FOREST RESOURCES OF PAPUA NEW GUINEA

EXPLANATORY NOTES TO MAP

J.C. Saunders

PNGRIS Publication No. 2

prepared by
Commonwealth Scientific and Industrial Research Organisation
for Australian International Development Assistance Bureau
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ABSTRACT

The 1:1 000 000 forest resources map shows the location and extent of the major forest resources of Papua New Guinea. The accompanying explanatory notes describe the mapping method and the eleven types of forest mapped.
ACKNOWLEDGEMENTS

The Papua New Guinea Resource Information System (PNGRIS) is a computer-based natural resource and land use planning tool. Under an agreement between the Papua New Guinea Government and the Australian International Development Assistance Bureau (AIDAB), the Commonwealth Scientific and Industrial Research Organisation (CSIRO) has contracted to develop PNGRIS further. This publication is one of a series produced under that contract.
1. INTRODUCTION

This map, Forest Resources of Papua New Guinea (Forest map), is a synthesis of two previously published maps, Vegetation of Papua New Guinea (Vegetation map) (Paijmans 1975) and Agricultural Land Use of Papua New Guinea (Land Use map) (Saunders 1993). It portrays the location and extent of the major forest resource of Papua New Guinea (PNG) and indicates the levels of disturbance within each mapped forest type.1

The boundaries of vegetation types on the Vegetation map are derived mainly from CAJ aerial photography dating back in some cases to the early 1950s. The Land Use map boundaries are derived solely from SKAIPIKSA aerial photography flown in 1973. The only significant changes to forest vegetation cover that have occurred over this 20 year period are due to land use changes. These changes are reflected in the Land Use map. The Forest map, therefore, is effectively a baseline map of the status of the forest resource in 1973 before major forestry operations commenced in PNG.

2. METHOD

The first step was to decide which of the vegetation types defined in the Vegetation map should be included as the major forest types on this Forest map. The forest resource and vegetation chapters of the CSIRO Resource Survey publications (1964 to 1976) were used to make this decision. Two additional forest types were included at the request of the PNG Department of Forests - mangrove communities and Terminalia brassii forests. The selected types are listed in Table 1.

The Forest map does not include some vegetation communities classified as forest in the Vegetation map but excluded by the above decision. These communities include swamp and littoral forests which may be a valuable resource to a local industry, and the high altitude montane and very small crowned lower montane forests which have an invaluable role in watershed protection.

Provisional stocking rates (SRs), based on those from CSIRO Resource Surveys, mounted between 1953 and 1973, were then allocated to each forest type. These SRs were used to facilitate the mapping of complexes comprising more than one forest type.

The Vegetation map and Land Use map were based on different projections, both at a scale of 1:1 000 000. The Vegetation map was based on a Mercator Projection, whereas the Land Use map was based on a Lambert Conformal Conic Projection. Also the drainage pattern and topographic detail was far more generalised and less detailed on the Vegetation map than on the Land Use map. Consequently, although care was taken in the transfer of forest type boundaries from the Vegetation map to the Land Use map, some inconsistencies were inevitable.

The following procedure was used in the production of the Forest map:

A. The forest type boundaries were transferred from the Vegetation map to the Land Use map by overlay. Necessary adjustments were made for projection. Each polygon thus created was then annotated with the appropriate forest type code.

Areas which were mapped as complexes on the Vegetation map were treated as follows. Their component vegetation types were assumed to be in proportion to their respective hatched areas on the Vegetation map.

(i) Complexes of 2 or more forest types were given the forest type code with the highest SR but with a suffix indicating a lower SR. This suffix, a single digit in the range 1 to 9, denotes the combined average SR as a percentage of the estimated SR of the highest-yielding type e.g. ‘2’ denotes 20%.

(ii) Complexes of a forest type with other vegetation communities were annotated

1. These data, and their occurrence within each Resource Mapping Unit (RMU), have also been incorporated into the Papua New Guinea Resource Information System (PNGRIS) (Bellamy 1986).
Table 1: Forest types

