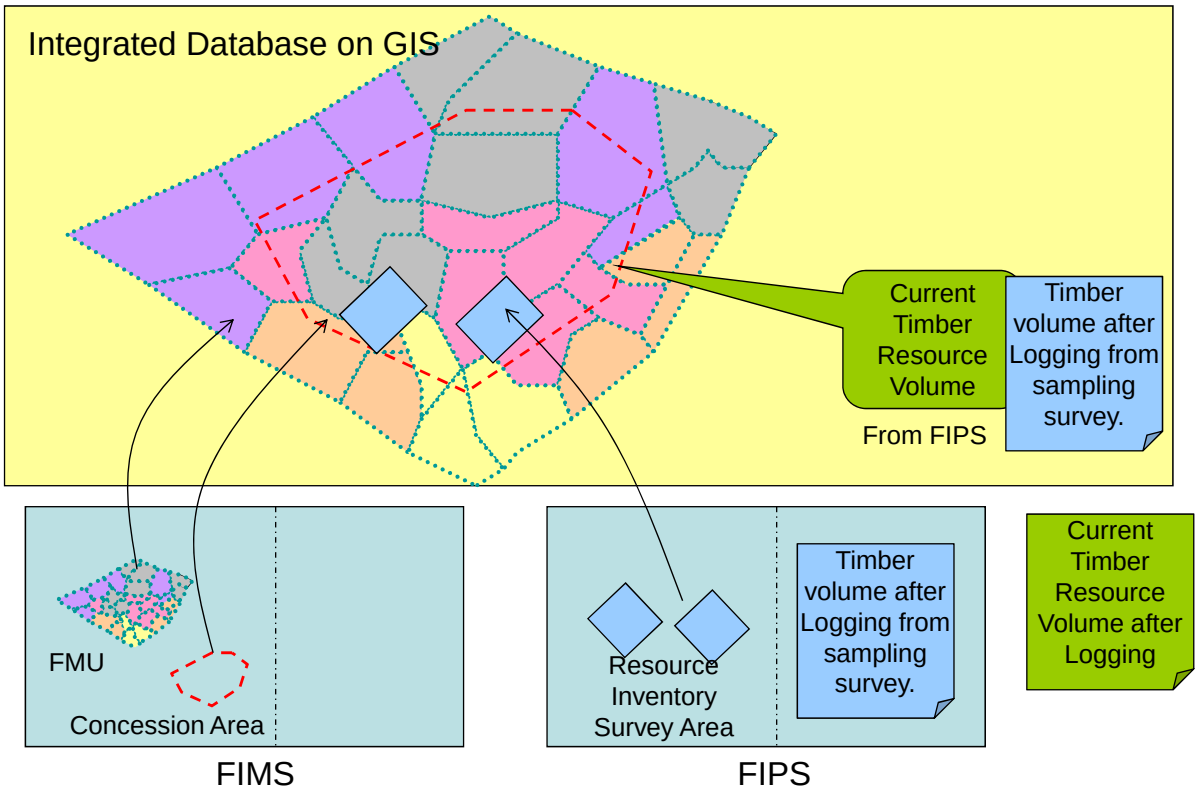
- GUI and the functions of the existing FIPS have been incorporated



Idea for Integration: After Resource Inventory



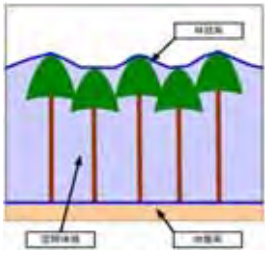
Idea for Integration: Post Logging Inventory



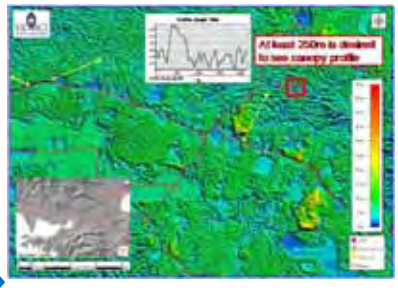
Canopy Volume Estimation for Carbon Stock Amount

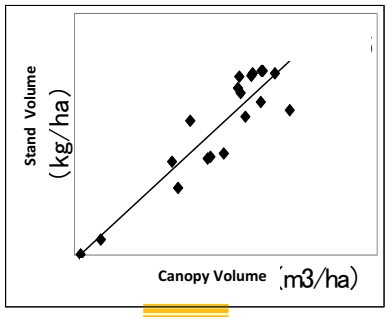
Airborne Survey (GeoSAR & LiDAR)

