AGRICULTURAL LAND USE OF PAPUA NEW GUINEA

EXPLANATORY NOTES TO MAP

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ABSTRACT

The 1:1 000 000 agricultural land use map and accompanying explanatory notes provide a broad overview of the distribution and intensity of agricultural land use in Papua New Guinea. Fourteen classes of agricultural land use intensity are described and mapped. The total area of each class of land use intensity is presented on both a provincial and a national basis.
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 further develop PNGRIS. This publication is one of a series produced under that contract.
1. INTRODUCTION

The 1:1 000 000 map, Agricultural Land Use of Papua New Guinea, provides a graphic representation of the distribution and intensity of agricultural land use in Papua New Guinea (PNG). The map, based on an interpretation of aerial photographs, was originally compiled at 1:500 000 as part of the Papua New Guinea Inventory of Natural Resources, Population Distribution and Land Use Project conducted by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) from 1982 to 1987 (Bellamy 1986). The 1:500 000 mapping has now been modified for publication at the convenient scale of 1:1 000 000.

The principal source of data for this agricultural land use intensity map was the black and white SKAIPIKSA aerial photography flown during 1973, at an average scale of approximately 1:105 000 at sea level. This was the most recent and uniform total coverage available for the whole of PNG. The CSIRO Land Research Series (1964 to 1976) publications and the 1:100 000 Topographic Survey, PNG Series, maps were also used to identify vegetation regrowth patterns. Post 1973 development, therefore, is not shown on the map except for the grassland areas of the Upper Ramu and Markham valleys. In these areas of extensive post 1973 development, the map has been updated to March 1986 (Holzknecht, H. pers. comm.).

Any analysis of the extent and intensity of use of land resources for bush fallow agricultural systems, however, must take into account both the land that is currently being used for food production, as well as the fallow areas under various stages of garden regrowth. The system of land use intensity mapping employed for the map, Agricultural Land Use of Papua New Guinea, is an elaboration of that developed and presented in earlier CSIRO regional survey maps and reports by McAlpine (1970), Fagan & McAlpine (1972) and Saunders (1970, 1972). This system is based on the premise that, in mapping bush fallow agricultural systems, both the garden and regrowth phases must be presented in an integrated manner. The methodology is outlined in detail below, and is illustrated in Figure 1.

2. CLASSIFICATION AND MAPPING OF LAND USE INTENSITY

2.1 Approach

In PNG, the bulk of agricultural land use is associated with short to long fallow cultivation practices (shifting cultivation). In this agricultural system, land may be either currently in food production (i.e. gardened) or at some stage of vegetation regrowth (i.e. under fallow). Commonly 5 to 15 years of fallow will elapse before regrowth is cleared for further food production.

By its very nature, this practice of bush fallow cultivation leads to very complex patterns of gardens and vegetation regrowth at varying stages of development. The sites of new food gardens may be adjacent to recently abandoned gardens. More commonly, the sites may be located in a scattered pattern within a matrix of vegetation regrowth, primary forest, grassland or other types of natural vegetation. The individual elements of this mosaic are not easily distinguished on aerial photographs at a scale of 1:100 000 and they are too small to be shown on small scale maps at 1:500 000 or 1:1 000 000. Consequently, the scale and quality of air photography precludes the separate delineation of the actual areas of either current food production or fallow.

The vegetation cover (i.e. regrowth and crop) for the whole area over which shifting cultivation takes place is referred to as anthropogenous. For the purposes of the land use map, ‘cultivated land’ refers to all land where there is evidence of a relatively recent cultivation history as indicated by the presence of anthropogenous vegetation. Cultivated land, therefore, includes land currently in food production plus land under various stages of vegetation regrowth resulting from past cultivation, as well as inclusions of primary forest and other types of non-anthropogenous vegetation too small to be mapped separately.

Areas of land which could be interpreted as cultivated land were delineated on the
SKAIPIKSA aerial photographs using a Toko Mirror Stereoscope (1 to 1.5 magnification). The delineation was based on recognizable vegetation patterns and their air photo characteristics (such as tone, texture, height, shape).

While the regrowth vegetation of the PNG bush fallow agricultural system is generally less than 20 to 30 years old, it may be up to 60 years old. Some areas were neither cultivated nor associated with grassland or sago, and on the air photographs were not interpreted as being cultivated land. These areas, including areas of primary forest and swamp vegetation, have been classified as 'other dryland and wetland areas'. Note, however, that these areas may be used for hunting and gathering.

Figure 1: Diagram to illustrate the approach employed for mapping land use intensity

A. Areas of cultivated land are delineated on the aerial photograph (at an approximate scale of 1:100 000), and then further subdivided into land use mapping areas (LMAs) on the basis of the land use intensity classification detailed in Table 1.

