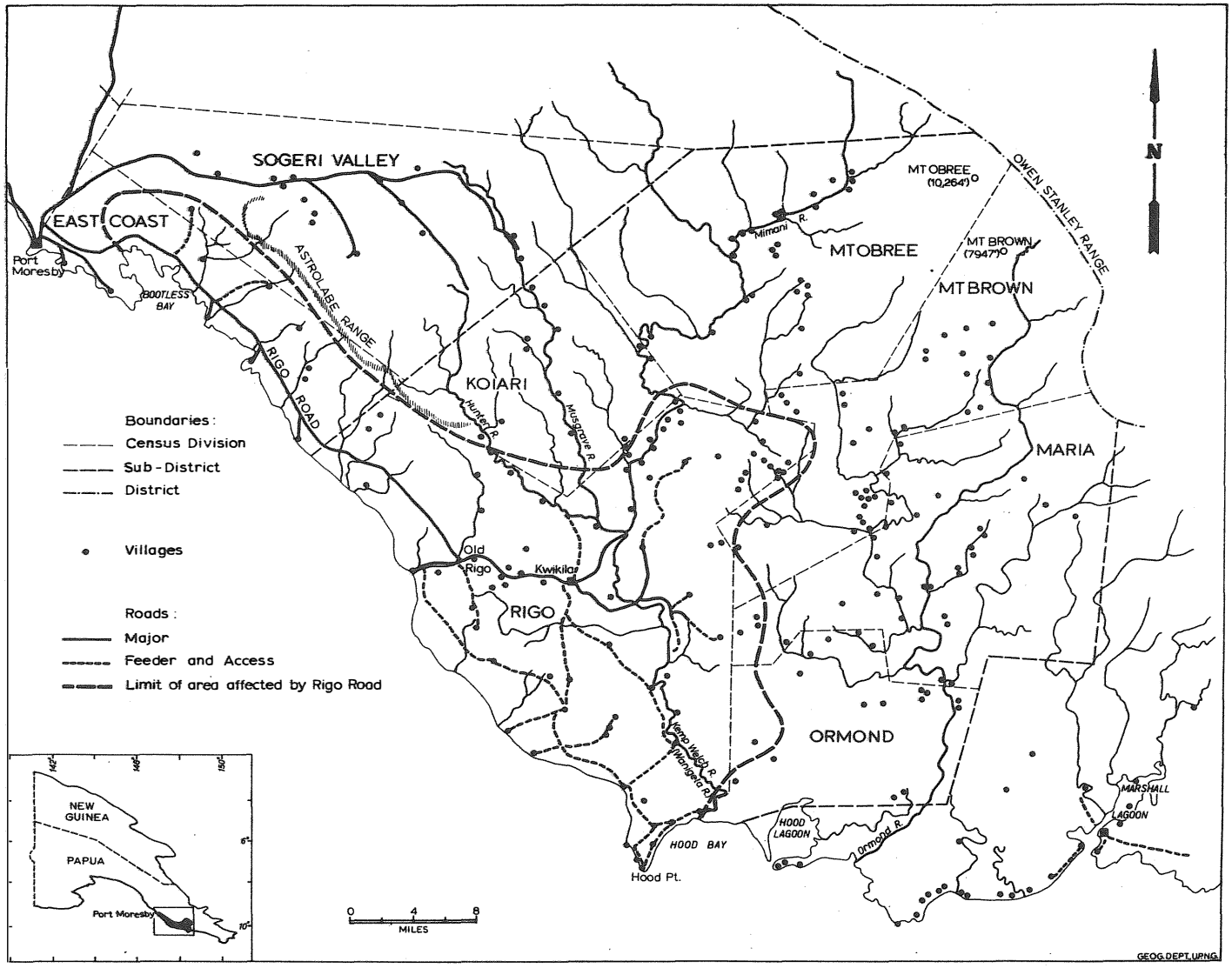
N E W G U I N E A R E S E A R C H

B U L L E T I N



Map 1. Location of the Rigo road

NEW GUINEA RESEARCH BULLETIN

Number 33

THE RIGO ROAD

A study of the economic effects
of new road construction

Marion W. Ward

January 1970

Published by the New Guinea Research Unit,
The Australian National University,
P.O. Box 4, Canberra, A.C.T.

and

P.O. Box 1238, Port Moresby, New Guinea

First published 1970

This work is copyright in all countries subscribing to the Berne Convention. Reproduction in whole or in part, without the written permission of the Publishers, is forbidden.

Printed and manufactured in Australia by
Allans Printers, Canberra

Library of Congress Catalog Card No.73-107383

National Library of Australia Reg. No.Aus69-4258

THE AUSTRALIAN NATIONAL UNIVERSITY

Research School of Pacific Studies

New Guinea Research Unit Committee

O.H.K. Spate, Chairman, Director of the School

J.W. Davidson, Department of Pacific History

A.L. Epstein, Department of Anthropology and Sociology

Ann Chowning, Department of Anthropology and Sociology

E.K. Fisk, Department of Economics

Marion Ward, New Guinea Research Unit

Marie Reay, Department of Anthropology and Sociology

Editor, New Guinea Research Bulletin
Marion Ward

Editor of this issue
R.G. Crocombe

Editorial Assistant
Susan Reeves

January 1970

Contents

Tables

Maps

Preface

When this study began in October 1967, there had been no studies in New Guinea of the social and economic effects of improving transport facilities. It was thought that a detailed examination of one particular case would be of value, not only as a case study, but also as an indication of the nature and scale of potential benefits from investment in transport. The case chosen was the Rigo road, which had been improved to all-weather highway standard in 1965. The road runs southeast from Port Moresby through savannah-clothed coastlands which, though seasonally dry, possess considerable agricultural potential.

The study was undertaken in three parts: first, the examination of relevant documentary material in Port Moresby and Kwikila; second, field interviewing of truck operators, trade store owners, and villagers in about one-third of the villages within the area affected by the Rigo road, and also of the majority of European farmers and plantation owners or managers; and third, the study and comparison of aerial photographs taken in 1957 and 1967.

The main field work was carried out in November and December 1967. Library and other work continued through early 1968. The manuscript was submitted in March 1969.

A study of this nature is made possible only by the help of many people. To all who have contributed directly or indirectly, I wish to express my thanks; in particular, the villagers and owners of trucks and trade stores who provided information about their businesses, and about village life and agricultural practice; members of the following government departments: The Directorate of Transport, District Administration, Agriculture, Stock and Fisheries, Forests, Lands, Surveys and Mines, Police, Trade and Industry, Bureau of Statistics, Public Works, Office of the Economic Adviser, the Commonwealth Department of Works; Messrs Johns, Lazeron, Luckie, Modra, H. Rosser, Toepfer and Wardrop; my research assistant, Mr René Labouchère; Dr S. Epstein, Department of Economics, the Australian National University; Mrs M. Ploeg, Department of Geography, University of Papua and New Guinea, who drew the maps and figures; Mr H. Gunther, Department of Human Geography, the Australian National University, for photographic assistance; and the staff of the New Guinea Research Unit, for secretarial assistance. Professor J.A. Barnes, Dr H. Brookfield and Dr R.G. Crocombe were members of the New Guinea Research Unit committee during the time the study was conceived and executed. Finally, I am grateful to Professor H. Kolsen,

University of Queensland, Professor J. Williams, then University of Papua and New Guinea, Dr H. Brookfield and Dr R.G. Crocombe, the Australian National University, and to my husband, Professor R.G. Ward, University of Papua and New Guinea, who have read critically part or all of the text. For the errors which remain I am, of course, responsible.

Chapter 1

The setting

The Rigo road runs southeast for about fifty miles from Port Moresby, in the Central District of Papua, to Kwikila, the administrative centre of the Rigo sub-district. It is one of four main roads radiating from Port Moresby into the Central District, none of which links with any other major urban centre. The fact that the Rigo road provides easy access to Port Moresby for people living up to eighty road miles away is the most significant aspect of its location.

The Rigo road may be regarded as the first stage of a main trunk road along the southeast coast of Papua. From the most easterly point that can be reached by road from Kwikila, near the village of Matairuka, it is about thirty miles to Marshall Lagoon, from where another road net continued for about twenty miles to the southeast. Construction of a road across this thirty miles would not be particularly difficult or expensive. It would pass through country capable of similar agricultural development to that which has occurred along the Rigo road, serve a potentially large cattle project proposed for the Southern Ormond District, and also provide access to Port Moresby for timber and agricultural development in the Marshall Lagoon and Cape Rodney areas.

The further continuation of the road to the southeast is as yet only in the idea stage, but it is worth noting that a short distance east of the present Cape Rodney network lies the best potential road crossing of the Owen Stanley Range. Construction of perhaps eighty miles of road, including a relatively low crossing, would link the Central with the Northern District network. In addition, it would require only about one hundred miles of road to link the Cape Rodney area with the administrative centre of Milne Bay District at Alotau. The route for this would lie through relatively easy coastal lowlands, and road construction would not be exceptionally difficult or costly compared with other areas of the country. While the building of such road links may have seemed pipedreams for the last half century, there is little doubt that their merits will be carefully examined against the needs of the rest of the country in the 1968-69 United Nations Development Programme Transport Survey.[1]

[1] This survey was undertaken by a team of experts at the request of the Administration to determine transport needs and recommend expenditure and construction priorities.

Physical bases of the area

The dominant physical features of the area influenced by the Rigo road are the scarp of the Astrolabe Range and the drainage system of the Wanigela, better known as the Kemp Welch River. The Astrolabe Range marks the southwestern edge of the Pliocene volcanics of the Sogeri plateau (see Map 1). It runs in a northwest-southeast direction for about twenty miles and rises to 3,200 ft in a steep seaward facing scarp. From its crest at about 2,000 ft the land drops away to sea level in a distance of about five miles. Near the range rough, strongly dissected slopes support very few people, but near the coast the alluvial lower valleys of the short and largely intermittent streams provide good agricultural land. The coastal population clusters near the mouths of the larger streams, which are separated by steep local ridges of limestone, chert, and other rocks.

Beyond the southeastern end of the Sogeri plateau the northwest-southeast trend of the country continues, with the upper tributaries of the Hunter and Musgrave Rivers and other streams which feed the Kemp Welch River occupying southeast trending valleys parallel to the main range. The Mimani River (or upper Kemp Welch) cuts across this trend, draining the slopes of Mt Obree (10,264 ft) on the main range of the Owen Stanleys. The Kemp Welch, after receiving these major tributaries, debouches from steel foothill and mountain country and meanders across the lowland coastal zone in a southerly direction to enter the sea at Hood Bay.

The general features of the Kemp Welch and Ormond River basins are first, a steep, inland foothill and mountain zone rising to over 3,000 ft. Second, nearer the coast, the land is in general undulating with occasional steep ridges rising to several hundred feet. The Saroa hills are a prominent landmark east of Old Rigo, and other ridges occur near the coast and in the lower Ormond. Communications are in general much easier than further inland, though the main channels of the major rivers are formidable obstacles. The rivers themselves are used to a small extent by rafts and small boats. Local tributaries are often intermittent, and water shortages can occur away from the main rivers. Third, a zone of low-lying swampy land occurs a few miles inland from the coast, extending for about thirty miles between Hood Point and Marshall Lagoon. The Ormond River loses itself in the mangrove forest of this zone, while the shallow Hood Lagoon is fringed by mangrove swamps and may be gradually infilling. Fourth, a zone of slightly higher sandy land fringes the coast from Hood Point to Marshall Lagoon. Hood Point is a low-lying spit of mixed sand and alluvium from the Kemp Welch River.

Between Port Moresby and Kapa Kapa the coast shows evidence of submergence, with the streams draining the Astrolabe face infilling formerly drowned river valleys. The process has been carried farthest in the Gaile-Kapa Kapa area where larger, more permanent streams have

produced a low straight coastline. The whole coast is reef-ringed, and the shallow intertidal zone provides good fishing for the coastal population.

The climate of the area is marked by a seasonal wind reversal, with southeasterlies dominant between May and October and northwesterlies from January to March, with periods of variable winds in December and April. Strong southeasterlies make coastal movement difficult, though traditional Hula and Motu trading voyages used the southeast winds to sail westwards to the Gulf of Papua, and the northwest winds for their return.

The generally parallel alignment of the winds with the coast accounts for the abnormally low rainfall of this part of Papua. The isohyets shown in Figure 1 approximate the mean annual rainfall of the area, and indicate a steep rainfall gradient between the coast and the summit of the Astrolabe Range. The gradient is less steep in the Kemp Welch valley, but inland mountain slopes receive over 140 inches, as does the crest of the Astrolabe Range. Mean annual rainfall data for the only two stations in the area (see Figure 1 and Appendix 1) indicate a marked dry season between May and November, which can cause water shortages in villages.