Canopy Volume



Correlation Analysis of Canopy Volume and Stand Volume





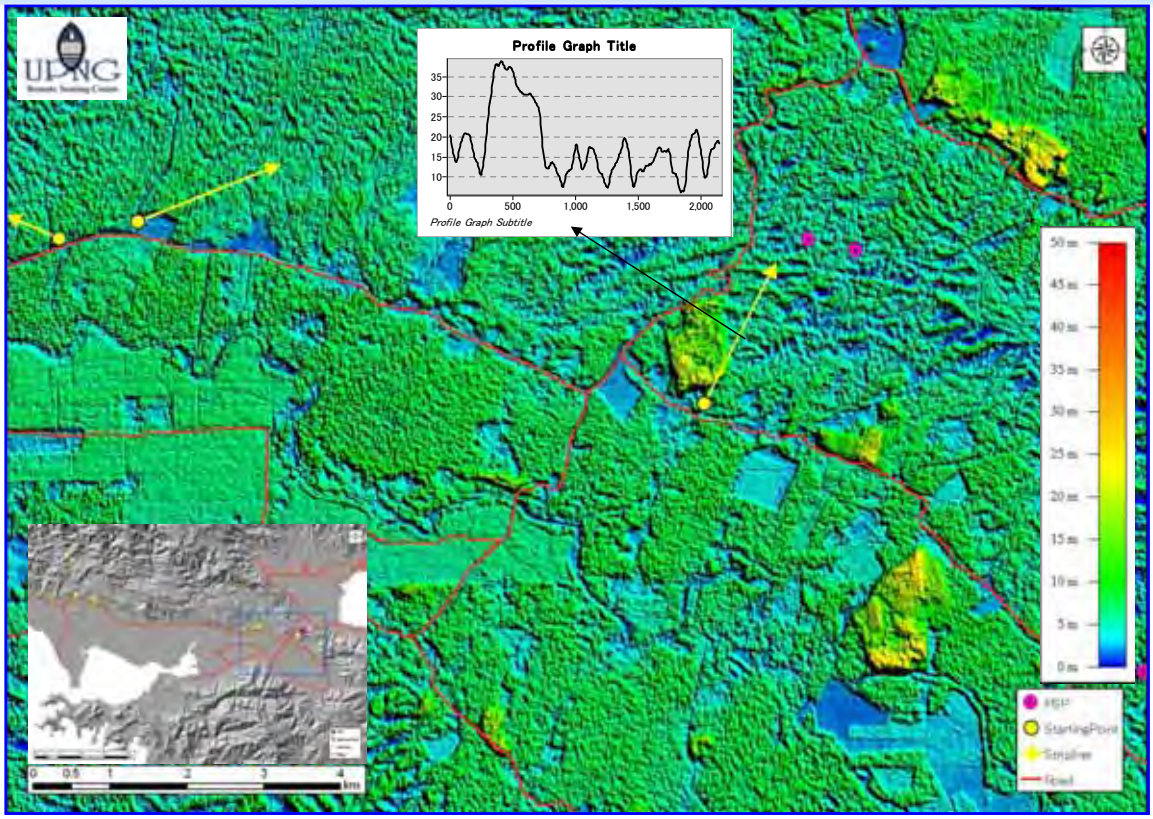
Carbon Stock Amount

Field Survey

Stand Volume

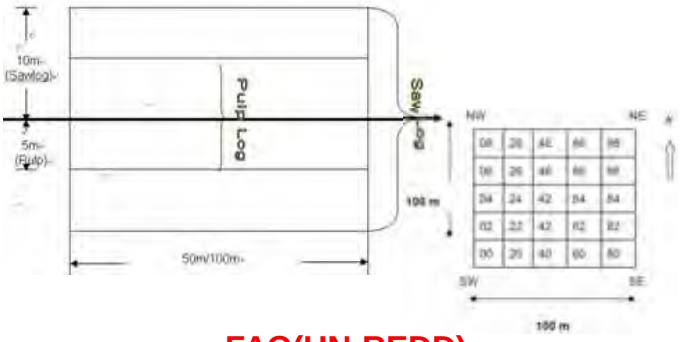
- ✓ Tree Species
- ✓ Tree Height
- ✓ DBH
  - ➢ Allometric Model