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<tr>
<th>Vegetation Map Code</th>
<th>Forest Map Code</th>
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<td>FIPL</td>
<td>Pl</td>
<td>Large to medium crowned forest</td>
</tr>
<tr>
<td>FPo</td>
<td>Po</td>
<td>Open forest</td>
</tr>
<tr>
<td>FPps</td>
<td>Ps</td>
<td>Small crowned forest</td>
</tr>
<tr>
<td>P(part)</td>
<td>PTb</td>
<td><em>Terminalia brassii</em> forest</td>
</tr>
</tbody>
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| Low Altitude Forest On Uplands |                  |                                                        |
| FH1                             | H1              | Large crowned forest                                   |
| FHm                             | Hm              | Medium crowned forest                                  |
| FHs                             | Hs              | Small crowned forest                                   |

| Lower Montane Forest |                  |                                                        |
| FL                  | L                | Small crowned forest                                   |
| FLc                 | Lc               | Small crowned forest with conifers                     |

| Dry Seasonal Forest |                  |                                                        |
| Fd                  | D                | Dry evergreen forest                                   |

| Estuarine Communities |                  |                                                        |
| Ma                  | M                | Mangrove                                              |
with the forest type code and a suffix indicating the percentage area covered by
the forest type.

B. On the composite map produced in step A, all polygons not containing a forest type
code were classified as non-forested and remained blank on the final map.

C. Within the boundary of each forest type, the Vegetation and Land Use map overlays
revealed that there were a number of areas of different land use classes, and some areas
with no land use class.

Areas with no land use class indicated undisturbed forest and were denoted by the
appropriate forest type code.

Those areas with land use class symbols were treated in the following way:

(i) Classes LU0 to LU3 and LU7 to LU11 had all of their symbols removed as they
had no significant areas of major forest types.

(ii) Class LU4 was annotated with the appropriate forest type code followed by
a single digit suffix, '5'. This suffix reflects the percentage area of forest
remaining in the mapped unit and is based on the maximum percentage area of
anthropogenous vegetation. The suffix '5' indicated that 50% of the forest remained.

(iii) Class LU5 was treated similarly and given a suffix of '8'.

(iv) Class LU6 was given a suffix of '9'.

(v) Concurrently with steps C(ii), C(iii) and C(iv), the percentage area of remaining forest was sometimes reduced further by
taking into account the regrowth/associated vegetation descriptors on the
1:50 000 land use map (Bellamy 1986), where these descriptors indicated a
significant proportion of non-forest vegetation on the unused land.

(vi) Also concurrently with steps C(ii), C(iii) and C(iv), the complexes mapped in step
A had their suffixes reduced in proportion to the land use class.

(vii) Major urban centres retained the code ‘U’.

(viii) All unnecessary boundaries between like codes were then deleted.

The resulting map shows forest types. Each forest type may have been subdivided on its
level of disturbance, or its admixture with other non-forest vegetation types. The suffix
to the code indicates the percentage area of the forest type present in the polygon. The
absence of a suffix indicates 100% forest cover.

D. By overlaying this final map with an RMU map and a dot-grid, areas were recorded for
each polygon. A combined total was calculated for each RMU.

E. The codes and areas for each polygon within each RMU were then input to the forest
codefile and integrated into PNGRIS.

3. DESCRIPTION OF THE FOREST TYPES

The forest types are described in the sequence found in Table 1 and in the Forest map
reference. Canopy trees only are used in these descriptions. A more detailed description of
each of the forest types can be found in Paijmans (1975). Forest types are also
discussed in Paijmans (1976).

The crown classes used refer to the average crown diameter of canopy trees: large crowned,
>15 m; medium crowned, 8–15 m; and small crowned, <8 m. Stem diameters are: very large,
90+ cm; large, 70–89 cm; medium, 50–69 cm; small, 30–49 cm; and very small, <30 cm.

The aerial photographs illustrating the various forest types described in the text are
reproductions of the CAJ series of photographs used by Paijmans (1975) to delineate the
vegetation types. In the reduction process from 1:50 000 scale to the 1:1 000 000 scale of his
published map, the boundaries of some polygons depicted in these plates would have been smoothed, or in some cases deleted.

Also, for the purpose of illustration, the assessment of the proportion of undisturbed forest remaining in each polygon was estimated from the individual CAJ photographs depicted. These assessments may differ from those on the accompanying map which were estimated from SKAIPKSA photography taken almost 20 years later.

3.1 Low altitude forest on plains and fans

**Large to medium crowned forest PI** (Figures 1, 8) The canopy of this forest type is generally 30–35 m high and is irregular in both height and closure. Emergent trees often attain, and sometimes exceed, 50 m in height accentuating the unevenness of the canopy. Stem diameters generally range from large to small but very large stems are not uncommon.