Temperatures are similar to those of Port Moresby (Fitzpatrick 1965:91): mean maximum temperatures range from 82°F in August to nearly 90°F in December, and mean minima from 73°F in August to 76°F in December. They decline somewhat with altitude. Fitzpatrick's (1965: 95-7) water-balance evaluations for Port Moresby data can be assumed to apply to the Rigo and coastal areas, and indicate that although 'rainfall has never been so low or so poorly distributed that an early termination of crop development' would result for crops planted in December, 'some degree of intra-seasonal water stress can be expected'. Referring to the Port Moresby area generally Fitzpatrick says (1965:97):

> From the point of view of prevailing temperature and moisture conditions, the area would appear to have a greater potential for agriculture and for pasture utilisation than is generally realised, although special agronomic problems related to other aspects of climate may present themselves. The coastal lowland has a more definite dry season than most parts of Papua-New Guinea. This would appear an advantage for some crops, but the prevailing high humidities may cause some difficulty in proper maturation and in harvesting operations. Low radiation receipts and the lack of marked seasonal differences in day length may also present special agronomic problems. With frequent and moderately heavy rainfalls causing continued leaching, maintenance of soil fertility would appear to be a major difficulty within the whole of the area.

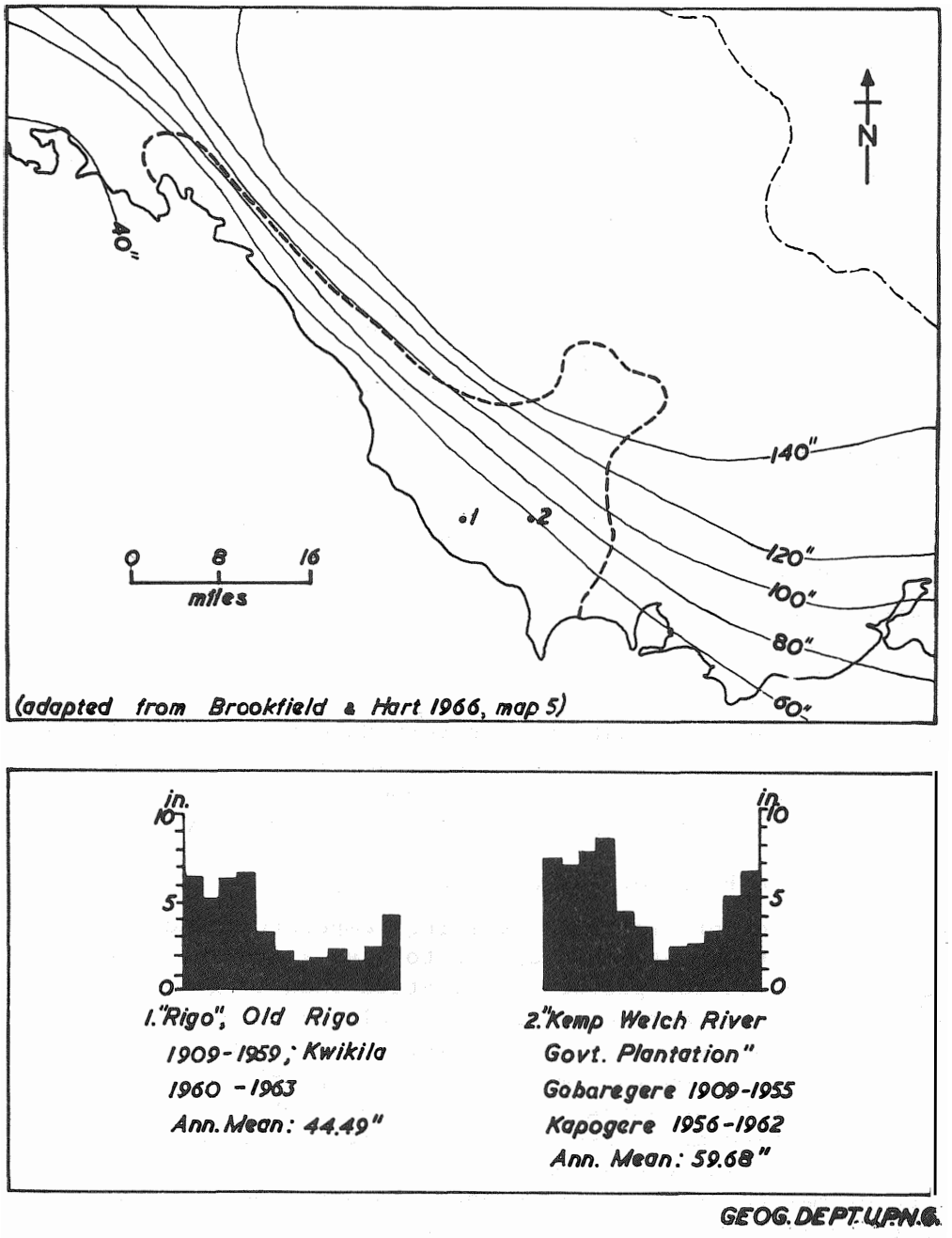


Fig. 1. Mean annual and monthly rainfall

In accordance with the relatively low rainfall experienced in the area, the vegetation cover is largely savannah[1] (Themeda australis - Eucalyptus sp., Ophiuros sp. - Eucalyptus alba) or tall grassland (Saccharum spontaneum - Imperata sp.), with semi-deciduous thicket (Garuga sp.- Rhodomyrtus sp.) and slightly deciduous forest (Planchonia sp. - Adenanthera sp.) where the rainfall increases in the Rigo sub-district (Heyligers 1965). The latter passes into evergreen forest (Lithocarpus sp. - Elaeocarpus sp.) inland near the slopes of the main range. Virtually all the savannah and grassland bears the marks of frequent burning. Watercourses, whether dry or not, often show on air photographs and on the ground by the dark lines of trees which fringe them. There are small areas of mangrove forest (Avicennia sp. - Ceriops sp., Rhizophora sp. - Bruguiera sp.) along the coast west of Hula, but mangroves become much more extensive east of Hood Point.

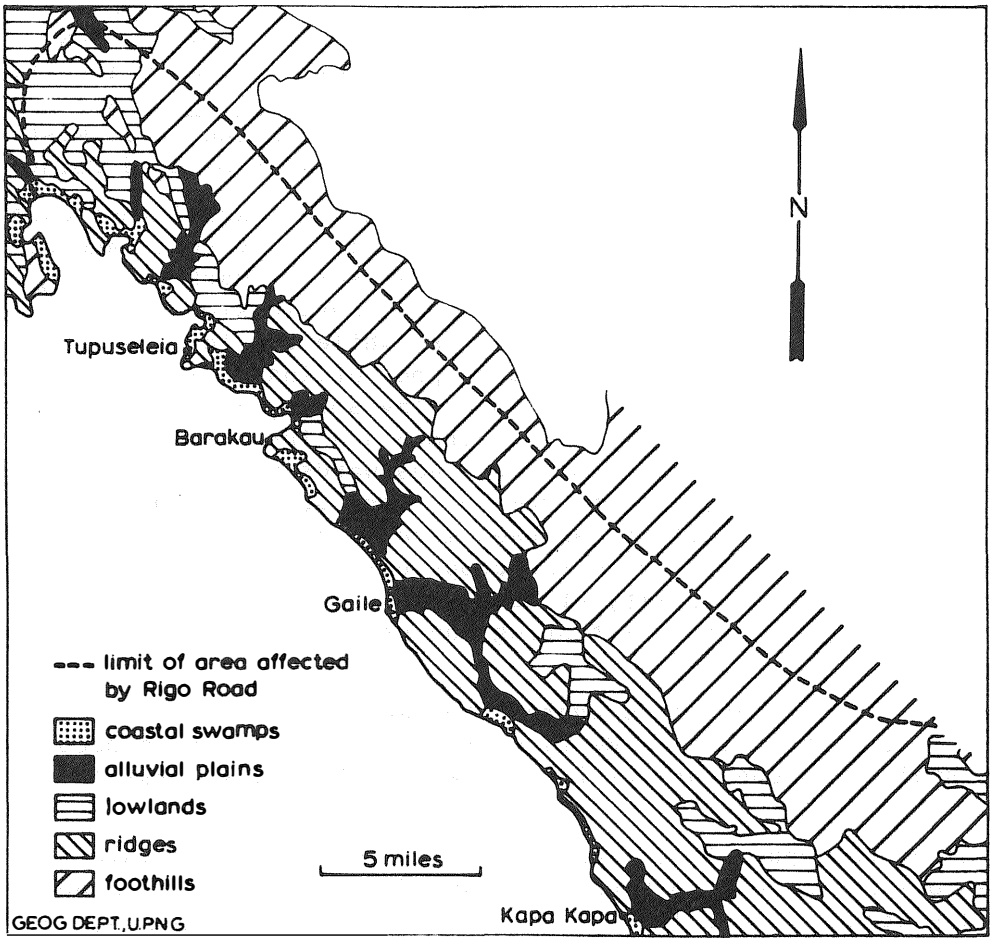
Soils in the area vary (Scott 1965a). In the coastal zone east of Port Moresby, lithosols with minor red gravelly clay soils and alluvials and others are interspersed with brown clay soils, dark cracking clay soils and alluvials. The inland hill and mountain slopes have acid red to brown clay soils with minor lithosols, while the lower Kemp Welch valley has alluvial soils with good to poor drainage, lithosols on ridges, red gravelly clay soils, brown clay soils, and dark cracking clay soils. The coastal zone has mangrove and intertidal alluvial soils, while the shore from Hood Point eastwards has a fringe of beach soils of sandy texture. Apart from some work at the Kapogere agricultural station, little effort has been made to determine soil needs and responses. It is obvious from the crops being produced on alluvial and clay soils that the fertility of such soils is fairly high, but a comprehensive programme of soil testing and experiment over the whole area is urgently needed.

An attempt to relate land systems to land classification has been made by Scott (1965b:178). He finds that the land systems occurring in the coastal hill zone east of Port Moresby are mostly Class III lands, which

> occur on the upper foot slopes, the less stable interfluves, and the lowlands mainly in Kopu, Fairfax, Bomana Creek, and Hanuabada land systems. These lands have a moderate erosion hazard, and the soils are liable to dry out for short periods. Class III lands also occur in valley flats throughout the area and in the minor alluvial plains of Boroko land system. The soils are mainly dark cracking clay soils with sticky consistence, which are too wet to cultivate in the rainy season and too dry in the dry season. They are very hard to work without heavy machinery unless cultivated when the moisture conditions are most suitable. (Scott 1965b:178)

---

[1] Though the present cover may well be anthropogenic.



Map 2. Land types of the East Coast area

The foothills of the Astrolabe Range are Class VII, where agriculture is limited by steep slopes and shallow soils (Scott 1965b:179). The coastal zone of the Rigo sub-district and the lower Kemp Welch valley continue the pattern of predominantly Class III land, with small areas of high quality Class I and Class II land in the immediate vicinity of the Kemp Welch. Inland of Kwikila Class VII land is likely to predominate, with tree crops the most suitable use, while Class VIII land unsuitable for commercial crop production is likely to predominate on the steeper and higher mountain slopes. Within the foothill and mountain zones, however, small areas of Class I and Class II land will occur on alluvial terraces beside the rivers and streams, and these are often important for vegetable and other crop production.

Map 2 summarises the physical aspects of a part of the area.[1] By grouping land systems together five types of land have been recognised. The minor alluvial plains (Boroko land system) are the most fertile, and are currently used for village gardens. The ridges which separate them (Hanuabada, Kopu and Kabuka land systems) are virtually unused at present but have considerable potential for cattle raising. The lowlands (Ward and Bomána Creek land systems) are intermediate between the alluvial plains and the ridges and carry potential for both agriculture (in some parts) and cattle farming. The foothills and scarp of the Astrolabe Range (Dubuna and Rouna land systems) have low economic potential, and should be reserved for hunting and recreational uses.

The coastal plains (Papa land system) are largely mangrove or salt flats, which have potential use as fish pond sites, a use not yet developed in Papua-New Guinea. A similar set of potential or actual land uses can be postulated for the Kemp Welch River valley to the east of the present area.

Minerals

Copper was discovered near the western end of the Astrolabe Range about the turn of last century, and the Astrolabe copper field was proclaimed in 1906. It was enlarged in 1919 and renamed the Astrolabe mineral field. Although at least eight copper lodes were found and worked, most of the 80,000 to 85,000 tons of copper ore produced from 1907 to 1965 came from three mines: the Laloki (40,000 tons), Dubuna (20,000 tons), and Sapphire-Moresby King (17,000 tons) (Yates and de Ferranti 1965:48). Of these, the Dubuna mine is located within the area affected by the Rigo road, along a track about five miles northeast of Bautama near the western end of the Rigo road (Grid Ref.: 348534 on 1:50,000 Sogeri Sheet 5229-1, Edition 1, Series T 784).

