PAPUA NEW GUINEA
MULTI-PURPOSE
NATIONAL
FOREST
INVENTORY

PNG FOREST AUTHORITY

Food and Agriculture Organization of the United Nations

Papua New Guinea Forest Authority

Papua New Guinea

UN-REDD PROGRAMME

EUROPEAN UNION

PAPUA NEW GUINEA MULTI-PURPOSE NATIONAL FOREST INVENTORY

PNG FOREST AUTHORITY

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Disclaimer

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1. Background & objectives

Background

New Guinea is the largest tropical island in the world and contains the third largest tropical rainforest after the Amazon and Congo Basin. Papua New Guinea (PNG) comprises the eastern portion, while West Papua which is part of Indonesia comprises the western portion and both make up the Island of New Guinea.

The Island is a well-known centre for biological endemism and species diversification. Currently PNG's tropical rainforest is relatively well conserved. Nevertheless, the forest is confronted with increasing pressure, due to resource extraction, especially through logging, but also from clearing for agriculture. Despite their extent, size and rich diversity, PNG forests are poorly known scientifically.

Huli Tribesman of Hela Province, PNG
(Photo: PNG TPA)

Tumbuan masks of New Britain
(Photo: PNG TPA)

Kairuku traditional dancers, Central Province
(Photo: PNG TPA)

About 97% of land in PNG is under customary tenure. Forests belong to the people and the majority of population rely directly on forest for their living. Forest provides food, water and materials. Forest forms soil, maintain biodiversity, purify air and water, regulate climate and prevent disasters such as flooding and land slide. Forests are also important for people both spiritually and culturally.

The Forest Industry is estimated to contribute about 9% of GDP and about 5% of formal employment of the country in 2005[1].

PNG has taken a global lead in seeking to combat climate change, particularly by proposing measures to realize the carbon abatement opportunity by preserving and sustainably managing tropical forests, i.e. through the concept of REDD+ into international negotiations at COP11 in Montreal in 2005.

The implementation of REDD+ require accurate national scale forest monitoring. The capacity on remote sensing based forest assessment in PNG has significantly improved in recent years. However a large information gap still remains. National scale information on carbon stock in the diverse forests subject to different disturbances is poorly known. With the completion of a national forest inventory (NFI), PNG will be able to obtain good information on carbon stock and accurately estimate Green House Gas emissions from deforestation and forest degradation.

The NFI is implemented by PNG Forest Authority and other collaborators like New Guinea Binatang Research Centre, PNG University of Technology, University of Papua New Guinea. International partners such as European Union, Food and Agriculture Organization and UN-REDD provided the funding and technical support. NFI also receives financial support from many organizations including the Crawford Fund and Mountain Partnership.

Objectives

1. Improve our understanding of PNG forest for better planning and management for people in PNG to receive sustainable ecosystem services.

2. Identify economic and social values of forest in PNG.

3. Contribute to international actions to combat climate change impacts and biodiversity loss.

Better information leads to better decisions, which lead to better actions.

2. Forest in Papua New Guinea

In PNG, forest is defined as: "land spanning more than one hectare, with trees higher than three metres and the canopy cover of more than 10 percent ". This excludes land that is predominantly under agricultural or urban land use.

PNG Forest Authority conducted a remote sensing based national forest assessment using satellite images in 2013 as a preliminary assessment of the National Forest Inventory. The assessment provided basic forest and other land use information in the country[1].
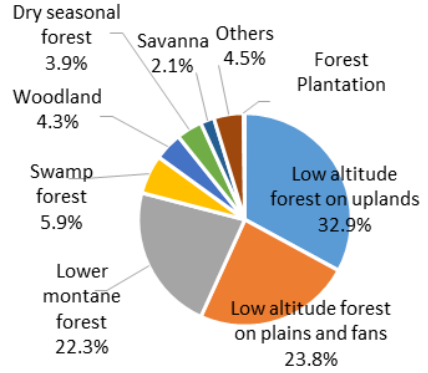
Forest and land use in PNG

PNG has a total land area of about 46.9 million hectares of which 37.7 million hectares (80.4%) is forest land and the remaining 9.2 million hectares for other land use. These land use include cropland, grassland, settlement, wetland and other land. The second major land use is cropland (0.7 million hectares or 8.4% of the total land area) which has two main activities, i.e. subsistence and commercial agriculture. The dominant activity identified under subsistence agriculture is shifting cultivation (0.5 million hectares or 83.1%) and for commercial agriculture are oil palm (0.05 million hectares or 7.4%) and coconut plantations (0.02 million hectares or 4%).