The floristic composition is very mixed with no single-species dominance. Tree species that are almost invariably present are *Pometia pinnata*, *Octomeles sumatrana*, *Ficus* spp., *Alstonia scholaris* and *Terminalia* spp. Other commonly occurring genera include *Pterocarpus*, *Artocarpus*, *Planchonella*, *Canarium*, *Elaeocarpus*, *Cryptocarya*, *Celtis*, *Dracontomelum*, *Dysoxylum*, *Syzygium*, *Vitex*, *Spondias* and *Intsia*. The proportion of deciduous trees is higher in areas with a marked dry season.

This forest occurs on well to imperfectly drained alluvial plains and gently sloping, undissected fans where flooding does not occur or is short and infrequent. It is often, but not exclusively, associated with volcanic landforms. The largest areas are found on the footslopes of Mt Lamington, the Goropu Mountains, the north coast of New Britain and east of Marshall Lagoon.

**Open forest Po** (Figures 1, 3, 5, 6) This forest has an uneven canopy up to 30 m in height with many, often large, gaps revealing a lower tree stratum. Large crowned emergents often reach 40 m, rising above a canopy comprising medium to small crowns. Large to very large stem diameters predominate.

The floristic composition is very similar to the large to medium crowned forest with *Planchonia*, *Bischofia*, *Cananga*, *Intsia*, *Teysmanniodendron*, *Nauclea* and *Vitex* featuring among the more commonly occurring genera. Locally, *Octomeles sumatrana* may be a common emergent in frequently flooded areas. Deciduous trees are more frequent in areas with a marked dry season.

The forest occurs on the lower and middle courses of the major rivers, on low levees, scrolls and plains subject to frequent short-duration flooding, on back plains subject to prolonged wet-season inundation, and on fans where impeded drainage occurs. The water table remains at or near the surface for most of the year.

**Small crowned forest Ps** (Figures 1, 6) This forest type has a dense even canopy of small crowns 25–30 m in height with no emergents. Stem diameters are generally small to very small.

Locally occurring dominants may be dipterocarps, *Casuarina*, *Intsia* or *Campnosperma*. The forest occurs on flat to gently undulating lowland plains and fans where soils are often bouldery, gravelly and/or poorly drained.

*Casuarina* colonises bouldery fans on the upper courses of major streams, forming a single-species stand of trees. As the fan stabilises, and the forest ages, mixed species invade the forest. Dipterocarp forest occurs on flat to gently undulating plains and fans, on gravelly and often poorly drained soils. *Campnosperma*, often with an understorey of sago, occurs on swampy sites.

**Terminalia brassii forest PTb** (Figure 3) The forest has an even to slightly undulating canopy of large woolly crowns 30–35 m in height. The canopy is dense in a single-species stand, but may be more open when associated with *Campnosperma*. The majority of stems range from very large to medium diameter.
The forest occurs on swampy fans and plains in flowing water, and sometimes along the banks of minor streams which are subject to frequent flooding. The latter occurrences are too small to be mapped, usually consisting of a single or double line of trees. The forest is confined to the island of Bougainville especially in the south and south-eastern regions.

### 3.2 Low altitude forest on uplands

**Large crowned forest Hl** (Figure 2) This forest type has an uneven canopy 30–35 m in height with a 60–80% closure. Emergents can reach 40 m in height. Large stem diameters predominate. In both structure and floristic content it is very similar to the large to medium crowned forest on plains and fans.

Frequent canopy trees are *Pometia, Canarium, Anisoptera, Cryptocarya, Terminalia, Syzygium, Ficus, Celtis, Dysoxylum and Buchanania*. However a wide range of other genera do occur.

The forest occurs on plateaux and gentle slopes with good drainage and non-limiting moisture conditions. It is usually found on the lower slopes of volcanoes where sufficient time has elapsed to allow the forest to develop.

**Medium crowned forest Hm** (Figures 1, 2, 3, 5, 7) The canopy of this forest type is 25–30 m in height, is generally only slightly uneven and has a 60–80% crown closure. Except for *Araucaria*, which can reach a height of 70 m, emergents rarely exceed 40 m in height. Very large stem diameters are rare except for *Araucaria*.

Floristically the forest is very mixed. Frequently occurring genera are *Pometia, Canarium, Anisoptera, Cryptocarya, Terminalia, Syzygium, Ficus, Celtis, Dysoxylum and Buchanania* amongst many other commonly occurring trees. Some trees, such as *Koompassia, Dillenia, Eucalyptopsis* and the dipterocarps *Vatica* and *Hopea*, are common to abundant in certain regions but absent from others. *Homalium* is a frequently occurring tree in New Britain, but may be rare to occasional elsewhere. Scattered *Araucaria* may be present in some areas and in others it may form dense stands.