Result of trial process/analysis of existing GeoSAR data

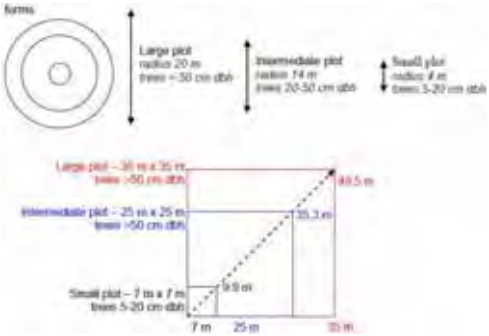


Review/Analyze Existing Inventory/Survey Method

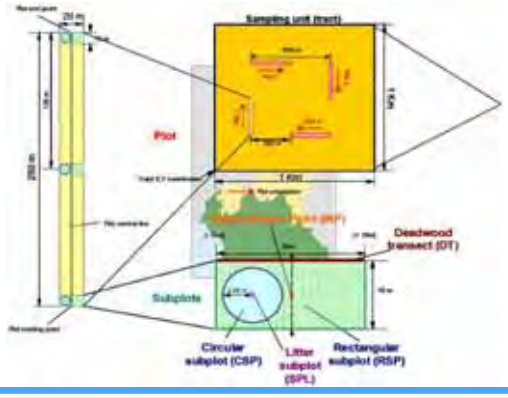
PNGFA FIPS/PSP



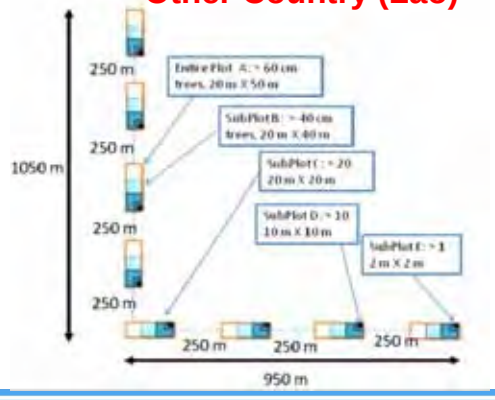
Winrock International



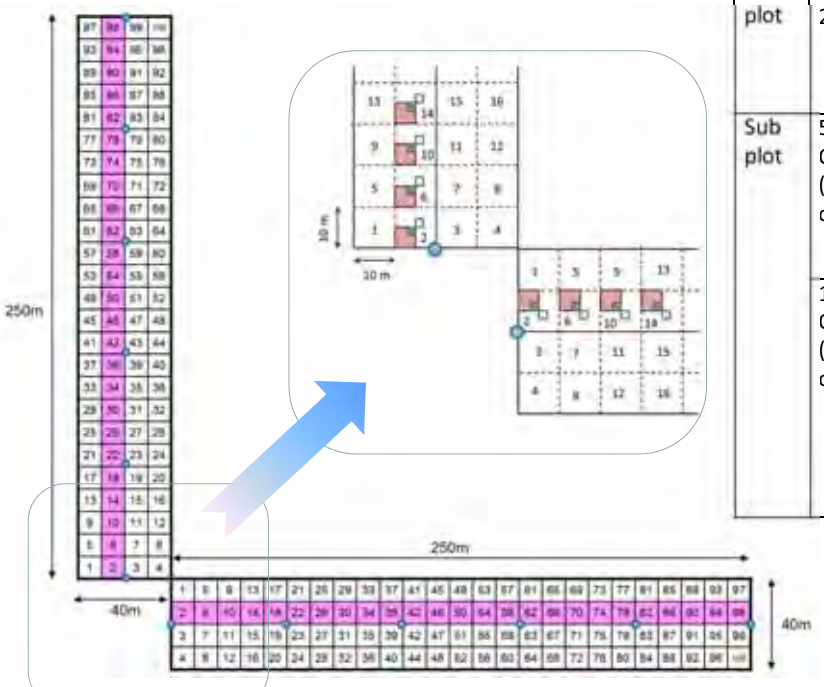
FAO(UN-REDD)



Other Country (Lao)