---

[1] Redrawn from Mabbutt *et al*., 1965. Unfortunately no similar study has yet been made of the Kemp Welch River Valley. The categories used on Map 2 and the land systems named in the text are defined in Appendix 2.

This mine began production of rich oxidised copper ore in 1910 and was the major source of ore exports to Australia in the following two years. Because of the high combustibility of the ore in ships' holds en route to smelters in Australia, an aerial ropeway and a narrow gauge railway line were built in the early 1920s to a smelter five miles away on the shores of Bootless Bay. Smelting problems were encountered, and because of fire in the mines, open-cut mining had to be undertaken. Low copper prices forced the closure of the operation in 1926. Although nearby mines were worked in the 1920s, the Dubuna mine has not been reopened. Reserves still in the ground are thought to be about 25,000 tons (Yates and de Ferranti 1965:61).

About one mile southeast of the Dubuna mine is the Mount Diamond mine, which was developed between 1907 and 1913. Its production is not known, but reserves of copper ore are thought to be a minimum of 24,000 tons (Yates and de Ferranti 1965:69).

The railway track and smelter which served the Laloki and Dubuna mines in Bootless Bay were removed and sold as scrap after the second world war. The gentle curves of the railway are followed by the Rigo road for about a mile between Bautama and the corner which leads to Mirigeda Hill. The railway route is also followed by the side track leading north up the Bautama Valley.

According to Yates and de Ferranti (1965:62), further testing of the Dubuna mine is unwarranted, though exploratory drilling might be worthwhile at the Mount Diamond mine. In September 1968 a private organisation was reported to be examining the copper potential of the Astrolabe mineral field with a view to redevelopment. In June 1969 it was announced that intensive exploration indicated 'extensive areas of copper mineralisation. The chief ore body had proven or indicated ore reserves of about 320,000 tons averaging 5.2 per cent copper, 2.5 to 3 dwts of gold and 10 dwts of silver to the ton'. Production was planned to start in 1970.[1]

A small copper prospect exists some thirty miles to the southeast near the village of Gidobada. The deposit was investigated about 1918-20, but little ore seems to have been produced (Yates and de Ferranti 1965:69).

Manganese occurs in the Rigo sub-district. Manganese oxides are found in small discontinuous deposits over twenty square miles around Old Rigo.[2] Between 1939 and 1962 about 2,200 tons of ore with an average grade of 85 per cent MnO_2 were exported to Australia from the

---

[1] South Pacific Post, 9 June 1969.

[2] In 1957, manganese deposits on the 'road' between Girabu and Gabuia, on the Sarokei-Imagolo road, near Kemaia and at Gegofi were reported. Rigo Patrol Report (hereafter abbreviated to RPR), 1957-58, No.4, p.10.

Pandora and Doavagi mines about 1½ miles northeast of Old Rigo. Yates and de Ferranti (1965:78) suggest that local people could prospect and mine the deposits on a co-operative basis. While total volume of production will never be large, such an activity might well be profitable at times of high prices for manganese.[1]

Population

According to village census counts, the total population of the East Coast, Koiari, Mt Obree, Mt Brown, Maria, and Ormond census divisions and the Rigo local government council area (Map 1) at about 1966 was approximately 24,000. This figure excludes only workers and students working outside the Central District and it probably therefore slightly exaggerates the number of permanent village residents. However, it is thought to be more realistic than either the total including all absentees, or the total excluding all absentees, many of whom were only as far away as the village school when the count was taken.

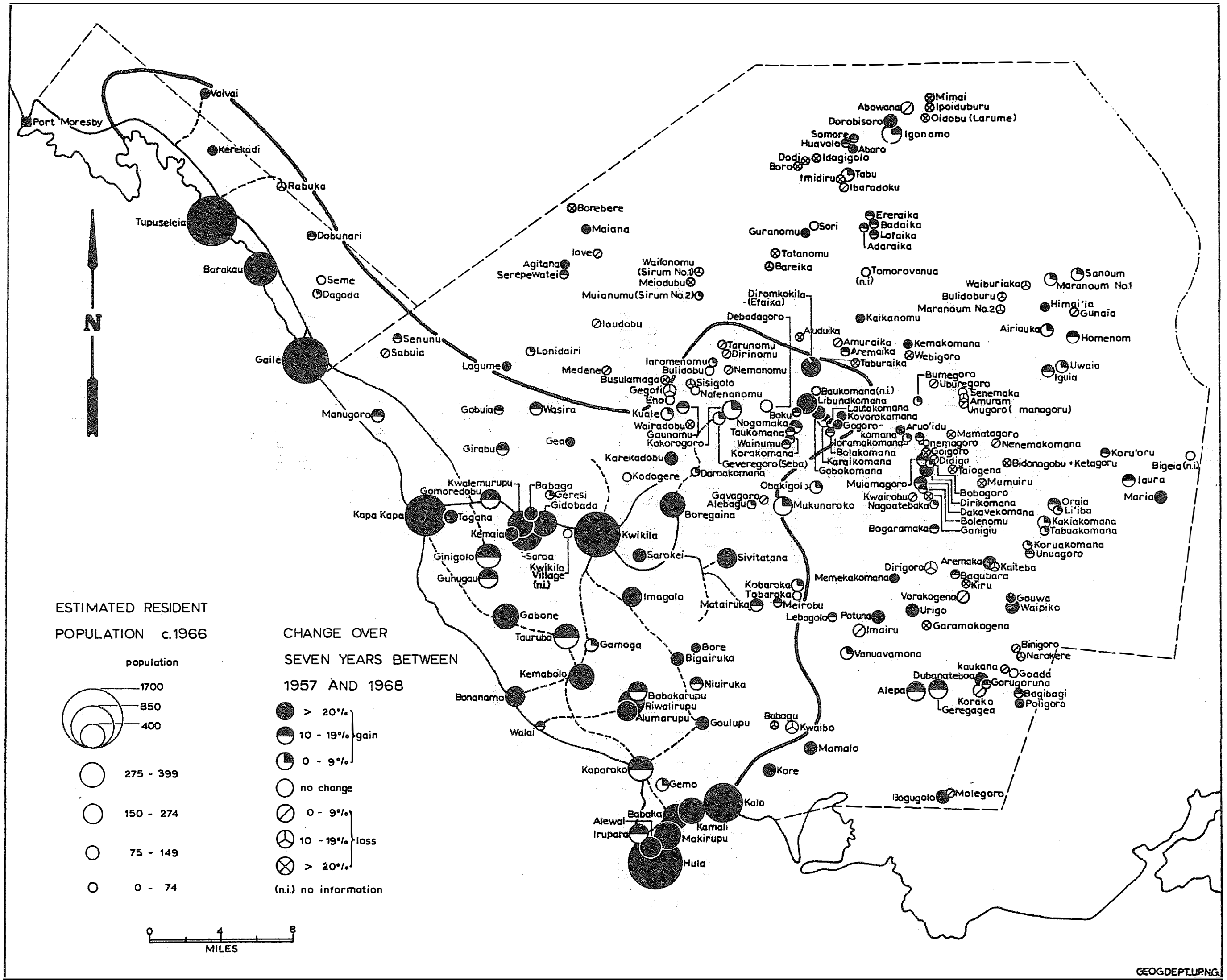
In Map 1 the area between the heavy dashed line and the coast is designated as the area affected by the Rigo road. This area has been determined partly by natural barriers, such as the scarp of the Astrolabe Range, partly by the inclusion of the furthest villages from which vehicles were registered in 1967, and partly by field evidence of the furthest villages which were sending produce to the Port Moresby market in 1967. The estimated resident population of this area is 18,000 and is detailed by village in Appendix 3.

The indigenous population lives almost entirely in nucleated settlements. There are a very few examples of small groups of people apparently permanently settled a short distance from their original villages. The European population (numbering not more than 150) is in part dispersed and in part nucleated, according to occupation. Farmers and plantation managers are dispersed, whereas administrative and most educational personnel are concentrated in Kwikila. A small number of European teachers and missionaries live in villages in the area.

The largest villages are located along the coast (Map 3). Between the coastline and Kwikila a number of moderately large villages cluster in groups, while the inland mountainous zone is characterised by small villages grouped along ridge tops or in river valleys. Over the last decade, and probably for longer, the inland villages have been losing population whereas the larger, more readily accessible coastal and lowland villages show fairly high growth rates. A few inland villages have amalgamated over the years, and a number have relocated. The most notable of the latter are Manugoro and Boregaina. The people of Manugoro moved to their present site in 1954 and those of Boregaina in 1943.

---

[1] As it was in Fiji in the 1950s. See Ward 1965:76.



Map 3. Population

Both groups seem to have successfully established model villages with economies integrated into the outside world.

The indigenous languages spoken are primarily Austronesian, though some non-Austronesian languages are spoken in the more inland villages (Map 4). Dutton (n.d.:58-9) reconstructs the prehistory of the area thus:

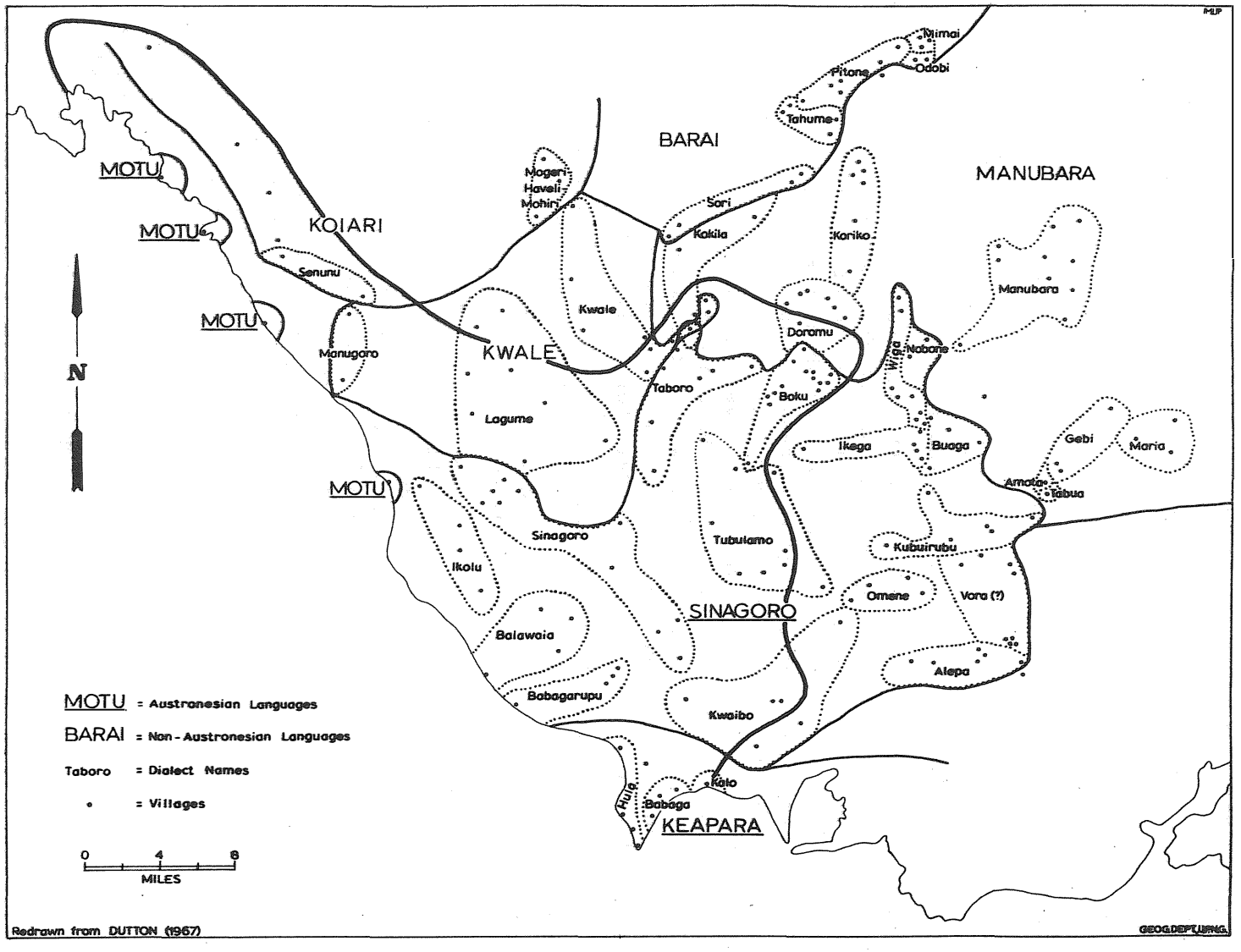
> Once Rigo was not very densely populated, particularly the drier lowland areas. Kwale [speakers]...probably occupied the mountainous areas around the headwaters of the Kemp Welch River before Koiari and Barai peoples began moving in across the Owen Stanley Range. When this happened the Koiari were forced out of their traditional territory southwards into the lower ranges.
>
> Then, or about the same time, came the Austronesian migrations - the ancestors of the present-day Sinaugoro-Motu-Keapara - who penetrated inland along the Kemp Welch River until they encountered the Kwale and Manubara peoples about the Margaret River. From here the Sinaugoro descendants spread out on either side of the Kemp Welch River until they completely occupied all the territory between this river and the Ormond to the east. However, they do not seem to have had much success in acquiring land on the western side whence the mountains come closer down to the sea. Indeed, their territory is practically limited to all land south of the rain forest line.
>
> At this point New Guinea is invaded by Europeans and further development arrested, though some coastal groups (e.g. the Motu at Kapa Kapa) took advantage of government protection to encroach on the territories of inland tribes....