There is a strong relationship between land use and altitude as depicted in the graph below. For instance, the distribution of forest is found at all elevation from sea level to 3,700 m above sea level and agricultural activities are more evident in the higher altitudes (1,300 m plus above sea level) mostly occurring in the Highlands Region.
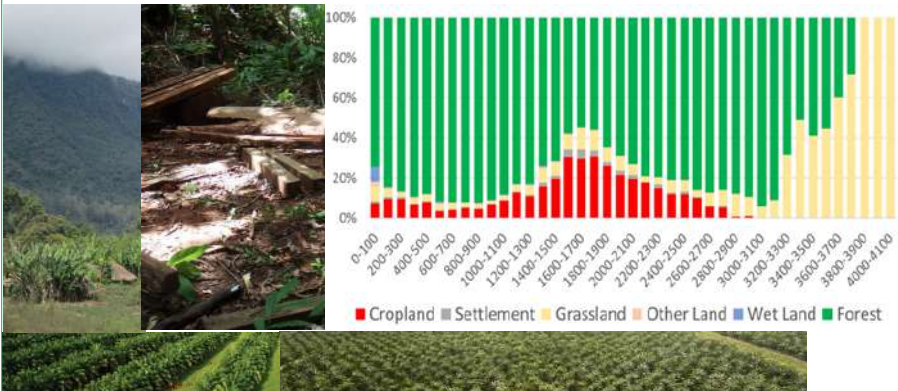
Forest types in PNG

PNG forest is classified into 13 forest types comprising 12 natural forest types and 1 forest plantation[2]. Out of these forest types, three are dominant; and they are: low altitude forest on plains and fans, low altitude forest on uplands, and lower montane forest, and they account for almost 30.1 million hectares (80%) of forest in PNG. Plantation forest accounts for only 0.07 million hectares (0.2%) of the total forest area.

Dry seasonal forest 3.9%
Savanna 2.1%
Others 4.5%
Woodland 4.3%
Swamp forest 5.9%
Lower montane forest 22.3%
Forest Plantation
Low altitude forest on uplands 32.9%
Low altitude forest on plains and fans 23.8%

Forest disturbance in PNG

About 22.6 million hectares (60%) of forest in PNG are primary (no human disturbance), 5.5 million hectares (14%) are logged over and 9.8 million hectares (26%) are disturbed by other activities such as gardening, fire, and small scale logging (wokabout sawmill). Logging operation or activities are only found occurring at below 1000 m above sea level mainly in the *Low altitude forest on plains and fans* and *Low altitude forest on uplands*.

14%
26%
60%

Lower montane
Low altitude on uplands
Low altitude on plains and fans

0% 20% 40% 60% 80% 100%
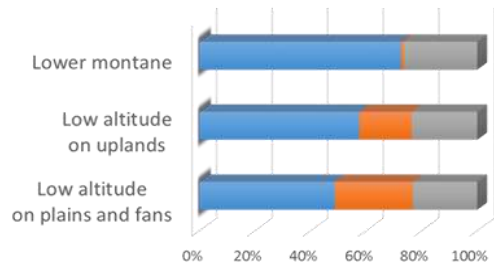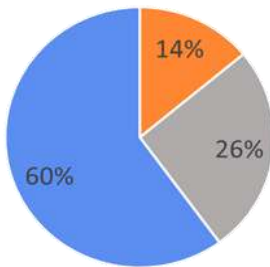
■ Undisturbed ■ Logged ■ Disturbed

[1] PNG Forest Authority (2015) *Forest and Land Use in Papua New Guinea 2013*.
[2] Hammermaster & Saunders (1995) *Forest resources and vegetation mapping of Papua New Guinea*.

3. NFI Methodologies

Two phases approach

PNG National Forest Inventory has progressed taking a two phased approach. In the first phase, remote sensing based forest assessment was conducted to stratify the forest in PNG. A number of clusters in each forest strata was determined according to its proportion. The location of clusters were then determined and distributed evenly throughout the country by their forest types. A total of 1000 clusters distributed across the country as shown on the map below. Moving into the second phase, the actual inventory work, measuring a proportion of the different forest strata out of the 1000 clusters across the country.