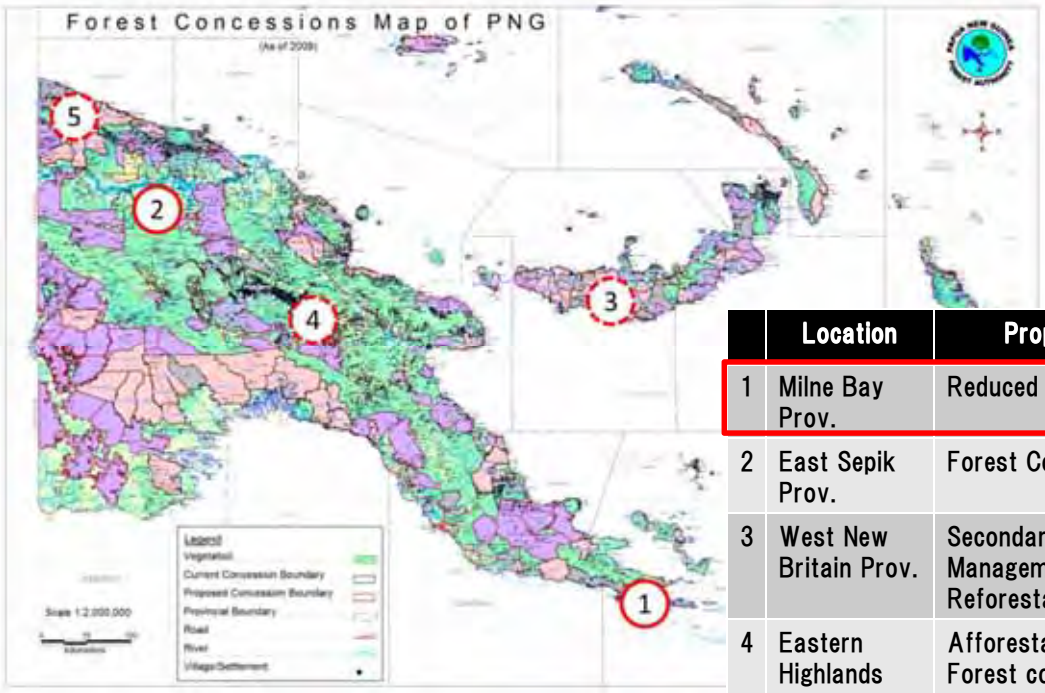


Draft Plot Design for Canopy Volume Estimation



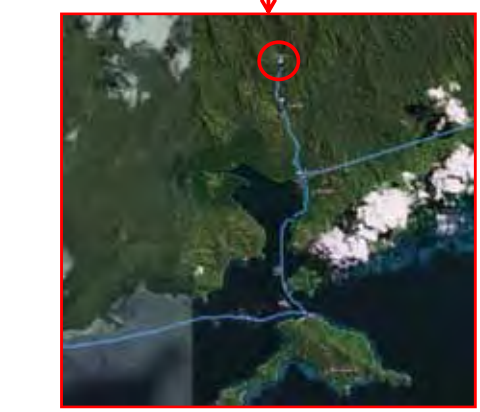
	Plot size	Area	Measurement Object	Size of Object
Entire plot	40m x 250m	1 ha	Live and dead standing trees, and vines	dbh ≥ 10cm
			Dead lying wood	diameter ≥ 30cm
Sub plot	5m x 5m Quadrates (pink color)	0.0625 ha	Live and dead standing trees	10cm > dbh ≥ 1cm
			Dead lying wood	30cm > diameter ≥ 10cm
	1m x 1m Quadrates (green color)	0.0025 ha	Trees	dbh < 1cm
			Dead wood	diameter < 10cm
			Understory vegetation without trees	All
			Litter	All

Proposed REDD+ Pilots in PNG

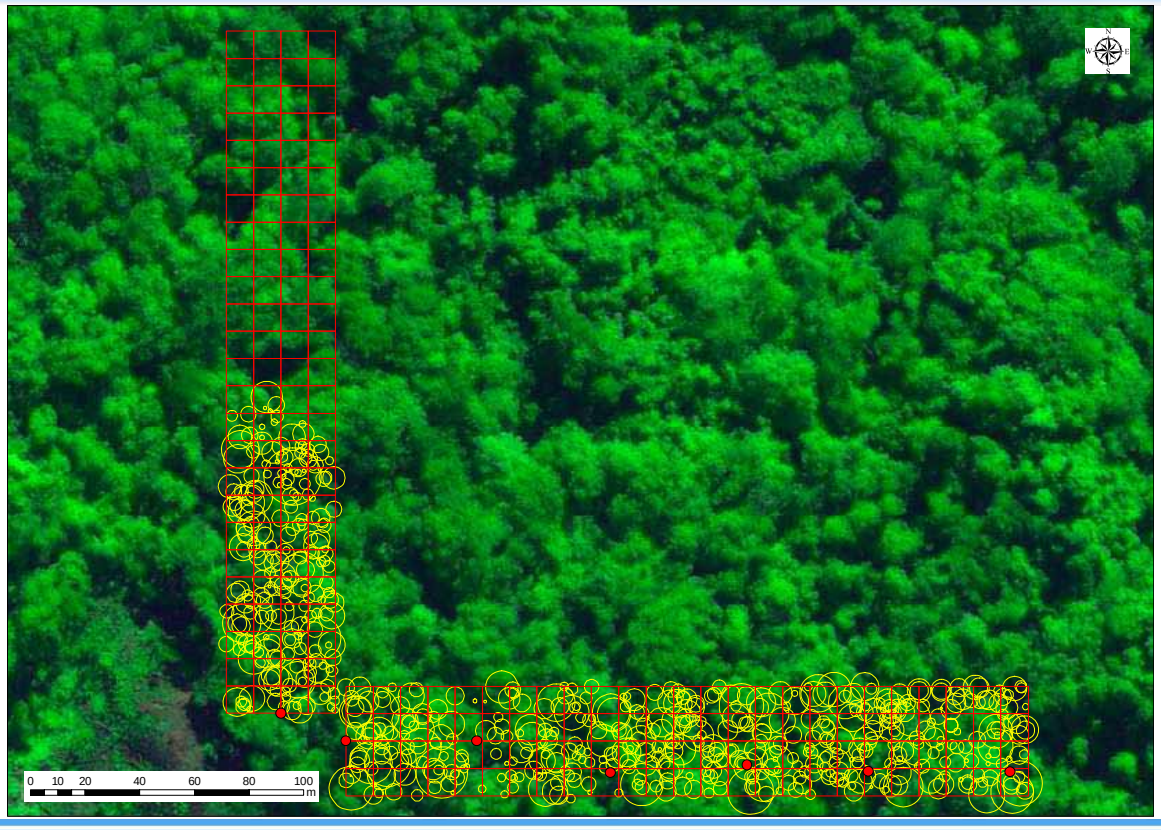


	Location	Proposed Activities
1	Milne Bay Prov.	Reduced Impact Logging
2	East Sepik Prov.	Forest Conversion
3	West New Britain Prov.	Secondary Forest Management Afforestation / Reforestation
4	Eastern Highlands Prov.	Afforestation Forest conservation
5	West Sepik Prov.	Afforestation / Reforestation Forest Conservation

Survey Location of Preliminary Survey in Milne Bay



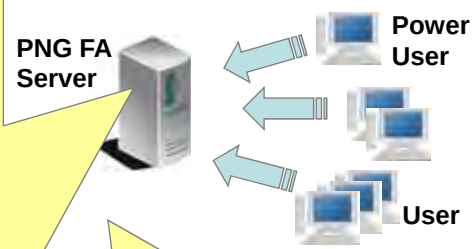
Survey Information and Satellite Imagery (GeoEye)