This forest type is found on a wide range of landform, slope, rock type, soil, climate and altitude up to 1400 m. Consequently the structure and floristic composition will vary widely over the full range of sites.

At low altitudes, and adjacent to a plain or fan, the forest is almost identical to the large to medium crowned forest except for its topographic position. At the higher end of its altitude range the forest forms a broad ecotone and includes many trees normally found in the lower montane forest.

On steep and unstable slopes the canopy is more open, more irregular and has smaller crowns. In areas of lower annual rainfall (1200–1800 mm) and a marked dry season, the canopy contains a larger proportion of deciduous and semi-deciduous trees, and often includes scrambling bamboo.

**Small crowned forest Hs** (Figures 7, 8) This forest has a relatively even canopy 20–30 m in height, with a 60–80% closure and no emergents. Large stem diameters are rare, the majority of trees falling into the medium to small classes. The forest may be either a mixed forest which is poorly developed due to adverse site or climatic conditions, or a forest in which a small crowned tree predominates in the canopy.

The mixed small crowned forest occurs on steep terrain with skeletal soils, and on low hilly to undulating terrain with poor, strongly weathered, acid clay soils. The species present in the canopy are similar to those of the medium crowned forest. In areas where there is a marked dry season, deciduous and semi-deciduous trees such as *Garuga floribunda, Brachychiton carruthersii, Intsia bijuga, Terminalia* spp., *Protium macgregorii* and *Sterculia* spp. form a significant component in the canopy.

In areas subject to severe seasonal water stress the forest is often less than 20 m tall and the deciduous trees *Gyrocarpus americanus, Bombax ceiba, Albizia* sp., *Maniltoa* sp., *Adenanthera pavonina* and *Erythrina* sp.
predominate in the canopy.

The species that form monospecific stands of small crowned forest are Gymnostoma papuana, Castanopsis acuminatissima and Hopea papuana. Gymnostoma papuana is typical of thin rocky soils on limestone and ultra-basic rock up to 1400 m altitude. Castanopsis acuminatissima dominated forest occurs on ridge crests and upper slopes up to 1900 m altitude. Hopea papuana dominated forest forms a thin-stemmed, tall, dense forest below 450 m altitude, mainly at the eastern end of the PNG mainland.

3.3 Lower montane forest

Small crowned forest L (Figure 4) This forest has an even to slightly undulating canopy 20–30 m in height. Canopy closure varies from dense to slightly open. The canopy height decreases with increasing altitude. Stem diameters are generally medium to small. However stands of large diameter, over-mature Nothofagus do occur. Araucaria can occur in dense to scattered distribution as an emergent to 40 m in height.

Frequently occurring canopy trees are Nothofagus, Lithocarpus, Castanopsis, Syzygium, Ilex, Lauraceae, Cunoniaceae, Elaeocarpaceae and conifers. Nothofagus can also grow gregariously on ridge crests, limestone pinnacles and doline rims, and sometimes on plateaux and upper slopes.

The forest occurs throughout the mountain ranges in the 1400–3400 m altitude range. With increasing altitude the height of the canopy becomes lower, stem-diameters and crowns smaller, and the floristic composition changes.

Small crowned forest with conifers Lc (Figure 4) This forest has a canopy 15–25 m in height with emergent conifers. Crowns are small to very small and the canopy is dark-toned on aerial photographs. Although the stems of the associated broadleaf species are generally small in diameter, the coniferous stems often exceed 50 cm diameter.

Papuacedrus, Phyllocladus, Dacrycarpus and Podocarpus are the most frequent canopy and emergent trees, with Myrtaceae, Myrsinaceae, Carpodetus and Drimys common broadleaf associates in the canopy.

The forest occurs in many places in the mountain ranges above 2400 m altitude.

3.4 Dry seasonal forest

Dry evergreen forest D This forest has a fairly open canopy 20–25 m in height with emergents to 30 m and occasionally to 40 m. Stems are often low-branched and crooked.

Commonly occurring trees are Acacia, Lophostemon, Syzygium, Rhodaninia, Xanthostemon, Maranthes, Mangifera, Halfordia, Flindersia, Oreocallis and Grevillea.

The forest is restricted to south-west PNG in a low-rainfall area (1800–2500 mm), and occurs on well to imperfectly drained, very gently undulating to low hilly terrain.