Map of National Forest Inventory Sites in Papua New Guinea
NFI 2016-2018
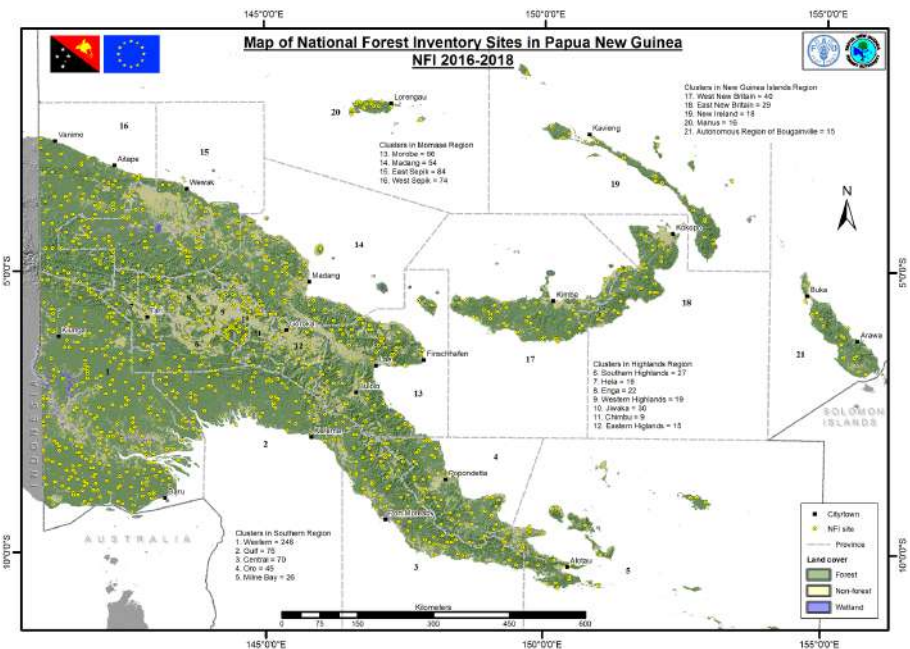
Multi-purpose NFI

Forest inventories were traditionally conducted for estimating harvestable timber volume. As the importance of multiple values of forest become recognized in recent years, additional diverse information are required in the forest inventory.

PNG's first National Forest Inventory is designed as a multipurpose NFI, which will collect information on timber volume, minor forest products, carbon stock, soil characteristics, biodiversity in both flora and fauna, and socio economic aspects of PNG forests.

Cluster plots

A cluster consists of four plots as shown in the figure below left. The plots are located 300 m apart to each other in the cluster, which is far enough to be treated as an independent plot. There are four circular plots in different radii within each plot shown in the figure below right. Each plot within a cluster has four circular sub-plots with different radii as shown in figure below (right) capturing different tree diameter classes to ensure sufficient number of samples for all diameter class.

Cluster Design
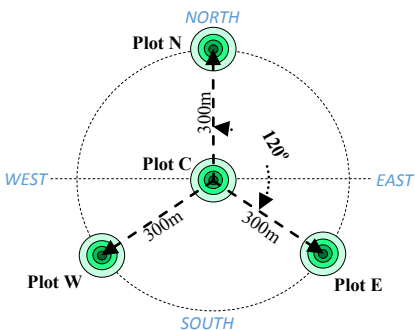
Plot Design
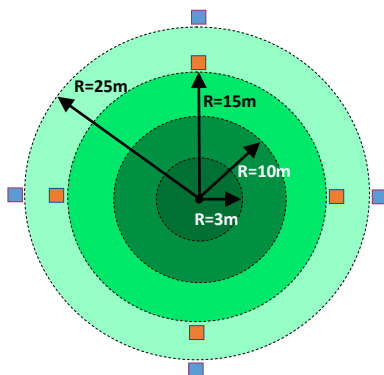
Radius (R) and DBH
R = 25m: Trees with DBH > 40cm
R = 15m: Trees with DBH > 20cm
R = 10m: Trees with DBH > 10cm
R = 3m: Trees with DBH > 1cm

KEY
■ Understory, litter, Fine CWD, Surface soil (1m x 1m)

■ Regeneration (1m x 1m)

4. Botanical Assessment

Trees

Living and dead trees are recorded in all plots; starting with trees having diameters larger than 1 cm but smaller than 10 cm in 3 m radius plot and moving up the radius up to trees having diameters larger than 40 cm in 25 m radius plot—see plot design. This method is adopted to equally capture enough trees in all diameter classes.

Diameter at breast height (1.3 m or point of measure above buttress) and height are measured to estimate volume and biomass (carbon).