Spatial Data Management: Design & Organize Data

File type	Folder name	Description
Satellite & airborne imagery (original /pre-analysis data)	01_Satellite	Satellite imagery
	02_Airbone	Airborne data
	03_DEM	Satellite imagery (DEM)
	04_TopoMAP	
Field survey data	11_FieldSurvey	
Analysis data	21_TopoAnalyst	
	22_SatelliteAnalyst	Satellite imagery analysis data
Thematic data	31_ForestMap	National forest basemaps
	32_CarbonStock	Carbon stock data
Other thematic and its parts data	41_Thematic	Other thematic data
	42_Boundary	Boundary data
	43_Planning	Planning data
Other spatial data	51_Others	Other spatial data
Map layout & output data	71_MapLayout	Map layout (Map document file)
	72_Output	Report file/Exported map
Exsisting system & data sets	81_FIMS	FIMS
	82_FIPS	FIPS
	83_PNGRIS	PNGRIS
	84_Geobooks	Geobook data produced by UPNG
	85_MRA	Spatial data produced by MRA
	86_NWS	Spatial data produced by NWS
	87_FreeData	Other free data
Other documents	91_Documents	Other documents

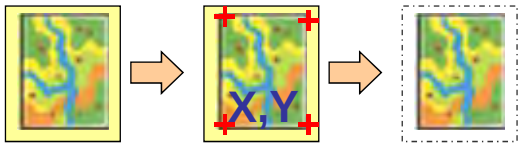
Folder construction rule



File naming rule

Topo Map Scaning: Using A0 Plotter/Scanner for GIS

Workflow



Scan　　Georectify　　Edgecut

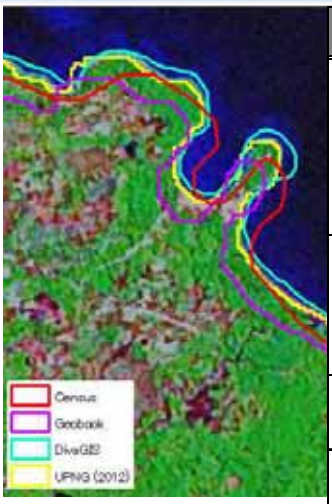
File Naming Rule

File	File Naming Rule
Scanned images	TOPOs＋Sheet No.＋Sheet Name
Georectified images	TOPOr＋Sheet No.＋Sheet Name
Edgecut images	TOPO＋Sheet No.＋Sheet Name

Index Map of Topographic Map

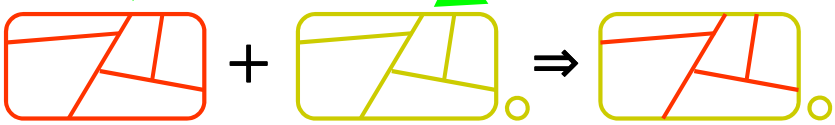
Enable to gain quick access to the maps

Administrative Boundary: Analysis and Pro. Conclusion



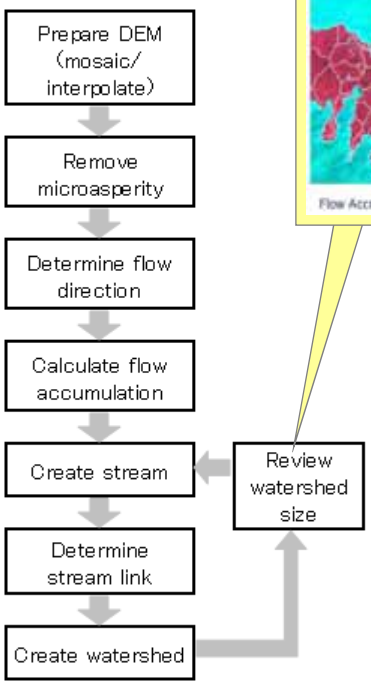
Mismatch between coast lines

		Census (PNG FA)	Geobook	DivaGIS (Free Data)	UPNG (2012)
Data accuracy	Matching between administrative boundaries	Good	Almost good, some features **don't match**	Good	Good
	Feature shape	Good	Good	Some feature shape are **strange**	One islands' shape looks a little **strange**
	Feature existence	There aren't some islands	No problem	There aren't some islands	No problem
Line figure (segment fineness)	mainland	Tidy	Tidy	Tidy, but **rough** boundary as to inland	Tidy
	island coast line	Natural	Some parts of shape are **not smooth**	a little parts of shape are **not smooth**	Some parts of shape are **not smooth**
	river mouth		Line fineness varies from place to place		
Topology		No problem	**Many topological errors, sliver polygon / gap**	No problem	**Some topological errors**
Location accuracy (matching between other data)	Landsat	A l**ittle mismatch**, < about 200m	A little **mismatch**, < about 200m, but good fit at some parts	Good fit	Good fit
	Rapid Eye	A**little mismatch**	A little **mismatch**	Better	Better
	Google Earth (high resolution area)	**little mismatch**	A little **mismatch**, better fit at some parts	**tter**	Better