B. Schematic diagram to illustrate the complex pattern of current gardens, regrowth vegetation/fallow and primary forest that is characteristic of LMAs classified as cultivated land (i.e. land use intensity classes LU0 to LU6).
### Table 1: Classification of land use intensity

<table>
<thead>
<tr>
<th>Code</th>
<th>Class</th>
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<th>Current Use(^a) (% area)</th>
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<td></td>
<td>Cultivated Land</td>
<td></td>
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<tr>
<td>LU0</td>
<td>Very high intensity with tree crops</td>
<td>75+</td>
<td>&gt; 20</td>
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<td>50+</td>
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<td>1 – 5</td>
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<tr>
<td></td>
<td>Other dryland and wetland areas</td>
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</table>

\(^a\) As a percentage of total area of LMA

### 2.3 Classification of cultivated land

The areas of cultivated land delineated on the air photographs were then subdivided into land use mapping areas (LMAs) on the basis of the classification detailed in Table 1 and Figure 1. Fourteen broad classes of land use intensity are distinguished – 7 types of cultivated land and 7 types of uncultivated land. In this classification, ‘cultivated land’ refers to complexes comprising current food gardens (including cleared uncultivated land), fallow areas under various stages of vegetation regrowth, and inclusions of areas of uncultivated land too small to be delineated separately. ‘Uncultivated land’ refers to land dominated by grassland, sago, urban centres or other unused land.

As previously noted, due to the complex nature of bush fallow agricultural systems and also to the limitations of photographic interpretation at a scale of 1:100 000, actual areas of current use and of fallow cannot be separately delineated. Rather, areas of used land classified as being cultivated have been subdivided into LMAs on the basis of 2 criteria:
the percentage of the total used area that is anthropogenous vegetation

- the percentage of this anthropogenous vegetation that is currently being used, expressed as percentages of the total used area.

In this context, current use refers to land devoted to food crop production from the time of garden clearing through to the final harvest and the onset of succeeding regrowth vegetation (i.e. the first 0 to 3+ years of the garden/fallow cycle). Similarly, in plantations, current use refers to land devoted to tree or other crop production from the time of clearing through to the disappearance of the last vestiges of cropping practices.

Uncultivated land includes areas dominated by grassland (LU7, LU9, LU10 and LU11). Grassland has been distinguished from other uncultivated land to indicate potential grazing areas which would require minimal clearing. Much of the grassland area is a stable disclimax community resulting from cultivation followed by regular burning. Areas of uncultivated land with significant stands of sago (LU8) are also distinguished as potential sources of starch or derived products, again with minimal establishment costs. Large urban centres are also delineated. Much of the remaining uncultivated land, i.e. 'other dryland and wetland areas', has potential for development as agricultural land, and is frequently used for hunting and gathering as a source for wild food collection.

Descriptions of each land use intensity class are provided in Section 3 below. The number associated with each land use intensity class is the number used to identify that type on the land use intensity map.

2.4 Compilation of the 1:1 000 000 map, Agricultural Land Use of Papua New Guinea

The LMA boundaries of both cultivated and uncultivated land were transferred from the air photographs onto transparent overlays to the PNG 1:100 000 Topographic Survey maps. These 1:100 000 transparent overlays were photographically reduced to 1:500 000 and maps of land use intensity were compiled on a provincial basis. Subsequently, the 1:500 000 provincial map sheets have been photographically reduced to 1:1 000 000 scale, and the LMA boundaries smoothed or generalised to accommodate the reduction in scale. Areas of cultivated land identifiable on the aerial photographs but smaller than approximately 15 km² were either discarded as too small to map at the 1:1 000 000 scale, exaggerated in size to stress importance, or included in contiguous mapping units.

3. DESCRIPTION OF LAND USE INTENSITY CLASSES

The 14 classes of land use intensity are described below in the order given in Table 1. The air photo patterns of land use intensity classes LU0 to LU8 are illustrated in Figures 2, 3, 4 and 5.

3.1 Cultivated Land

Class LU0 **Very high intensity with tree crops** >75% anthropogenous vegetation with >20% current use (Figure 2) Denotes high intensity land use with its area dominated by large holder plantations and/or very extensive tree crop (or other plant e.g. sugarcane) planting by smallholders.

In some areas falling into this class, there may be a substantial amount of associated food-production cultivation in complex pattern or intercrop. This is particularly true of the Gazelle Peninsula in East New Britain Province where bananas are planted under the coconuts for food production.