The Rigo area experienced early contact with Europeans, both missionaries and government officials. The first London Missionary Society Polynesian missionaries arrived in Hula in 1877, followed by European missionaries who established a station at Keapara in 1889. The station was moved to Hula in 1910 (Oram 1968:250). The Rigo government station was established four miles inland from Kapa Kapa in 1887, and the Kemp Welcha valley up to the slopes of Mt Obree patrolled for the first time in that year. By 1892 the Sinaugoro, Koiari and Kwale tribes in the Rigo sub-district were under control. In the 1890s prospecting miners and government patrols penetrated the headwaters of the Kemp Welch and Musgrave Rivers, and by 1905 the Rigo sub-district was under complete control.

In the first decade of the century, the government established agricultural centres at Rigo, Kapogere and Gobaragere to supply material for planting such crops as rubber, coconuts, cocoa and sisal, and to

---

[1] Annual report, British New Guinea, 1905:24.



Map 4. Languages

test a wide range of other crops and shade trees. Roads and bridges were gradually constructed in the Rigo area and nearer Port Moresby to serve the developing copper mines.[1] The first Kapa Kapa wharf must have been built about this time although the exact date of its construction is not known. Missionaries penetrated inland and stations were established at Boku (well inland) and near Kapa Kapa, and some villages had mission schools.

Economic activity

The traditional indigenous economic activity is subsistence gardening supplemented by fishing on the coast. A wide range of crops is grown, including European introductions such as tomatoes, pumpkins, cucumbers, onions, citrus fruits and others. In the past it was common for men to seek work away from the villages, especially the inland settlements. Workers from the Koiari District have long had a work relationship with plantations on the Sogeri plateau, to which their area is still linked by well used foot-tracks. More recently, Port Moresby has been an attractive lure for young men and women seeking employment, while others have ventured to other parts of the country.

European economic enterprise entered the Rigo area comparatively early with a number of crops being tried at Old Rigo shortly after the turn of the century. Plantations were taken up for rubber and coconuts on the Kemp Welch River after 1907, when ten holdings were surveyed and alienated. Other Europeans attempted to establish sisal plantations in the Old Rigo and Tavai areas but these failed about the time of the first world war.

One of the Kemp Welch River holdings (Gobaragere) remained a government rubber research station until after the second world war, when it passed into private ownership. The Kapogere agricultural research station, across the river, has increasingly been used as a training centre for rubber and other cash crop production. After the second world war the remaining estates were mostly run-down, some producing copra, rubber and a little cocoa, others remaining in forest and scrub. In the past decade some have been sold and are now being redeveloped. Rubber and coconut have been replanted, and new crops such as peanuts introduced. Most managers are now introducing cattle. At Old Rigo there is a European mixed farming enterprise which includes beef, dairy cattle, pigs, sorghum, bananas and pineapples. Nearer Port Moresby other European farmers raise poultry and cattle, and grow sorghum and vegetables for sale in the town.

The Rigo road, then, links Port Moresby to the relatively populous and relatively fertile lower Kemp Welch River valley. A marked dry

[1] See Chapter 2.

season does not preclude cash crop production, and the area also has considerable potential for cattle raising. The area served by the road is about 2,000 square miles, in which about 18,000 people live. Overall crude population density is low at 9 per square mile, but the density per square mile of cultivated land is much higher. Complete data is not available, but sample agricultural densities appear to be about 5 to 8 people per acre of cultivated land for three villages, a figure which indicates the presence of some cash cropping in the agricultural system. The area has considerable potential for increase and intensification of agricultural and pastoral production.

Chapter 2

History of road construction in the Rigo area

Until 1965 the inhabitants of the Rigo area had four modes of access to the outside world. The needs of the Administration and European planters were served by small coastal vessel through Kapa Kapa. Coastal villagers used canoes for fishing and for longer journeys to Port Moresby and farther west. Inland dwellers used the network of inter-village foot-tracks which, in the Koiari census division, gave access to the Sogeri plateau, and hence to Port Moresby. Foot or horse travel was possible also along the coastal strip from Kapa Kapa and Old Rigo to Port Moresby. After 1960 there was a grass emergency landing ground near the new District Office at Kwikila, and there was an abandoned wartime air strip near Hula. Both villagers and government officers habitually rafted downstream from the upper reaches of the Kemp Welch River to the plantations on its middle course. Local people still bring produce to the road heads at Kodogere and the Bannon Bridge by this means.

A network of internal roads grew up in the Rigo District over a long period of time. The earliest record is of 1½ miles of road being built towards the coast from the government station at Old Rigo in 1901.[1] By 1908 the Rigo-Kapa Kapa road was 'in good order' though two bridges on it were in a bad state, and a new cart road was proposed to link Rigo and the Kemp Welch River where plantations were being developed.[2] Map 5 shows cart and horse tracks in 1908. In the year 1909-10 the following public works in the district were 'completed or under way':[3]

	Estimated cost (£)[4]
Road from Rigo to Saroake (15 miles)	401.10. 0
Road from the Kemp Welch nursery (Gobaragere) to Rigo road (6½ miles)	100. 0. 0
Road from Bootless Inlet to copper mines	175. 5. 0
Bridge at Kapa Kapa	50. 0. 0

[1] Annual Report, British New Guinea, 1901, Central Division:41.

[2] Annual Report, Papua, 1908:60.

[3] Territory of Papua, Report of the Administrator, 1910:2, 3.

[4] Monetary values used in this bulletin are expressed in Australian dollars and cents, except where they are drawn (as here) from sources

Road construction slackened during the war decade, but survey and construction began in 1918 for a cart road from Kapa Kapa to the Kemp Welch River.[1] About four miles of this road were completed inland from Rigo by 1920 (see Map 6) when several miles of cart road were also in use in the populous Hood Peninsula. There is little reference to road construction in the Rigo District in subsequent pre-war reports. It seems, however, that a road which wheeled vehicles could negotiate was completed to link the Kemp Welch River with Kapa Kapa. As mentioned, a timber-construction wharf at Kapa Kapa was probably built in the first decade of the century.

The first attempt to construct a modern road link between Port Moresby and the Rigo area occurred in September 1942. As Australian troops retreated across the Kokoda Trail, a detachment of American troops of the 114th Engineers, 32nd Division, constructed a motor road to Rigo and established a base at Gobaragere. They pushed a vehicle track up the east bank of the Kemp Welch (here the Mimani) River as far as Larume at the foot of the main Owen Stanley Range, from where American forces struggled on foot across the mountains to Buna (McCarthy 1962:242). No information is available about the use made of the Port Moresby-Rigo road, but from the speed of its construction it seems likely to have been temporary, and probably became difficult to negotiate in the following wet season. It was described in 1964 as 'dozer track which was never used'.[2] Traces of the route remain visible on the ground and can be discerned on aerial photographs taken in 1957.

Little progress was made with road construction until the following decade. A good vehicular road existed from Hula to Kalo as early as 1954[3] and by 1957 it was possible to drive a Landrover from Old Rigo east to Ginigolo and west as far as Manugoro.[4] In 1958 a Landrover could reach Gabone from Kapa Kapa[5] and in 1960 a road was being started from New Rigo (Kwikila) to Hula via villages on the west bank of the Kemp Welch River.[6]

In 1958 a plantation owner drove a bulldozer some sixty miles from Port Moresby to his plantation on the Kemp Welch River, roughly following

---

4 (continued)
which date from before the change to decimal currency in 1966. The conversion rates are: £1 = $2, 1 shilling = 10 cents.

1 Annaul Report, Papua, 1917-18:37.

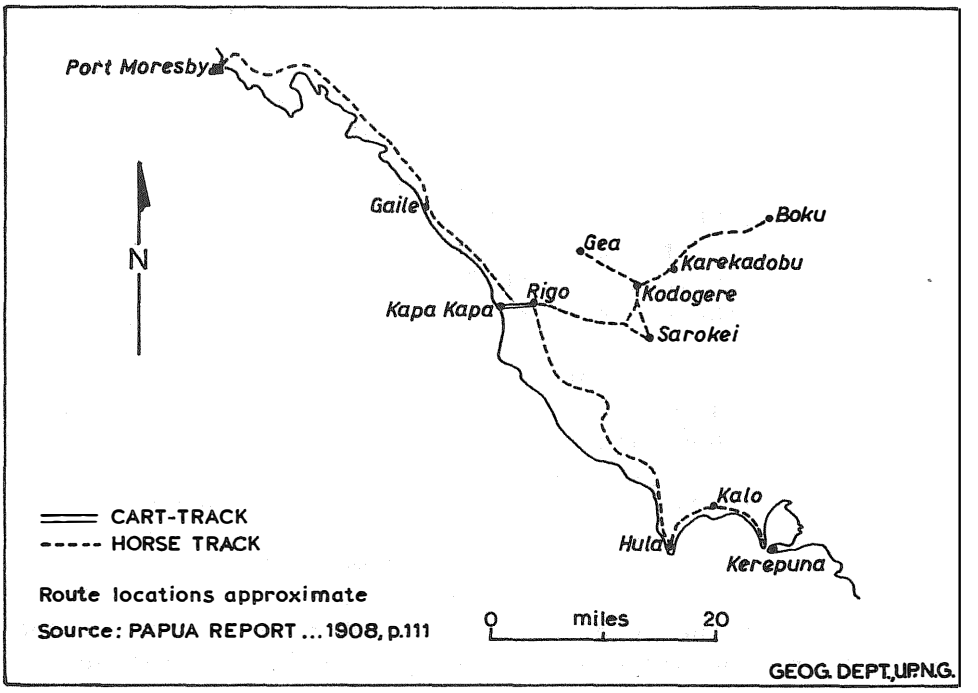
2 Public Works Department (PWD) file, 'Rigo coast road', 6 July 1964. An Australian who travelled from Port Moresby to Gobaragere by jeep in late 1942 recalled it to me as 'a rough jeep track'.

3 RPR, 1954-55, No.1, p.9.

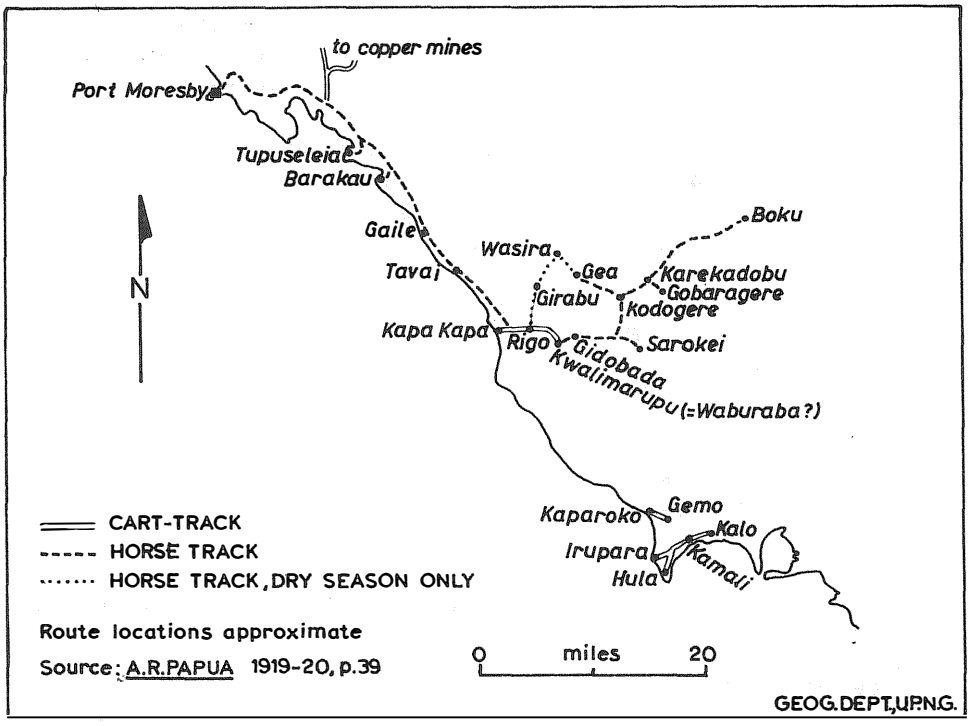
4 RPR, 1956-57, No.6, and 1957-58, No.2.