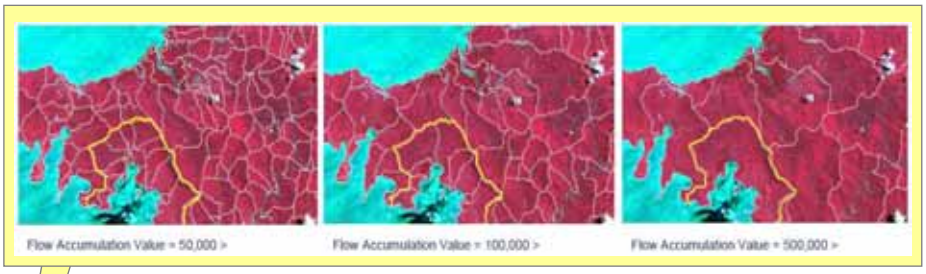


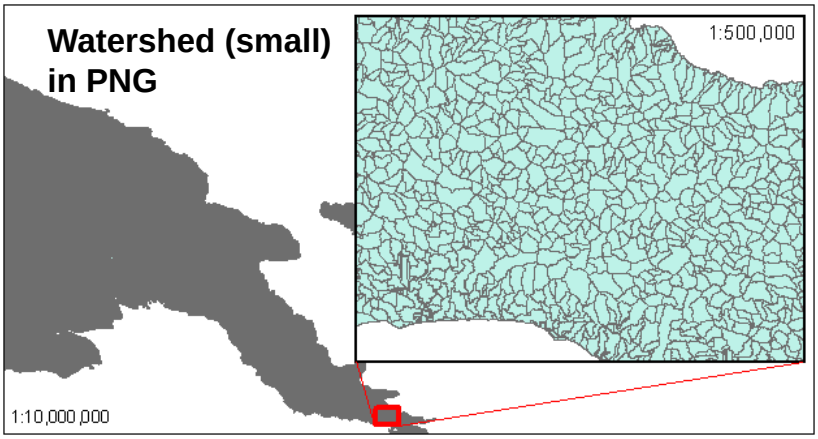
Watershed: for Forest Classification & Management

Watershed analysis flow



Review of watershed size

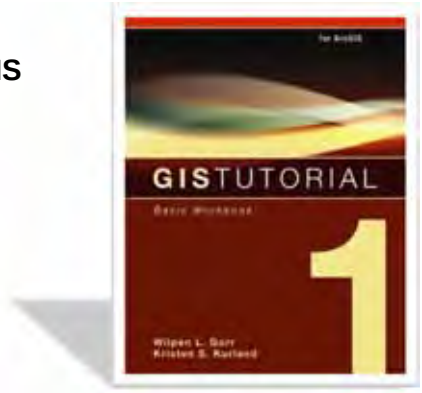




GIS Training Program for Universities and Institute

Contents:

- Introduction to ArcGIS
- Map design
- GIS outputs
- File geodatabase
- Spatial data
- Digitizing
- Geoprocessing
- Spatial analysis
- Introduction to ArcGIS 3D Analyst
- Analyzing raster data
- Creating surface
- Analyzing topographic surface
- Analyzing distance
- Suitability analysis
- Hydrological analysis
- Ecotope mapping



Future Plan 1

- TA1
  - Based on the methodology developed through JICA TC & training in Japan, expanding to Sub-National, National
  - Using ALOS/PALSAR pre-processed through GrantAid TA, analysis of recent deforestation area (forest change)
  - Integrate national level forest basemap & forest change as a benchmark for developing trial-base REL/RL
- TA2
  - Design and Development for Integrated Database of FIMS and FIPS
  - Corresponding to the new requirements for updated FIMS and FIPS
    - E.g. Adding “10-19cm Diameter class” in the report form of FIPS
  - Discussion on the feasibility of the PSP data integration to forest resource database management system