Class LU1 **Very high intensity** >75% anthropogenous vegetation with 10–20% current use (Figures 3, 4) Denotes a high intensity land use with its area dominated by food-production cultivation. It is associated with a very high population density and a near permanent form of agriculture in which gardens may remain in production for well over 5 years.
This class is largely restricted to the highlands and East Sepik areas, and includes the highland compost-mounding cultivation of kaukau (*Ipomoea batatas*) and the intensive lowland cropping on the Screw River floodplain in East Sepik Province.

Small plots of cash crops can be associated with this land use intensity class.

Class **LU2 High intensity >50% anthropogenous vegetation with 5–10% current use** (Figures 2, 3) Denotes relatively high intensity land use where the area is primarily devoted to food-production cultivation. It is typical of the high population density areas associated with semi-permanent cultivation in highland valleys. In the lowlands, it occurs only in very restricted areas of the East Sepik and Madang Provinces.

Small plots of cash crops can be extensive in this land use intensity class.

Class **LU3 Moderate intensity 20–50% anthropogenous vegetation with 1–5% current use** (Figures 2, 4) Denotes moderate intensity land use where the area is primarily devoted to food production and is associated with moderate population density and cultivation with short to moderately long fallow periods.

Small plots of cash crops may be present in this land use intensity class.

Class **LU4 Low intensity 20–50% anthropogenous vegetation with <1% current use** (Figures 2, 5) Denotes low land use intensity for food production in areas of low to moderate population densities based on cultivation with short to moderately long fallow periods. It commonly occurs in all lowland provinces and occasionally in the highlands.

Some plots of cash crops may be associated with this land use intensity class.

Class **LU5 Very low intensity 10–20% anthropogenous vegetation with <1% current use** (Figures 2, 3, 5) Denotes very low land use intensity for food production in areas of very low to low population densities and moderate to long fallow periods. This class is rare in the highlands but widespread in the lowlands, and it is often associated with dependence upon an alternative source of food (e.g. sago or fish). Usually there is little cash cropping in this land use intensity class.

Class **LU6 Extremely low intensity <10% anthropogenous vegetation with <1% current use** (Figures 2, 4, 5) Denotes extremely low land use intensity for food crop production in areas of extremely low population density showing a widely scattered distribution of current gardens. Cash cropping is minimal.

### 3.2 Uncultivated Land

Class **LU7 Grassland** (Figures 4, 5) Denotes major occurrences of dryland, continuous grasslands of the lowlands and highlands. These are mainly anthropogenous in origin but are currently maintained as a stable disclimax by regular firing.

Small discontinuous patches of grassland associated with current gardening and regrowth are included under classes LU1 to LU6.

Class **LU8 Sago stands significant** (Figure 5) Denotes areas with a continuous stratum of sago palms, with or without emergent trees. While these areas are not used for food garden cultivation, they provide a staple food source for the population in many wetland areas. In some cases the natural stands are enhanced by the planting of preferred cultivars.

Much of the sago used as a food source, both naturally occurring and planted, occurs in narrow valleys and stands too small to be mapped at 1:500,000 scale. This is a particular feature of parts of the Western Province where stands of minimum map unit size are virtually non-existent, yet sago is widespread and provides a major staple food.

Class **LU9 Subalpine grassland** Denotes those grasslands and tree-fern (*Cyathea*) savannas found in intermontane valleys and basins between approximately 2500 and 3000 m
Figure 2: Land use patterns in the Gogol River area, Madang Province. Very high land use intensity with tree crops at Erima Plantation (LU0), coconuts and rubber. High land use intensity (LU2) in the Amele locality. Moderate land use intensity (LU3) at the southern end of the Adelbert Range. Widespread occurrences of low (LU4) and very low (LU5) land use intensity throughout the area. Occurrences of extremely low land use intensity (LU6) confined mainly to the river floodplains and adjacent low hills. (SKAIPKSA)
Figure 3: Land use patterns in the Wabag area, Enga Province. Very high land use intensity (LU1) in the middle Lai River and lower Ambum River valleys near Wabag. High land use intensity (LU2) in the upper Ambum and Lai River valleys. Some moderate (LU3) land use intensity in the river headwaters. Lower parts of the dividing ranges have a very low land use intensity (LU5). Higher parts of the ranges carry virgin forest. (SKAIPIKSA)
Figure 4: Land use patterns in the Wosera area south of Maprik, East Sepik Province. Very high land use intensity (LU1) on the Screw and neighbouring river floodplains. High (LU2) and moderate (LU3) land use intensity on the foothills and lower slopes of the Torricelli Mountains. Low land use intensity (LU4) on floodplains and low hills in the south-west of the area. Extremely low land use intensity (LU6) on low hills, and on a less well drained area of the Screw floodplain. Grassland with gully forests (LU7) on upland plains and low hilly areas extending southwards to the Sepik River floodplain. (SKAIPIKSA)
Figure 5: Land use patterns in the Lower Ramu River area, Madang Province. Low land use intensity (LU4) on higher parts of the Ramu River floodplain and low hilly land. In the former, the patches of grassland are considered to be non-anthropogenous in origin. Very low land use intensity (LU5) also occurs on higher parts of the floodplain. Extremely low land use intensity land (LU6) with widely scattered gardens and tall woody regrowth and grassland indicating prior gardening is found throughout the floodplain and low hilly land. The Bosman grassland (LU7) is located on an undulating raised platform west of the Ramu River. Sago palm communities (LU8) are found throughout the area in predominantly pure stands, or with emergent trees. (SKAIPIKSA)
altitude. They are subject to cold air drainage and frost, and although their origin may have been anthropogenic in some cases, it is unlikely that they have ever been used for food cropping. Floristically they are more akin to the alpine grasslands than to the highland grasslands of the lower occupied valleys. They may be subject to occasional burning.