Species are identified to understand biodiversity and forest characteristics. There are over 4,000 tree species in PNG. It is very difficult to accurately identify species in the field. Therefore specimens (leaves, flowers and fruits) are collected for identification and storage at the PNG National Herbarium in Lae. Some specimens are sent to the herbaria overseas for identification and information exchange.

Pangium edule (Flacourtiaceae)

Steculia *shillinglawii* (Malvaceae)

Myristica fatua (Myristicaceae)

Plants other than trees

Plants other than trees including palm, pandanus, fern, shrub, grass, epiphyte and liana are also recorded, measured and their species identified in the plots. They are also an important component in indicating forest structure and status, biodiversity, carbon and economic and cultural values.

Pandanus polycephalus
(PANDANACEAE)

Calamus longipina
(ARECACEAE)

Licuala longispadix
(ARECACEAE)

It is estimated that about 20,000 plant species exist in PNG. It is very challenging to identify all the plants found in the plots even for most experienced botanists in PNG.

5. Zoological Assessment

The multi-purpose National Forest Inventory could be a starting point for assessing PNG's legal compliance for a comprehensive biodiversity audit and in addressing its commitments to the REDD+ agenda.

Why insects and birds?

The selection of insect groups and birds for NFI is influenced by several factors which are: (a) their significant roles and rapid responses in the forest ecosystem; (b) the simple quantitative assessment methods that fit the NFI short time frame allocation per cluster, (c) the availability for rapid sampling; (d) the sampling which can be done independently from weather and season, and (e) they are moderately known taxonomically for immediate sorting out, identification and analysis.

Moths, fruit flies and ants are key insect groups that represent a significant biodiversity. There are about 4000-5000 species in total for PNG. Our knowledge of their richness and diversity across different forest types, and altitude as well as their contributions toward forest ecosystem enrichment, is still very limited.

1. Moths (Geometridae family)

Moths are key herbivorous insect groups that feed on plants. There are over 2,500 species found in PNG, and among them many are still unknown to science. This family group which is highly diverse locally, is often used for bio-indication and ecological studies with good indication value across different altitudes (elevation) in the tropics. We plan to conduct two simultaneous white-sheet light traps over 2 nights (4 sampling nights) per cluster.

2. Fruit flies (Tephritidae family)

Fruit flies are common pest of most tropical food crops and fruits trees. A total about 770 species has being recorded in PNG, which only 250 species of them were described. Our knowledge is limited only to their destructive feeding habits and reduction of the food crops and edible fruits. However, we do not fully understand their contributions in enriching the forest ecosystem as herbivores. Sampling is done using the Steiner trap method baited with a combination of three lures: (i) cue lure, (ii) methyl eugenol or zinger one and (iii) the insecticide.

3. Ants (Formicidae family)

Ants are often used as indicator taxa because of their importance as common forest dwelling predators and mutualists on tropical vegetation. According to PNG collection records, there are about 800 species at present, and the NFI is expected to contribute towards updating that information. A simple tuna-cordial bait method is used for sampling a subset of ant species present for ecological analysis.

4. Birds

PNG is re-known for its high diversity of birds with 786 species and around half of these are endemic, thus are not found anywhere else in the world. Birds are recognized for their roles as key pollinators, dispersal agents and indicators of rich terrestrial ecosystems. A combination of sampling techniques which include: (a) Point-count; (b) MacKinnon lists; (c) Automatic recordings using song meters; and (d) Daily checklist is adopted for NFI sampling purposes.

Lesser Bird of Paradise
(*Paradisaea minor*)

Yellow-faced Myna
(*Mino dumontii*)

Sulphur-crested Cockatoo
(*Cacatua galerita*)

6. Soils & other studies

Soil

Soil is an important component of forest ecosystems as it helps regulate important ecosystem processes, such as nutrient uptake, decomposition, and water availability. From the limited studies conducted, soil may store about 50% to 75% of forest carbon in PNG.

Soil profile of 1 m depth are planned for 100 selected NFI clusters in various major geological types to collect fundamental information of forest soils in PNG. Surface soil (30 cm depth) samples are collected at all NFI plots to understand soil carbon and nutrient in relation to forest types and human disturbances.

Dead Trees and other Plants

Partly to fully decomposed trees and other plants on the forest floor hold substantial carbon and nutrient in their bodies. Litters (fallen branches and leaves) on forest floor are regarded as an important carbon and nutrient pool in the forest ecosystems. These materials will also be measured in the NFI plots to determine the carbon contents in different forest types.