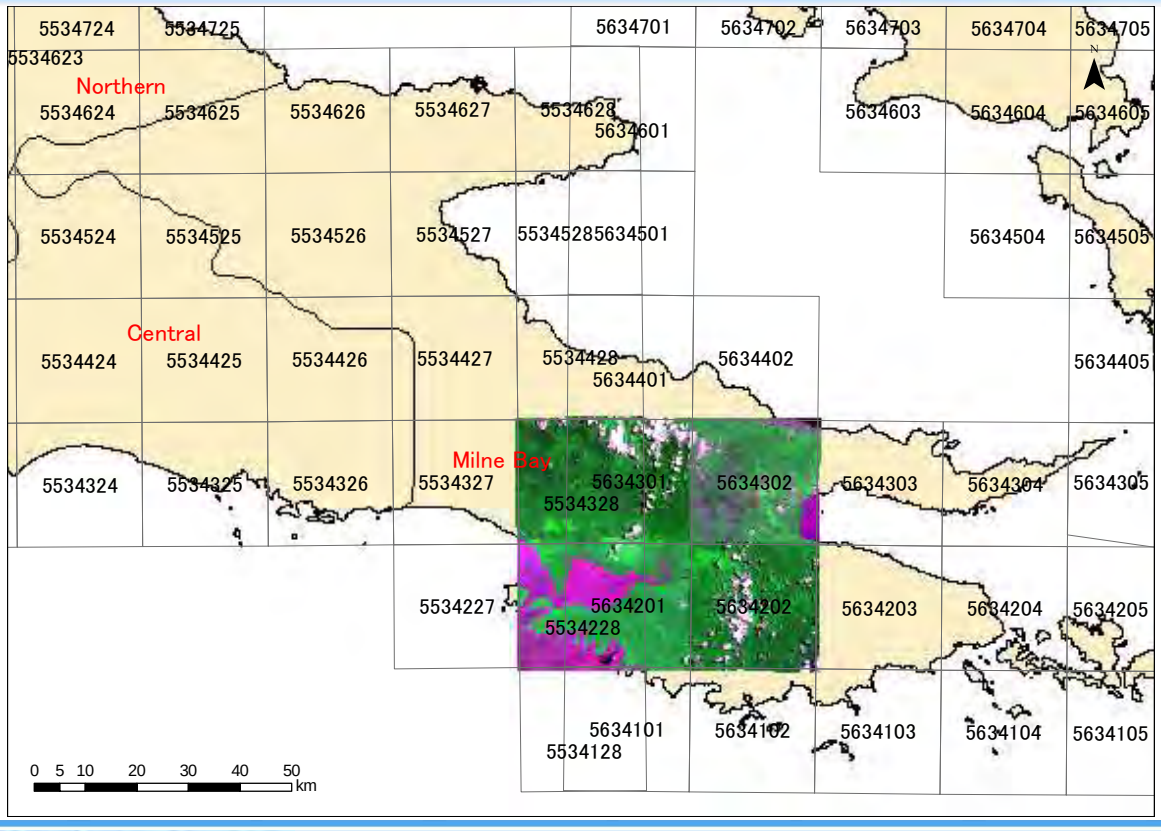
Future Plan 2

- TA3
  - Based on the preliminary analysis of field survey and GeoSAR2006, re-design survey method & implement survey
  - Pre-processing of GeoSAR and LiDAR 2012 and using lesson learned from DEC Kokoda experience
  - Developing the canopy volume estimation for carbon stock amount using existing GeoSAR and new GeoSAR/LiDAR
- TA4
  - Spatial data (survey and analysis will be stored/organized in the designed management rule and structure
  - Scanning of Topo map will be continued and Geo-rectify the scanned map for GIS use
  - GIS Training for trainers for UPNG and UNITECH/Forestry department was conducted (Jun. at UPNG, Dec. at UNITECH)