Class LU10 Alpine grassland Denotes grassland above the tree-line, well above the altitudinal limit of garden crop cultivation.

Class LU11 Savanna woodland Denotes dryland communities which have single-stemmed woody plants over 3 m tall having a 'foliage projective cover' (Specht 1981) of 2% and a ground cover with a graminoid cover of >2%. Like LU7 (grassland), savannah woodlands are mostly of anthropogenous origin but show no visible evidence of current or past food garden cultivation. They are subject to irregular burning.

Class LUU Larger urban areas

Other dryland and wetland areas Denotes all areas not included above. These areas are currently unused for food crop production but widely used for hunting and gathering as a source of wild food.

4. EXTENT AND INTENSITY OF AGRICULTURAL LAND USE IN PNG

The total area of each class of land use intensity is presented on both a provincial and a national basis in Table 2. The percentage of the total land area of PNG that comprises each of the 12 categories of used land (excluding urban centres), i.e. land use intensity classes LU0 to LU11, is illustrated in Figure 6.

In PNG, of the total used land area of approximately 140,300 km² (or 30.5% of the total land area), only 11,000 km² (or less than 2.4% of the total land area of PNG) is under high to very high intensity of use (LU0, LU1, LU2). These areas of high intensity use are concentrated in the central highlands provinces of Southern Highlands, Enga, Western Highlands and Chimbu, principally in areas of steeplands or alluvial or volcano-alluvial fans and with a mean annual rainfall of 2000 to

Figure 6: Used land by land use intensity class as a percentage of the total land area of PNG
4000 mm. Of the remaining area of used land, the greater part – approximately 107 000 km² or 23.3% of the total land area of PNG – is under moderate to extremely low intensity of use (LU3, LU4, LU5, LU6). An additional 14 300 km² (or 3.1% of the total land area) is dominated by grassland (LU7, LU9, LU10, LU11). Natural stands of sago palm (LU8), which have a capacity for starch production and which may be used as a staple food crop, occur in significant stands over a total area of approximately 8200 km² (or 1.8% of the total land area). This area is concentrated in the lowland provinces of the East Sepik, Madang and West New Britain.

Land currently used for food and cash crop production in PNG, i.e. the cultivated land area (LU0 to LU6), accounts for 25.6% of the total land area of PNG – an area of approximately 118 000 km². This is the area of land over which the population has ranged in search of sites for cultivation. However, as noted above, this area includes a proportion of land not used in the current cultivation cycle or in that of the recent past. This is particularly the case for areas of extremely low land use intensity (LU6), which is virtually unused. Areas with low and very low land use intensity (LU4 and LU5) also have large areas of unused land which are surplus to that required at current levels of use. Allowing for these unused areas of land (i.e. inclusions) within the cultivated land area, the amount of land actually currently in the food production cycle (that is, land currently in food production plus vegetation regrowth) is approximately 30 300 km², or 6.6% of the total land area of PNG.

Table 2: Total area in km² of each class of land use intensity by province

<table>
<thead>
<tr>
<th>Province</th>
<th>LU0</th>
<th>LU1</th>
<th>LU2</th>
<th>LU3</th>
<th>LU4</th>
<th>LU5</th>
<th>LU6</th>
<th>LU7</th>
<th>LU8</th>
<th>LU9</th>
<th>LU10</th>
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² Total area of land use classes 0 to 6 inclusive
² Total area of land use classes 0 to 11 inclusive
REFERENCES


PNGRIS PUBLICATIONS (ISSN 1320-5765)

1. Agricultural Land Use of Papua New Guinea: [map with explanatory notes]. Scale 1:1 000 000. ISBN0642196044

2. Forest Resources of Papua New Guinea: [map with explanatory notes]. Scale 1:1 000 000. ISBN0642196036

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