5 RPR, 1957-58, No.4, p.5.

6 RPR, 1959-60, No.4, p.5.



Map 5. Routes, c. 1908



Map 6. Routes, c. 1920

the old Army track and taking ten days over the journey.[1] The track left by this machine was used by vehicles during the dry season, but after heavy rain was virtually impassable. The refusal of some truck operators to recognise this resulted in high operating and depreciation costs on the vehicles, and in accelerated deterioration of the track.

Demands that the road should be improved were made from several quarters after 1959. European plantation owners from the Kemp Welch River area were anxious to obtain a seasonally reliable and less expensive means of communication with Port Moresby than that provided by coastal vessel from the old Kapa Kapa wharf. Indigenous truck operators attempting to maintain a regular service on the rough track from Rigo to Port Moresby were asking for PWD help in improving the road.[2] The District Officer in Rigo urged in 1961 that culvert work on the road was urgent, since without it, 'natives in Rigo would not be able to bring their produce into Port Moresby'.[3] The Rigo local government council complained in May 1961 of the lack of maintenance on the road, which made transport of produce to Koki market very difficult.[4] The Administration hoped that an improved road would increase and make cheaper the supply of fresh food to Port Moresby. It was felt also that it would permit the development of 2,000 acres of Crown land at the Rigo end,[5] and encourage some already active co-operative societies in the area.[6]

In response to these demands, Ministerial approval was given in March 1959 for the inclusion on Design List 'A' (i.e. priority projects) of 1958-59 of a road from Port Moresby to Rigo, following a route surveyed by the Commonwealth Department of Works.[7] The Public Works Department commenced construction work on parts of the rough track, and put in some essential culverts. For this work authority to spend a token amount of £5,000 over the two years 1960-62 was granted in March 1960.[8] During 1959-61 the dry weather track was formed to highway standard for 45 miles from Port Moresby (that is, at least as far as Old Rigo), but it remained ungravelled. Bridges and culverts were mostly lacking.

---

[1] Personal communication: Mr H. Rosser, November 1967.

[2] South Pacific Post, 21 and 23 October 1959.

[3] PWD file 'Rigo coast road', 28 September 1961.

[4] Rigo District Office, Kwikila, file 10-2-2, 'Roads, wharves, bridges, Kwikila', Pt II, 8 May 1961.

[5] See p.45.

[6] Directorate of Transport file NDP 21-3-1, 'Roads Central District - Rigo road', 26 February 1959.

[7] Directorate of Transport file NDP 21-3-1, 6 April 1959.

[8] Directorate of Transport file NDP 21-3-1, 26 October 1959 and 1 March 1960.

Meanwhile a parallel controversy developed over the rebuilding of the Kapa Kapa wharf, which had served the government station at Rigo, the plantations on the Kemp Welch River, mission and other needs for several decades. By 1956 the Central District Advisory Council requested that 'steps be taken for the construction of a new wharf at Kapa Kapa, as the old wharf is in such a state that it cannot be economically repaired'.[1] Storms in the wet season caused further serious deterioration and the Acting District Commissioner requested urgent repairs.[2] Some temporary work was done, although the money for these repairs seems never to have been properly authorised.

In July 1957 the building of a new timber wharf 20 ft by 90 ft at the end of a 500 ft rock-filled causeway was recommended. The estimated cost was £20,000 which the PWD regional engineer pointed out was one-third of the then estimated cost (£60,000) of improving the Port Moresby-Rigo Road,[3] and the whole question of 'wharf versus road' was aired. The Directors of the Departments of Agriculture, Stock and Fisheries; Lands; Works; and Marine, and the District Officer at Rigo favoured the road, the District Commissioner remained neutral, and the European planters and traders of the Rigo and Kemp Welch areas preferred a new wharf, 'providing the internal roads of the sub-district were first brought up to reasonable condition'.[4] The planters were immediately condemned for the self-interest of their decision, but in the circumstances it was not unrealistic.

A year later a request for authorisation of £20,000 for a new Kapa Kapa wharf was made to the Department of Territories, Canberra, which questioned the justification for this sum.[5] The Public Works and Marine Departments meanwhile searched unsuccessfully for an alternative site with more protection from the southeast wind. In February 1959 the Administration asked Canberra for urgent authorisation of £22,100 for the wharf project, but the Minister demurred on the grounds that this sum was being requested as an upgrading of the £6,000 requested earlier (which had never been officially authorised), and that the project was in essence an entirely new one.[6]

The application was accordingly resubmitted as a new project and in April 1959 the Minister approved the expenditure of £22,100. In October 1959 the figure was raised to £24,000 to cover the cost of the

---

1 PWD file 23-3-4, 'Rigo Kapa Kapa wharf', f.2, 21 September 1956 (Archives 63).

2 PWD file 23-3-4, f.7, 14 February 1957.

3 PWD file 23-3-4, f.32, 24 September 1957.

4 PWD file 23-3-4, f.35, 15 October 1957.

5 PWD file 23-3-4, f.57, 23 October 1958.

6 PWD file 23-3-4, f.66, 20 February 1959 and 27 October 1959.

tender accepted, which was for £22,897.[1] Construction began about December 1959, and was completed in 1960. Modifications during construction cost another £4,000.

Due to storm damage and other factors, the wharf and causeway leading to it have required significant maintenance and repair in the nine years since their construction, requiring an allocation of $1,000 per annum. In 1968-69 $2,000 was allocated for maintenance.[2]

In 1960 the Bannon Bridge[3] across the Kemp Welch River near Sarokei was opened. This eliminated a canoe crossing of the river, either at this point or further upstream at Kapogere, and greatly improved access for villagers, several plantations, and the agricultural station on the east bank of the river. In subsequent years, local roads (mostly now under the direction of the Rigo local government council) have been extended out from the bridgehead, northwards into the populous hill zone, eastwards towards the Ormond River, and south along the east bank of the Kemp Welch.

A strong bid to get the Rigo road construction off the ground was made by PWD late in 1961. It submitted a request for £114,000 for major reconstruction of the 53 miles of road between Port Moresby and the Bannon Bridge, and for the new construction of bridges and culverts where necessary. The road was to be of all-weather standard, and it was estimated that construction could be completed in two years. Arguments for this proposal included first, the need to protect the investment of (by PWD estimate) £25,000 prior to 1961 in the first 45 miles east from Port Moresby; second, the lowering of freight rates on produce coming into Port Moresby from areas served by the road; and third, the link which the improved road would give between the port of Kapa Kapa and the sub-district office which had been transferred from Old Rigo to Kwikila in 1959. (The last point did not anticipate the drastic effect on the port that the completed road would ultimately have.) It was also argued that the improved road to Kwikila and the Kemp Welch River would link with a network of roads serving many villages, the Kapogere agricultural station and four plantations, and that the Port Moresby-Kwikila-Kemp Welch River road was the first stage of a road system extending southeastwards towards Marshall Lagoon and Abau sub-district.[4]

---

[1] PWD file 23-3-4, 7 October 1959 and 27 October 1959.

[2] Commonwealth Department of Works 'Urgent minor and operational and recurring maintenance to administration engineering installations', February 1968, p.3. Mimeo.

[3] Named after the first European surveyor in the Kemp Welch area, who had made the original land purchase surveys in 1907, and who at that early date had identified the present site as the most suitable bridging point on the river.

[4] PWD file 23-3-4, 28 September 1961.

Only in August 1963 was a decision finally made to act on this request, when an initial amount of £30,000 was allocated for work on the 10 miles of road (from Austin's Crossing at the head of Bootless Inlet, some 10 miles east of Port Moresby, to Surveyor's Creek), and engineering consultants were commissioned to survey the entire route. A further allocation of £175,000 (£92,000 for roadworks and £83,000 for bridges) was approved in October 1963,[1] and appeared in the Works Programme for 1963-64.[2] The £92,000 was intended only to finance improvements to the existing dry-weather road. The consultant's report recommended that the road should be completely redesigned to the minimum acceptable Territory standards, after which it was estimated that an additional £128,000 would be required, bringing the total cost (excluding bridges) for the 38-mile section from Port Moresby to Old Rigo to £220,000.[3]

At this stage the only cautionary note was sounded by the then Assistant District Commissioner of the Central District, who suggested early in July 1964 that, provided the bridges were built, the existing road could cope with the traffic bringing produce into Port Moresby, and that the large amount of money it was proposed to spend on some 26 miles of road between Austin's Crossing and Manugoro village could more usefully be spent in other ways. He suggested also that 'to make any real and immediate impression on the quantity of produce entering Port Moresby it is necessary to extend the Vanapa River road to the Galley Reach road and to subdivide resettlement blocks at the Brown River'.[4] Although this argument seems to have been ignored in 1964, the provision of access to, and development of, supposedly more promising agricultural land to the northwest of Port Moresby as a source of food for the town later became official policy.

It is, of course, impossible to prove or disprove the A.D.C's first point, but in view of the relatively large increase in traffic on the new Rigo road[5] it seems likely that to have provided bridges without improving the road itself would still have generated a considerable amount of traffic, and that it would have been necessary to reconstruct the road anyway before long.

The amount authorised for reconstruction of the Rigo road was increased to £220,000 in July 1964.[6] Work on the section between Austin's Crossing and Manugoro began on 5 November 1964, and was completed by September 1965.[7] It proved necessary to re-survey the site for a

---

1 PWD file 23-3-4, October 1963.

2 T.P.N.G. Works Programme 1963-64:20, 23.

3 PWD file 23-3-4, June 1964.

4 PWD file 23-3-4, 3 July 1964.

5 See Chapter 4.

6 PWD file 23-3-4, July 1964.

7 Personal communication: Mr W.M. Johns, December 1967.

bridge, and the new alignment involved extra construction costs, so that in September 1965 approval was given for an additional expenditure of £20,000. Work on the 9-mile section between Manugoro and Old Rigo was carried out by day-labour, and its cost included in the £240,000 total. It is not possible to isolate the actual construction cost of the sections of the road from Rigo to Kwikila, or from Kwikila to the Kemp Welch River.

The total identifiable expenditure on the 38-mile stretch of road from Port Moresby to Rigo, through what by New Guinea standards must be regarded as relatively easy country, was therefore £323,000 ($646,000), or about $17,000 per mile. Disregarding the earlier ephemeral wartime track, it took about seven years to complete to good all-weather condition. Within this period the Kapa Kapa wharf, serving at least part of the area served by the road, was built at a cost of £28,000 ($56,000).

Chapter 3

Vehicles

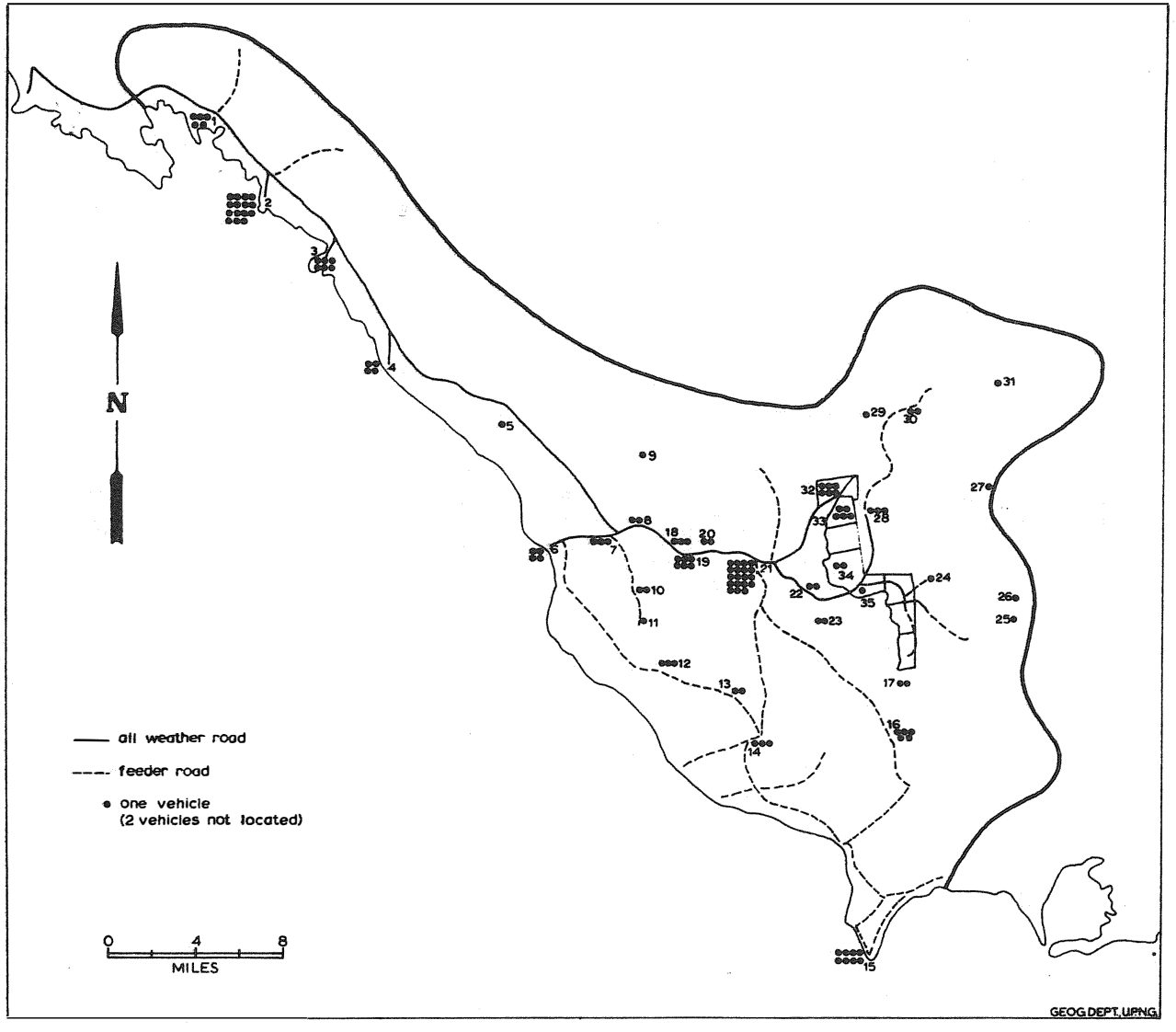
One of the most obvious changes brought about by the improvement of the Rigo road is the increase in vehicle ownership in the area.[1] In 1967, 133 vehicles were registered, and their distribution is shown in Map 7.