Indigenous knowledge

Indigenous knowledge forms the basis of local-level decision-making in many rural communities in PNG. A funded study under the NFI anticipates to identify and align the indigenous knowledge with the changing trend of forestry businesses. Furthermore merge the traditional knowledge with the present and future policies that creates a win-win situation among forestry stakeholders.

Non-Timber Forest Products

Non-Timber Forest Products refer to the woody and non-woody plants other than timber that have other socio-economic benefits. NTFP such as rattans, orchids, eaglewood, tulip-nutmeg fruits, Dendrocnide leaves and mushrooms are classical examples. NFI records the uses by different traditional communities.

7. Capacity Building and Collaboration in NFI

Capacity Building

Capacity building within the PNG Forest Authority and its collaborative partners is an important key element for the successful implementation of National Forest Inventory. A number of capacity building activities have been conducted both in-country and overseas. The training areas include:

⇒ Remote sensing and GIS, Data management and analysis, Plant species identification, Zoological surveys, Soils, etc.

⇒ 13 scholarships for post-graduate studies at the University of Technology and UPNG were awarded to PNGFA scholars and others involved to research NFI research topics of interest.

Collaboration

The PNGFA works in collaboration with other in-country institutions such as the PNG University of Technology, the University of Papua New Guinea and New Guinea Binatang Research Centre to implement the NFI. PNGFA also collaborates with few international institutions such as Sapienza University of Rome, University of Queensland, University of Tasmania, University of Melbourne and Forestry Practices Authority in Tasmania for capacity building, quality assurance and quality control.

8. NFI launching & key message to the people

Message from the Prime Minister

The NFI Project was launched by the Prime Minister of Papua New Guinea, Rt. Honourable Peter O'Neill and Minister for Forests Honourable Douglas Tomuriesa, and other key ministers at the PNG Forest Authority headquarters in Port Moresby on March 9th 2016. Other official guests at the event were; the European Union Ambassador to PNG HE Ioannis G. Argyropoulus, FAO Representative in PNG Mr. Ken Shimizu, and the then PNGFA acting Managing Director, Mr. Goodwill Amos.

Prime Minister, Peter O'Neil said, "Forests are very important part of our lives, part of our communities throughout the country for thousands of years. It has fed our people, looked after our people, sheltered our people and that is why we are here today. It is important that we conserve forests for future generations because it will continue to serve them for thousands of years in the future. Forest contributes a significant amount to our nation's development. We need to do the right things to protect our people's interest and our forests for future generations".

Grade 8 students of Eki Vaki Primary School preparing to sing the national anthem during the NFI launching

Message to the people of PNG

The purpose of the official launch was to inform the people of PNG and the resource owners throughout PNG about the project. The intended NFI outcome is important to PNG as it will provide the country with additional information on what is in the forests and its values.

PNGFA and its collaborating partners will be assessing about 1,000 clusters selected in different forest types throughout the country. Documentation of plants, birds, insects and the assessment of soils are key activities associated with the assessment of the clusters. Success of the NFI depends on the support of the provincial governments and most importantly the landowners. Therefore, PNGFA and its collaborating partners call for the support and assistance of all stakeholders at the provincial, local level government and the rural communities.

## NFI Office Building Opening

NFI work in PNG now has an office to operate from. It was named the National Forest Inventory (NFI) office. The high post building was officially opened by the EU Ambassador to PNG H.E Ioannis Giogkarakis-Argyropoulos on the 3rd of August, 2017. Ambassador Giogkarakis-Argyropoulos when opening the office said the support to the PNGFA is part of the contribution towards a state-of-the-art Forest Monitoring System in the country. The main objective is to improve the understanding and appreciate the value, wealth and uniqueness of PNG forests.

9. NFI Progress

The Multipurpose NFI officially began the field assessments proper in May 2017. Prior to that, selected clusters were assessed as part of field protocol testing and training exercise back in November 2016. So far, 16 clusters have been assessed, covering 57 plots in total. Clusters assessed were mainly in Madang, Central, Oro, Eastern and Western Highlands and Morobe Province.

Awareness and reconnaissance exercises have commenced in Madang from March to May 2018. Field assessment proper is expected to commence soon, targeting 16 clusters cleared following awareness and reconnaissance exercises.