3.5 Estuarine communities

Mangrove M (Figure 8) This forest type covers a wide range of vegetation communities from forest to low scrub about 1 m tall. Under optimal conditions the forest has a dense, small crowned canopy of trees up to 30 m tall. Because the mangrove species are sensitive to changes in the flooding regime and the salinity of the water, they commonly grow in distinct zones, each zone dominated by a different species or set of species. This gives a banded pattern of tones on an aerial photograph.

The main mangrove tree genera include Rhizophora, Bruguiera, Avicennia, Sonneratia, Ceriops, Lumnitzera, Xylocarpus and Excoecaria. Nypa palm, included in the mangrove communities, is characteristic of areas subject to daily tidal flooding with brackish water.
Mangrove communities occur on estuaries, tidal flats, and muddy shores in a tidal environment. They may grow on peat, clay, sand or coral detritus. Although found along the coast of the mainland and islands of PNG, mangrove communities attain their maximum development on the deltas of rivers draining into the Gulf of Papua.
Figure 1: Upper Ramu River area. Medium crowned forest (Hm) occupies the foothills and dissected fans at the base of the Bismarck Range. The alluvial terrace along the upper course of rivers emerging from the mountains may carry a mixed stand of small crowned forest (Ps), grading into a large to medium crowned forest (Pl) on well-drained sites, or open forest (Po) on sites with impeded drainage. On swampy sites small crowned forest with *Campnosperma* (Ps(C)) may occur. The alluvial plain of the Ramu River carries an open forest (Po) on well to imperfectly drained sites and other swamp communities (unmarked) on swampy sites. The very light-toned areas are grassland. (Approximate scale 1:50 000)
**Figure 2:** Lower slopes of Mt Lamington. Large crowned forest (HI) occurs on the lower slopes of the volcano Mt. Lamington. Medium crowned forest (Hm) generally occupies the more deeply dissected areas. (Approximate scale 1:45 000)
Figure 3: Abia River area, Bougainville. Medium crowned forest (Hm) occurs on the hills in the lower part of the figure. Open forest (Po) occupies the imperfectly drained soils of the Abia River floodplain in SE Bougainville. Locally within this floodplain, stands of the light-crowned *Terminalia brassii* forest (PTb) indicate areas of surface flowing water. Unmarked polygons indicate areas of moderate to very high land use intensity, and swamp communities on the alluvial plain. (Approximate scale 1:70 000)
Figure 4: Doma Peaks region. In the Doma Peaks region areas of subalpine grassland are surrounded by small crowned forest with conifers (Lc). The conifer crowns are darker in tone than those of the adjacent broadleaf forest and their shape, and often the fine texture of their foliage, impart a somewhat diffuse image on the aerial photograph. In the south-east the Lc forest grades into montane (mossy) forest on ridge tops. In contrast, the more sharply defined, rounded crowns of the broadleaf-dominated small crowned lower montane forest (L) exhibit a sharper image. Both forest types, L and Lc, commonly form a complex (L/Lc). (Approximate scale 1:35 000)
Figure 5: Gogol and Naru Rivers area. Open forest (Po) occupies the alluvial plains of the Gogol and Naru Rivers south-west of Madang. Medium crowned forest (Hm) occurs on the hills surrounding the plains. Unmarked polygons indicate high to very high land use intensity with negligible forest remaining. (Approximate scale 1:50 000)
Figure 6: Ramu River floodplain. Open forest (Po) occupies imperfectly drained areas of the Ramu River floodplain. Small crowned forest (Ps(C)) dominated by Campnosperma may occur on swampy sites. Small crowned forest (Ps) of mixed species composition occurs on the well-drained colluvial aprons to the south of the river. Unmarked polygons include swamp and pioneer riverine communities, and grassland. (Approximate scale 1:50 000)
Figure 7: Long Island crater and lower slopes. Small crowned forest (Hs) occupies the exposed ridgetops surrounding the western and southern sides of the Long Island crater. Medium crowned forest (Hm) occupies the lower hill slopes. (Approximate scale 1:50,000)
Figure 8: Estuarine area south-west of Malalaua. Mangrove communities (M) occupy the estuarine area south-west of Malalaua. Large to medium crowned forest (Pl) occupies the alluvial plain to the north of the mangroves, separated from them by a band of swamp communities and areas of grassland and high to very high land use intensity. To the north the foothills carry a stand of small crowned forest (Hs) of mixed species composition. (Approximate scale 1:50 000)
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