The largest number of registrations for any single village, 15, occurs in Tupuseleia, twenty miles east of Port Moresby. The three large coastal villages of Barakau, Gaile and Kapa Kapa, together with Manugoro, have another 15 vehicles between them. The small villages on the inland side of the road as far as Old Rigo have no vehicles. Between Old Rigo and Kwikila the roadside villages and others up to three miles on either side of the road account for 20 vehicles. Villages located along the access roads radiating from Kwikila for twenty miles account for 33 vehicles, while at least 4 vehicles are registered from villages which lie beyond any road access to Kwikila and the main road. These vehicles are left at the nearest roadhead, and produce is carried to them over foot trails, or rafted down the river to the Kadogere loading point.

The remaining vehicles in Map 7 are non-indigenous or government-owned. Twenty-three, located in Kwikila, are owned by Europeans in mission service (at nearby Ruatoka College), by the Rigo local government council, or by the Administration. A further 10 vehicles are owned by European planters on the Kemp Welch River and at Old Rigo,

---

[1] The information on which much of this chapter is based was obtained from a survey of motor vehicle registrations in the Central District, up to December 1967, made available by the Bureau of Statistics. The Police also made available data on the passenger motor vehicle licences issued in the Central District, which permitted some cross-checking. The registration figures appear to be a realiable source of information, since unregistered vehicles do not appear on the public road, although a few may be used privately on farms or in villages. Information gathered in the villages has been checked with the registration data so that the figures used in this chapter can be considered reasonably accurate.



Map 7. Vehicle registrations, 1967

and by Administration employees at the Kapogere agricultural station. Five more are owned by Europeans in the Bootless Bay area at the Port Moresby end of the road.

Although an attempt to measure the overall density of vehicles to population would be meaningless, there is some interest in examining this ratio for the villages in which vehicles are owned. (Village vehicles are all trucks or utilities, except that both Tupuseleia and Barakau each have an additional car and tractor.) The expected ratio would be low, that is a large number of people per vehicle. For Papua-New Guinea as a whole, this ratio is approximately 1:150. Table 1 summarises the local situation.

Table 1

Vehicle:population ratio in villages near the Rigo road, 1967

Vehicle:population ratio	Villages
About 1:250	Tauruba, Hula, Gunugau, Gaile, Kapa Kapa
About 1:150	Ginigolo, Imagolo, Kemaia, Sivitatana, Manugoro
Between 1:125 and 1:75	Tupuseleia, Barakau, Tagana, Gomoredobu, Girabu, Kwalemurupu, Saroa, Gidobada, Kemabolo, Gabone, Boregaina, Nogomaka
1:69	Sarokei
1:49	Geverogoro (Seba)
1:33 to 1:23	Gavagoro, Bore, Niuiruka

Of the three villages with the fewest people per vehicle, Gavagoro is a small remote inland village with 33 people in 1966. Bore and Niuiruka are neighbouring villages on the lower flood plain of the Kemp Welch River; the former had two vehicles in 1967 and a population of 52 in 1965, the latter five vehicles in 1967 and a population of 114 in 1965 (121 in 1966).

The comparatively high vehicle:population ratios found in Bore, Niuiruka, and neighbouring Sarokei can be primarily attributed to their agricultural productivity. Similar ratios seem attainable by other villages with similar advantages of available fertile land. The high ratio for Geverogoro (Seba) can be attributed to the enterprise of a single owner (who works for the Administration away from the village). He owns a trade store at Vinibara near the Kadogere loading point on the middle Kemp Welch River, and at least one of his trucks operates

from there, catering for people and produce rafted from the upper reaches of the river.

The large group of villages with vehicle:population ratios of about 1:100, and the others with even lower ratios, seem to have considerable potential for increase in vehicle numbers. At present the most rapid expansion of cash cropping is taking place between Kwikila and the coast to the southwest. Four of the eight new truck registrations in the last three months of 1967 came from villages in this area (Imagolo, Tauruba, Gabone and Niuiruka).[1] The other were from Boregaine and Gavagoro (east of the river) and from Gidobada and Kwalemurupu (on the Rigo road west of Kwikila). As access roads are improved and agricultural production rises many more vehicles will be owned by people from villages up to twenty miles beyond the main road at Kwikila or the Bannon Bridge.

Composition

Table 2 gives the numbers of vehicles registered, and the percentage of various types for the three years, 1965-67.

Table 2

Vehicle registration, Rigo road, 1965-67

Type of vehicle	1965		1966		1967	
	No.	%	No.	%	No.	%
Trucks	19	36	59	55	76	57
Utilities	14	27	21	20	30	23
Cars and station wagons	11	21	14	13	13	10
Motor cycles and scooters	7	14	7	6	7	5
Tractors, trailers, etc.	1	2	7	6	7	5
Total	52	100	108	100	133	100

Source. Duplicates of motor vehicle registration certificates, Bureau of Statistics.

Trucks were the dominant type of vehicle on the road: while their absolute number rose four times during 1965-67, the proportion of trucks to all vehicles increased from 36 per cent in 1965 to 57 per cent in 1967. Utilities doubled in number but declined proportionately from 27 to 23 per cent. Cars and station wagons remained about the same numerically but halved their percentage share from 21 to 10 per cent. Motor cycles and scooters also remained at the same number, but dropped from 14 per cent to 5 per cent of the total registrations in 1967. Tractors,

[1] An additional truck was bought by Bonanamo people in the same period.

trailers, and other heavy equipment such as bulldozers and graders increased to seven in number, though they account for only 5 per cent of all vehicles.

This situation, where 1 out of every 2 vehicles in the area is a truck, and almost 9 out of every 10 vehicles are potentially productive units rather than private cars (however valuable private cars may be for their owners' mobility), is typical when a new road enters an area. Through 1965-67, the proportion of trucks increased, though at a much slower rate between 1966-67 than between 1965-66. This trend will gradually change as people become wealthier, but trucks will dominate for many years.

The stable numbers of cars, motor cycles and scooters can be accounted for by the fact that these are largely owned by Europeans, whose numbers are unlikely to increase greatly in the immediate future. The increase in the number of heavy vehicles is partly due to increasing interest in mechanisation of agriculture, and this trend may well strengthen in future years.

The makes and weights of vehicles have been analysed from the results of a questionnaire covering 47 trucks and utilities, or 44 per cent of all such vehicles in 1967.[1] The results indicate that 84 per cent of the sample were Japanese makes. Among them Toyota and Prince dominated, but Isuzu, International and Nissan were also well represented. Twelve per cent were Landrovers, Thames Traders, Bedford or Holden vehicles, and the makes of 4 per cent were not recorded.

The dominant size was the 'two-ton truck', 60 per cent being within the 1½ to 2½ ton ranges, and the majority close to 40 cwt. A further 28 per cent were below 1½ tons weight, 6 per cent were from 3-5½ tons, and the weights of 6 per cent were not recorded.

Most vehicles in the sample (89 per cent) were bought in 1966 or 1967, and most of them were bought new rather than secondhand.

Growth in the number of vehicles

Before the Rigo road was improved, a few vehicles were in use in the Rigo, Tupuseleia and Bootless Bay areas. One reliable informant recollects that in 1957 there were five Landrovers and three trucks operating on the roads between Kapa Kapa, Old Rigo and the plantations on the Kemp Welch River, most belonging either to the Administration or the three plantations (Gobaragere, Sivigolo and Kokebagu) then in production. A few additional vehicles appeared in the early 1960s, but it was not until the road became open to Port Moresby that vehicle ownership increased greatly.

---

[1] See Appendix 4.

The numbers of vehicles registered in 1965-67 are given in Table 2 and shown graphically in Figure 2. The total number of registered vehicles more than doubled between 1965 and 1967, though the rate of increase was much steeper between 1965 and 1966 (104 per cent) than between 1966 and 1967 (23 per cent). Registrations of trucks show an even more spectacular rise. Between 1965 and 1966 they increased by 210 per cent, but between 1966 and 1967 this rate slackened to 25 per cent. Utilities showed a lower but steadier growth rate, increasing by 50 per cent between 1965 and 1966, and by 43 per cent between 1966 and 1967. The number of cars has remained nearly constant. The steep rates of increase in the first year represent the satisfying of the immediate demand for vehicles, which had been pent up until the road became available for use. The slackening in succeeding years was to be expected.

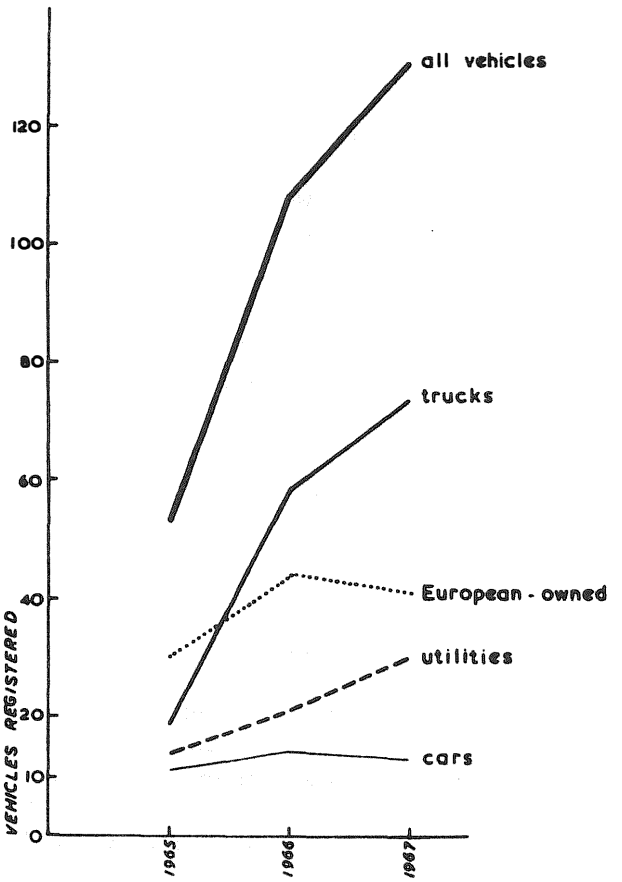


Fig. 2. Vehicle registration, Rigo road, 1965-67

Given the present level of development in the area, there are, for the time being, enough locally owned vehicles available to meet freight and passenger demands. At the time of the survey, particularly in the area about fifty miles from Port Moresby, truck owners in Kapa Kapa, Gomoredobu and other villages complained of severe competition and difficulty in obtaining passengers and cargo. The owners of a village co-operative truck in Kapa Kapa had recently lowered the passenger fare to Port Moresby by one-third in an endeavour to attract custom. To generate further exceptionally rapid growth in the number of vehicles, it will be necessary to inject a new development impetus, such as agricultural extension work, the improvement of access roads, improvements in marketing of produce, or the extension of the main road to the south-east, to name only a few possibilities.