Map showing PNG NFI 16 clusters sites surveyed during 2016-2018
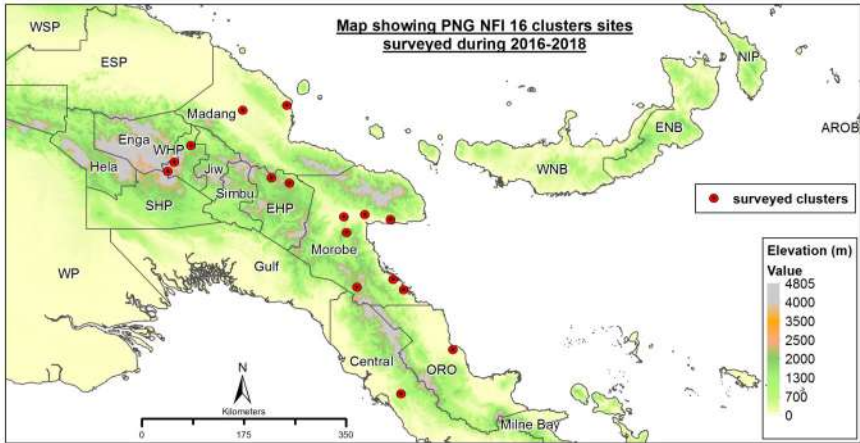
Mt. Giluwe, Tambul, WHP

Bukawa, Morobe

Henganofi, EHP

Bena, EHP

Biaru, Morobe

Bena, EHP

Henganofi, EHP

Mt. Giluwe, Tambul, WHP

Bena, EHP

Biaru, Morobe

Fostering Community Relations at the Cluster level

Building good community relations is a key aspect that paves way for execution of assessment proper at the cluster level. Importantly, for the landowners to understand the aim of the survey and to seek their free prior consent and granting the accessibility rights to their forests.

To date, awareness and reconnaissance exercises have proven to work successfully for the assessed clusters. Follow-up meetings and traditional obligations held between the PNGFA and the landowners' particularly in the Highlands strengthened the accessibility agreement. Involvement of landowners in the assessment proper provides cash return opportunities and direct learning experience in forestry survey.

Henganofi, EHP

Henganofi, EHP

Mt. Giluwe, Tambul, WHP

Sogeri, Koiari, Central Province

10. Preliminary Results

Preliminary results of 15 clusters (53 plots) and remote sensing based studies were presented at the NFI Research Conference in Lae on 14 to 15 February 2018. Below are some key findings on the NFI research topics.

Forest and Land Use Change

Around 78% of the country is covered by forest with about a quarter of them being disturbed by human activities such as logging. Deforestation rate in the country is not so significant. Over a period of 15 years between 2000 and 2015, 0.67% of forest was converted to other land use mostly cropland. Major deforestation drivers were subsistence agriculture and Oil Palm plantations. Forest degradation have been occurring more severely which indicated a 6.1% of forest being degraded mostly by commercial logging during the same 15 year period.

Above Ground Biomass in the Forest

Average above ground tree biomass of primary forest is 274 t/ha and disturbed forest is 152 t/ha. We do not have enough data to compare the biomass of different forest type or different elevation range yet. It is estimated that 503 plots (126 clusters) are required to be assessed to obtain statistically reliable biomass estimate of all forest types in PNG.

Botany

A total of 2,222 trees with 240 species being measured and recorded. A total of 1,438 species of plants were recorded and specimens collected.

Zoology

NFI assessment has recorded 245 bird species from 11 clusters. A total of 478 moth species from 6 clusters, 83 species of fruit fly from 14 clusters and 67 species of ant from 7 clusters were recorded . Many of these insect morpho species recorded in NFI can be new to science.
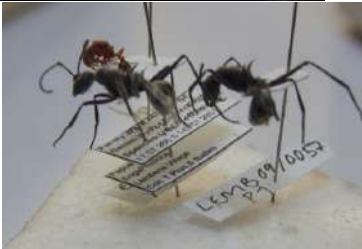
Ribbon-tailed Astrapia (*Astrapia mayeri*) recorded in Mt. Giluwe, Tambul, WHP

Soils

Average soil carbon to 1 m depth at the 11 NFI clusters studied is 113 t/ha. Highest carbon content (196 t/ha) was recorded at floodplain in Manabo, west of Bomguina River, Central Province. It contains buried soil (photo below left), which is an important repository of extra carbon. Lowest carbon content (58 t/ha) was recorded at seasonally inundated area in Ononda, Oro Province (photo below right). Recent alluvial deposits cause the low carbon content.

Manabo,
Central Province
Soil type: Cambisol

Ononda,
Oro Province
Soil type: Gleysols

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Implementing partners:

Funding agencies:

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Better information leads to informed decisions that result in better actions.