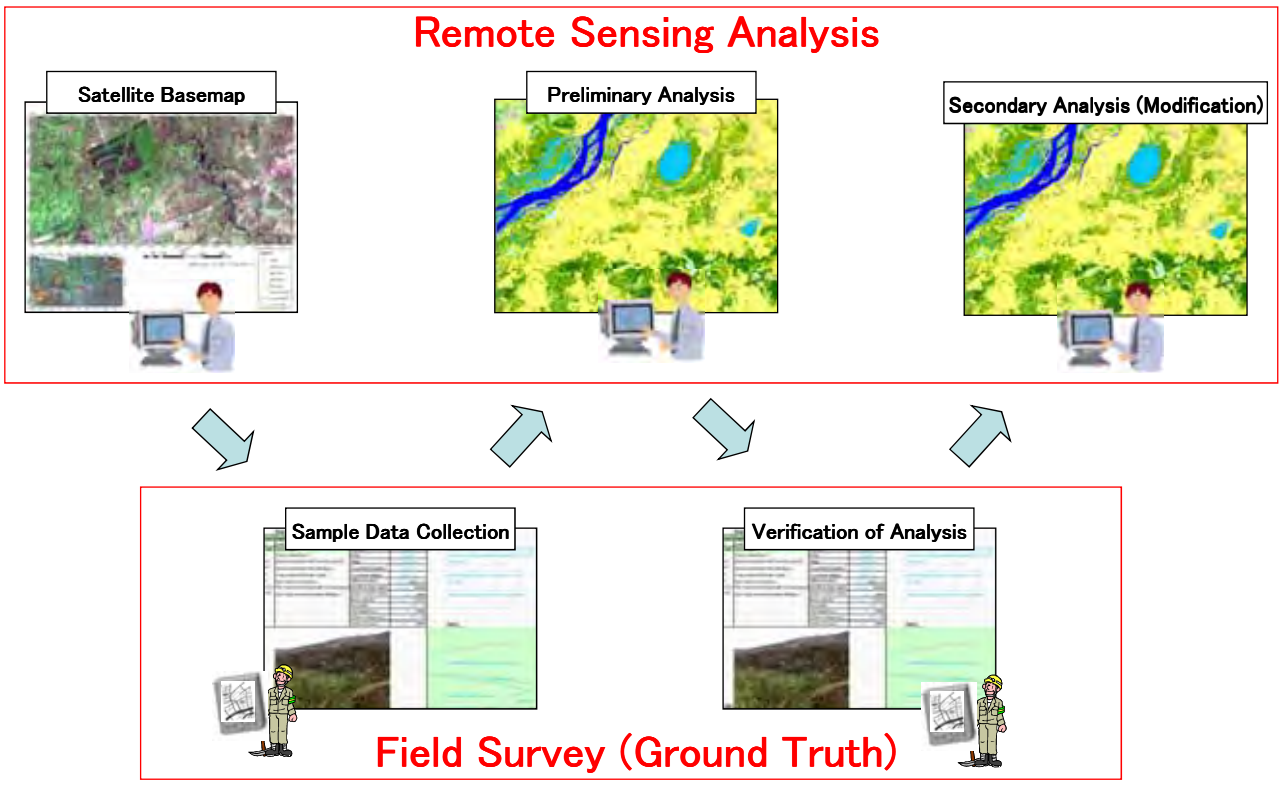
Summary of Progress

- Equipment Procurement
  - Delivery and Setting-up (including other organizations) is completed except airborne data
  - Airborne Radar (GeoSAR) and LiDAR are successfully collected and delivered recently (Feb. 2013)
- Technical Cooperation/Assistance
  - TA1: Methodology is defined through training but it took time because it is important/necessary of CP experience
  - TA2: Replace of FIPS and new FIMS is developed and design of integration is prepared (PSP DB is also being analyzed)
  - TA3: Plot design for Canopy Volume Estimation is developed and preliminary survey is conducted, analysis will start again
  - TA4: GIS training for trainers is conducted at UPNG, Unitech and HQ/FRI, basic data preparation (scanning Topo) is going

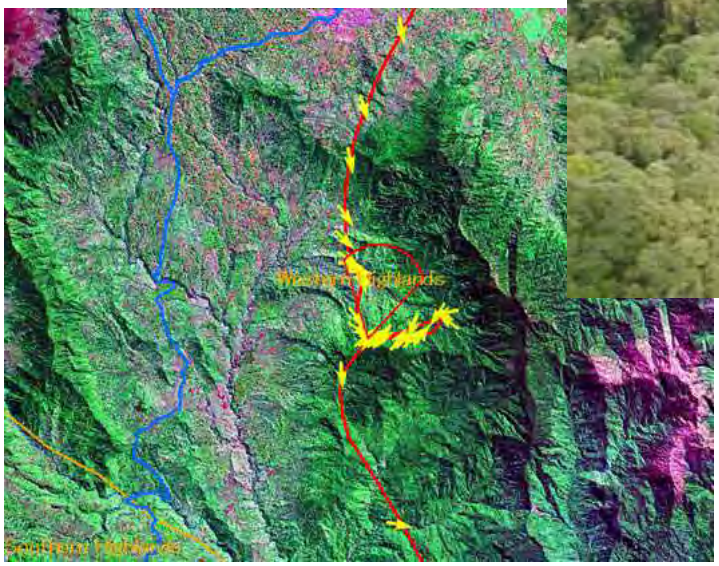
Satellite Imagery are Ready to Use: Index & Imagery



Flow of Remote Sensing & Field Survey (Ground Truth)



Ground Truth of Vegetation Type using GPS & GIS



GIS Data Output

Data Transfer & Communication with Local Office

Data & Functions

Satellite Image

Landcover Map

Survey Sheets

Cloud-free Data with using Satellite Imagery

CD-R

Province

Province Office1

Field Survey & Monitor

Province Office 2

Field Survey & Monitor

Province Office 3

Field Survey & Monitor

Area Office

Commonly installed

- ArcView (Map View & Simple Edit)
- Satellite Imagery (related tile)
- Simple project-file for easy use

Existing Data

Head Quarter

search analysis display …

Shared data

Shared Functions

Forest Monitoring System for REDD/MRV

Information and capacity upgrade and enhance

Result Sheets

KML

PDF

GIS Data Output

Landcover/Forest BaseMap for Carbon Estimation

Background & Needs

National Level Forest Resource Monitoring

Forest Resource Basemap for Biomass/Carbon Estimation

Challenges & Countermeasures

Overall Comprehension using Radar Satellite (ALOS/PALSAR)

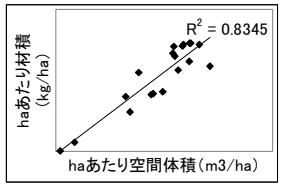
Biomass/Carbon Modeling & Estimation by Sampling Analysis

National Level ForestMonitoring with Radar Satellite

Nation-wide Expansion

Biomass/Carbon Modeling based on Spatial Volume

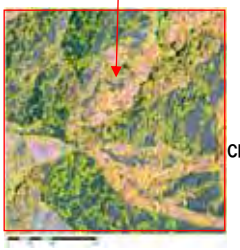
Tree Stand Volume



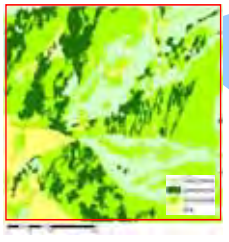
Relational Expression of Spatial Volume & Tree Stand Volume

Multi Platform Sensing

Forest Basemap Development with Optical Satellite

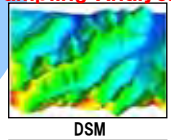


Classification

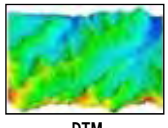


2D: Area of Forest/Vegetation Type

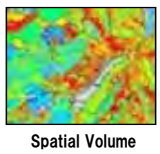
Sampling Analysis for Spatial Volume Estimation



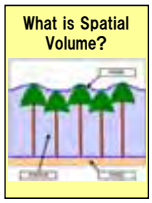
DSM



DTM



Spatial Volume



3D: Spatial Volume for Carbon

Data Transfer & Communication with Local Office

- Remote Sensing analysis needs good field survey information (sample & verification) which is good to be implemented with cooperation with area/provincial officers
- The way of field survey can be improved by using Remote Sensing, GIS and GPS and PNGFA is ready to start applying for these technologies (Kick off in this workshop)