If we assume that the number of vehicles registered from the Rigo area will follow national annual growth rate of about 14 per cent, by 1970 there will be 197 vehicles in this area, and by 1975, 379. As any large increase in the number of Europeans residing in the area during this period is unlikely, it seems that by 1970 perhaps 150, and by 1975, perhaps 330, trucks and utilities will be owned in the villages. This rate of increase in vehicle ownership is four to five times greater than the likely rate of population increase.

Ownership

Of the 133 vehicles registered in 1967, 38 (28 per cent) were owned by Europeans. Some are relatively permanent residents on farms or plantations, while others, in government or mission service, are liable to a fairly steady turnover. The remaining 95 vehicles are mostly trucks or utilities owned by villagers. The questionnaire showed that 32 per cent of the sample vehicles were individually owned, 10 per cent were owned collectively by the 'village', by a church group within a village, or by a village co-operative society, and the remaining 58 per cent were owned by a number of co-owners ranging from 2 to over 20, within a village. The most common size of groups were 2, 3 and 5, which each occurred five times. Four other groups had about 12 members. The individuals in these groups were invariably related in some degree: brothers and brothers-in-law, or father, sons and son-in-law. In some cases, women were included in the ownership groups.

Twelve owners (29 per cent of those questioned) had owned 22 vehicles between them in the past six or seven years (not including their present vehicles). These had rarely been sold, but almost always were described as having broken down irreparably, or as being 'in a workshop in Port Moresby awaiting repairs'. Since they were mostly old models - a number were ex-Army surplus trucks - there is great difficulty in obtaining replacement parts for them.

Financing of vehicle purchase

In the sample of 47 vehicles, 75 per cent had been bought with the help of a loan, 21 per cent without a loan, and there was no information for 4 per cent. Cash for the deposit or outright purchase of a vehicle was derived heavily from sales of garden produce and fish, and from salary or wages earned, as Table 3 shows.

Table 3

Sources of money for purchase of vehicles

Source	No. of vehicles	Percentage
Sales of garden produce and/or fish	7	15
Salary or wages earned	7	15
Sales of produce and salary earned	15	32
Trade store earnings and salary or wages earned	3	6
Earnings from copra sales and salary or wages earned	3	6
Earnings of another vehicle	2	4
Church funds	2	4
Sales of produce, wages, and trade store earnings	2	4
Wages and earnings of another vehicle	1	2
Sales of produce, wages and earnings of another vehicle	1	2
Sales of produce and earnings of another vehicle	1	2
Wages earned, earnings of another vehicle, and trade store	1	2
No information	2	4
Total	47	98

Most indigenous truck owners who have received loans rely on the earnings of the vehicle to repay the loan. Although very few owners keep formal records, from the answers obtained to questions it is possible to estimate that the incomes earned by trucks range widely between about $20 and $100 per week. The income comes primarily from passenger fares, charges for freight being a small proportion of total earnings. Expenditure on the vehicle consists mostly of the driver's wages (if one is employed), petrol, repairs (though frequently no allowance is made for this before the need arises). Again there is a range of expenditure, depending on how much the truck is used, but most is between $10 and $30 per week.

Because of these wide ranges it is difficult to estimate profit making very reliably. It seems, however, that roughly one-third of the trucks were earning less than $10 per week (including a number of old trucks used mainly locally, and also a number of trucks in the 45 to 55 mile zone, where competition was particularly keen at the time of the survey).

Another third appeared to be earning $10 to $30 per week, and another third from $40 to $90 per week. The last group includes those trucks which operate a regular commuter service, some owned by well-organised groups from villages where there is little or no competition from other vehicles, and some which are hired out on contract.

Loans are usually repaid on a monthly basis. The amount varies depending on the deposit a purchaser was able to raise, but often it was about $100 per month for 12 to 18 months. Hence it would seem that perhaps half the trucks in the area are earning enough to pay off their loans fairly easily, even if they are not making much profit in the first years. Perhaps as many as one-quarter are likely to have difficulty meeting their repayment obligations.

Loans are available from several sources: from the motor company which sells the vehicle, from finance companies (there are several in Port Moresby), or from banks, including the Papua-New Guinea Development Bank. Provided the prospective borrower can satisfy the lending agency that he is likely to meet his obligations, there seems to be little difficulty in obtaining credit. Enquiries among several of the lending agencies revealed that complete failure to make good the loan and hence the final drastic step of repossession, was rare. Several agencies, however, reported that they experienced difficulty in obtaining payments on time. The most common causes seem to be lack of financial budgeting, lack of mechanical knowledge (which contributes to poor driving and hence accidents), and inadequate maintenance and repair of the vehicles. The lending agencies naturally prefer the trucks to be kept in operation, and hence have been liberal in encouraging owners to get their vehicles back on the road after breakdowns or accidents, and in renegotiating contracts where necessary. It would seem that the provision of short training courses for truck operators in simple business management, in good driving, and the maintenance and care of vehicles would be a useful encouragement to indigenous entrepreneurs.[1]

[1] Since this survey was undertaken a booklet has been prepared for prospective truck owners, which will be distributed by the Business Advisory Service, Department of Trade and Industry, possibly in conjunction with the Reserve Bank.

Chapter 4

Traffic

Growth

A second predictable consequence of any new or improved road is that traffic will increase, though the scale and duration of such increases are more difficult to predict. The lack of reliable evidence of the volume of traffic on the Rigo road in earlier years makes estimation of the growth rate difficult, but the meagre data available indicates a very rapid increase since 1965.

The first record of motor vehicle movement between Rigo and Port Moresby is of an indigenous entrepreneur who made two trips per week by truck in 1959.[1] It is not known how long this was maintained but in 1961 this entrepreneur, by then a Member of the Legislative Council, reported that 'up to eight trucks a day were now using the road'.[2] There is some support for this figure in a letter from the Rigo local government council requesting more maintenance on the road,[3] but in view of the known poor condition of the road at this time, and because a count in 1964 revealed no more than this number of trucks, it seems that this figure may be an overestimate for 1961. In any case, it appears that virtually all activity stopped during each wet season, from December to March.

Firmer evidence for increasing use of the road, even in its then relatively poor condition, is provided by a vehicle census taken at Old Rigo between 25 and 31 August 1964, under the direction of the Rigo District Office. The total for the week of 346 vehicles yields an average of 49.4 vehicles per day. Table 4 gives the details of the census.

---

[1] Directorate of Transport file NDP 21-3-1, 'Roads, Central District - Rigo road', 21 October 1959.

[2] South Pacific Post, 24 November 1961.

[3] Rigo District Office file 10-2-2, 8 May 1961.

Table 4

Vehicle census, Port Moresby-Rigo road, 1964

Date	Koki trucks*		Contract trucks**		Utilities		Cars		Others, tractors, etc.		Total	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Tues., 25 August	3	4	3	2	8	10	2	2	-	-	16	18
Wed., 26 August	7	11	2	1	5	4	1	2	-	-	15	18
Thurs., 27 August	5	3	9	3	4	12	6	2	1	-	25	20
Fri., 28 August	7	11	4	4	6	7	7	2	-	-	24	24
Sat., 29 August	6	6	2	1	18	14	11	10	-	-	37	31
Sun., 30 August	7	10	2	2	15	16	15	16	-	-	39	44
Mon., 31 August	5	6	2	2	5	10	1	4	-	-	13	22
Total	40	51	24	15	61	73	43	38	1	-	169	177

* i.e. truck carrying produce for sale at Koki market, Port Moresby.
** Trucks carrying goods for the Administration on contract. In view of the imbalance in the inward and outward truck totals it is assumed that there is an observer's error. A more realistic assumption is that two-thirds of all inwards trucks (say, 43) were 'Koki' trucks and one-third of all outwards trucks (say, 22) were 'contract' trucks.

Source. Rigo District Office, file 10-2-2, 4 September 1964.

The contractor estimated that in June 1965, when the road was usable from Port Moresby to Rigo, about 60 vehicles per day were using it, and that at weekends this figure rose to about 100 per day.[1]

The most recent data comes from a special count by the Commonwealth Department of Works at Austin's Crossing immediately east of Dogura Road junction, on Wednesday, 6 December 1967, when a total of 252 vehicles passed the check point (see Table 5). Since this was a twelve-hour count the total underestimates the true daily total. Support for such a figure comes from an undated but recent (probably 1967) count by the Directorate of Transport which recorded a 24-hour total of 244 vehicles.

These various estimates of traffic flow over the years 1959-67 are collated graphically in Figure 3, which shows the marked increase after the road reached all-weather standard in 1965.

[1] Personal communication: Mr W.M. Johns, December 1967.

Table 5

Traffic count, Rigo road, 6 December 1967

Time	To Rigo		From Rigo	
	Cars	Trucks*	Cars	Trucks*
6 a.m. - 9 a.m.	8	14	15	12
9 a.m. - 12 noon	8	25	9	26
12 noon - 3 p.m.	4	18	5	20
3 p.m. - 6 p.m.	14	29	8	37
Total	34	86	37	95

* Includes vans and loaded utilities.

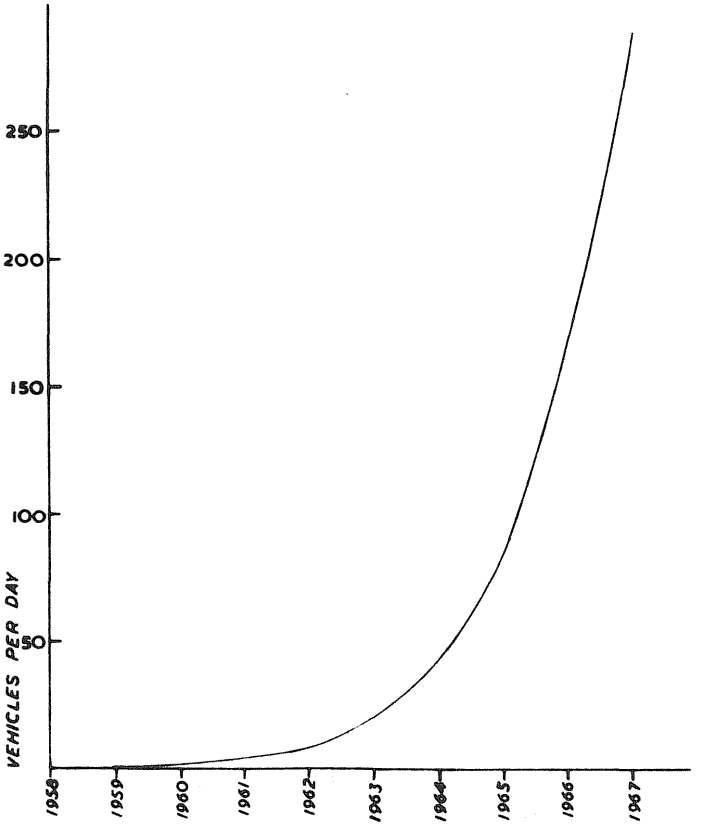


Fig. 3. Growth of traffic, Rigo road, 1958-67

An attempt has been made to calculate the annual rate of increase between the years 1964-67, using the following formula:

$$r = \left(\sqrt[t]{\frac{F_1}{Fo}} - 1 \quad x \ 100 \right)$$

Where r = annual rate of increase
t = number of years
Fo = flow at beginning of period
F_1 = flow at end of period.

Using the 1964 average figure of 49.4 vehicles per day (v.p.d.) as the starting level, and the 1967 count of 252 v.p.d., the annual rate of increase is 72 per cent. A more valid comparison might be obtained by using the 1964 Wednesday figures of 32 v.p.d. The annual rate of increase in this case is 99 per cent. It might be not unrealistic to assume that the annual rate of increase in traffic lies somewhere between these two figures for the 1964-67 period, say, 85 per cent.

The nature of the curve in Figure 3 conforms to that expected for traffic using a newly opened road. The only uncertainty lies in when and how fast the rate of increase can be expected to ease.[1] Future rates of increase on the Rigo road are likely to be governed by the rate at which further economic development proceeds in the area, and possible extensions to the road.

Daily and weekly patterns

The most accurate record of traffic pattern throughout the day is given by the December 1967 count. The data graphed in Figure 4 show marked morning and late afternoon peaks, which are confirmed by my experience during numerous journeys at different times on week-days over all or part of the road. In the hot middle of the day the road is largely empty for several hours. The direction of traffic recorded on 6 December 1967 is surprisingly evenly distributed in both directions. The expected pattern would be a surplus of vehicles bound to Port Moresby in the morning, and a marked exodus from the town in the late afternoon and evening. On this day at any rate, such a pattern can only be seen for the movement of cars. It is likely that the

[1] Evidence from a somewhat comparable situation in Thailand suggests that the rate of traffic growth will tend to slacken. Economic studies of the Friendship Highway linking Saraburi and Korat show that traffic volume rose to 1,000 v.p.d. in 1962, after four years of service, and was expected to rise to 1,500 v.p.d. by 1964 (Jones 1964:7-8). Rates of increase calculated as above for these figures show a rate of over 200 per cent for the first period, falling to 23 per cent per annum for the second period.

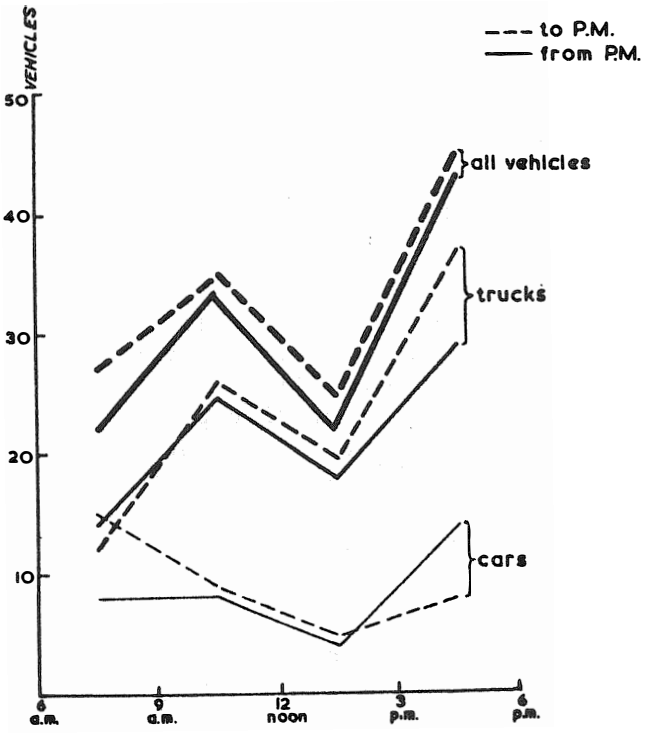


Fig. 4. Diurnal traffic fluctuation, Rigo road, 6 December 1967

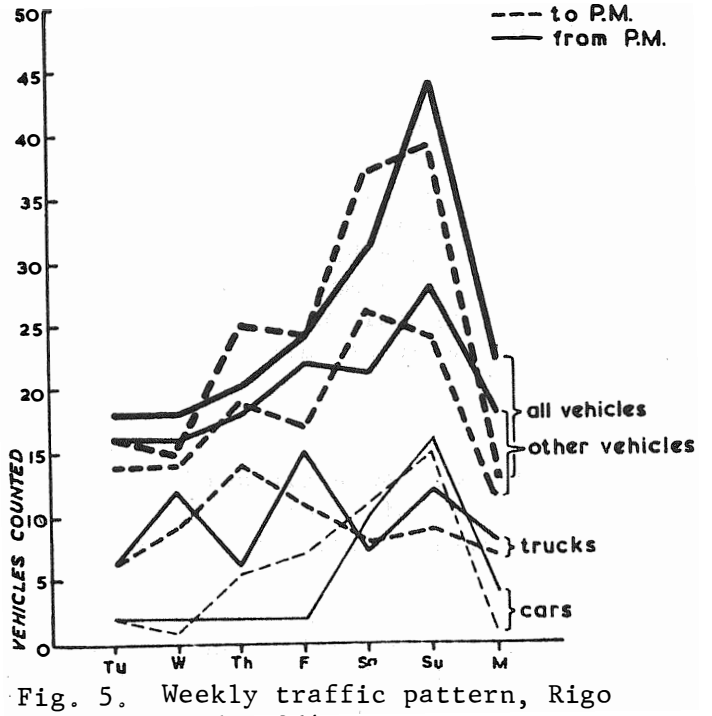


Fig. 5. Weekly traffic pattern, Rigo road, 1964

majority of the 15 cars inbound between 6 a.m. and 9 a.m., and the 14 cars outbound between 3 p.m. and 6 p.m. were carrying daily commuters from Tupuseleia village and other points rarely further than 20 miles from Port Moresby.

The weekly traffic pattern based on the 1964 week-long census is shown in Figure 5. Conversations with residents along the road indicate that the pattern it shows remains typical today. Traffic is greatest at weekends, largely due to the increase in cars and utilities. The number of trucks remained about the same at weekends as on week-days.

No data is available on the year-round pattern of traffic on the Rigo road. Before improvement it was little used in the wet season. Since 1965 any seasonal variation in traffic volume is likely to be related to fluctuation in agricultural production with the seasons, rising from a low in the first quarter to a high in the fourth quarter of the year.

Composition

The fragmentary evidence available on the composition of traffic is summarised in Table 6.

Table 6

Percentage composition of traffic

Vehicle type	25 to 31 August 1964*	c.1967**	6 December 1967*
Trucks	37	51	72
Utilities	39	49	
Cars	23		28

* Based on traffic counts on these days.
** Based on undated map (probably 1967), Directorate of Transport.

At least half the traffic consists of trucks, mostly of the 2 to 2½ ton size. If utilities are included, approximately three-quarters of the traffic is potentially freight-carrying. The movement of commuters in and out of Port Moresby by car has already been mentioned and is significant only from Tupuseleia village. I was informed that the poor condition of access roads from Barakau and Gaile villages to the main road, rather than distance from Port Moresby, deterred people from commuting regularly from them.

Weekend traffic contains a large element of recreational traffic seeking egress from Port Moresby. The data from the 1964 traffic count indicate that this 'extra' traffic (cars and utilities) amounts to one-fifth (21 per cent) of the total traffic counted that week.

Freight movements

Evidence for an increase in freight movements after the road was improved is fragmentary, though there have undoubtedly been considerable increases in the amount of garden produce moving into Port Moresby and in outwards freight movement.

In 1961 the Rigo local government council estimated that 'when the road was reasonable there was over £400 a week passing in produce over the road to Koki market' with passenger fares of more than £50 a week.[1] A survey at Koki market about 1962 found that over a week 21,174 lbs (9½ tons) of produce at a value of 22,580 shillings was brought in from Rigo.[2] On the basis of these figures, the 1961 value corresponds to about four tons weight per week. The 1964 census of vehicles on the Rigo road produced an estimate of 98 tons of produce moving in to Koki in the sample week in August 1964.[3] This figure seems to be a considerable overestimate. The recorder assumed that each truck (described as all of 5 tons) was carrying two tons of produce. He also used the outward count of 'Koki' trucks, namely 51, instead of a possibly more relevant estimate of two-thirds of all inward trucks for the week.[4] If 42 trucks are assumed by a generous estimate to be carrying ten people, each with five bunches of bananas weighing 30 lbs each (or the equivalent weight in other produce), the total inward movement in the sample week would have been about 28 tons.

The returns to the questionnaire in November-December 1967 showed that 47 vehicles carried about 34 tons of freight into Port Moresby in the sample week. When this figure is adjusted for seasonality and scaled up to represent all village trucks in the area,[5] a figure of 57 tons per week is obtained as the average inwards freight moved by village trucks. With another 6 tons per week of plantation produce moved into Port Moresby, there is a total of about 63 tons per week.

Very little information is available about the change in outwards freight moving along the road. The 1964 vehicle census figures can be used to indicate a figure of about 31 tons of outward freight per week.[6]

---

[1] District Office, Kwikila, file 10-2-2, 'Roads, wharves, bridges', 8 May 1961.

[2] Department of the Administrator file NDP 21-3-1, 'Roads, Central District - Rigo road', no date, but between 20 September 1962 and 18 October 1963.

[3] District Office, Kwikila, file 10-2-2, 4 September 1964.

[4] See p.33, Table 4, note **

[5] See Appendix 4.

[6] On the assumption that 22 'contract' trucks each carried one ton per week of outward freight, and that 44 'Koki' trucks each carried the same amount of outward freight as the sample indicates their counterparts did in 1967, namely 0.19 tons per week.

Answers to the 1967 questionnaire indicate that 47 trucks carried 8.9 tons of outward freight during the sample week.[1] Hence the scaled-up figure representing all village trucks in the area at the time is 15.5 tons per week. To this figure in 1967 must be added the outwards freight carried by European-owned trucks to plantations and trade stores, and on Administration contract, totalling about 32.2 tons per week. Outwards freight in 1967 is thus likely to have been about 48 tons per week. Freight moving outwards in indigenous-owned trucks from Port Moresby consisted of imported foodstuffs (especially rice, sugar and flour), fuels and building materials.[2] European-owned trucks in 1967 were carrying supplies and stores for plantations and trade stores, building materials, fuel, and animal feeding stuffs.

Figure 6 graphs the increase in inwards and outwards freight since 1961, and shows that the rate of increase in inwards freight exceeds that of outwards freight. It is apparent that the increase in inwards freight movement seems to have anticipated the reconstruction of the road, but this corresponds with documentary evidence scattered through the relevant files, and with oral recollections of people then in the area.

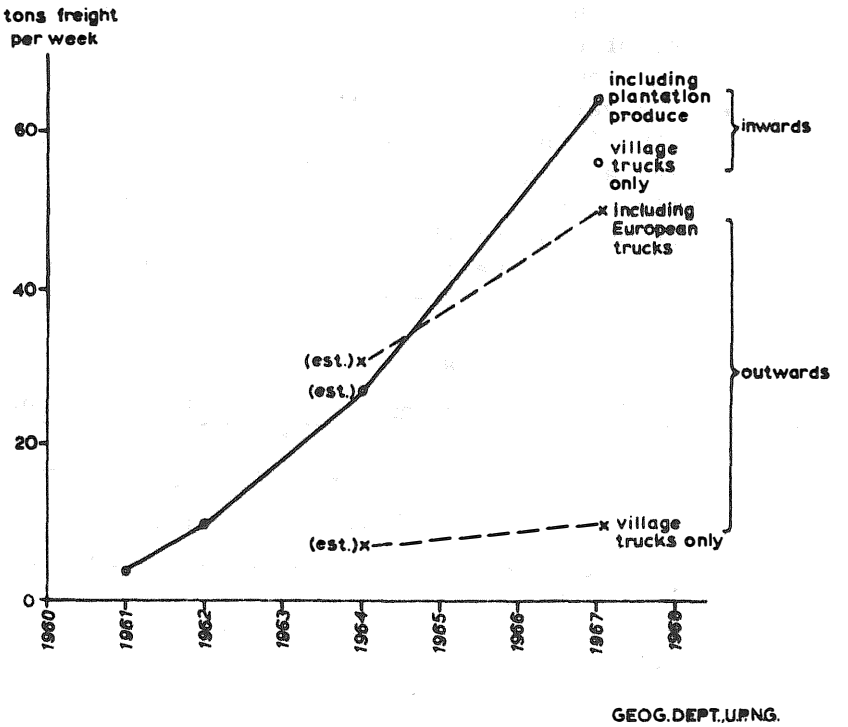


Fig. 6. Growth of freight, Rigo road, 1961-67

As there is no firm evidence of passenger movements before 1967, no attempt is made here to assess this aspect of growth. Some discussion of the 1967 volume of passenger movements follows in Chapter 8 and Appendix 4.

[1] See Appendix 4.

[2] See Appendix 4.

Chapter 5

Effects on agriculture and land use

The improved access to Port Moresby that the new Rigo road affords has resulted in increased agricultural activity in the area it serves. Information about the changes has been derived from comparison of aerial photos of 1957 and 1967; from field interviews in twenty-eight villages, and with most European farmers and other residents of the area; and from the results of the truck survey.

The two sets of aerial photographs available were exhaustively examined for village gardens, other cultivated land (mostly that under European control), and tree crops (coconuts, rubber and cocoa). Unfortunately the direct comparison hoped for proved difficult to obtain. The 1957 set of photographs, which are at scale 1:50,000 and are of poor quality, consist of east-west runs covering an area which extends from Tupuseleia to the Kemp Welch, and north over the Hunter, Musgrave and upper Kemp Welch Rivers, but does not extend southwards for more than a few miles south of the latitude of Kapa Kapa and the present Kwikila. The 1967 set are at scale 1:20,000 and are of good quality, but cover only a strip of country approximately one mile on each side of the road from Port Moresby to the Kemp Welch River. After a careful comparison of the same areas the figures shown in Table 7 were obtained for village garden and village coconut acreage in the coastal strip.

Table 7

Acreage of village gardens and coconuts, 1957 and 1967

	1957	1967	Percentage increase 1957-67	Average annual rate of increase
Village gardens, from southeast of Tupuseleia to Kapa Kapa	236	497	110.6	11.1
Village coconuts at Kapa Kapa	100	100	nil	nil

There has been a marked expansion of village gardening in the area. An estimate of population increase in villages in the same area (based on village census figures for 1960 and 1965) indicates that the average

annual rate of population growth here is 3.8 per cent.[1] Hence the rate of expansion of village garden area, over and above that required to keep pace with population growth, is about 7.3 per cent per annum. It is worth noting that the village coconuts at Kapa Kapa have shown no increase in acreage. In fact the palms are an old stand which is probably reaching the end of its useful life. It is, however, an interesting commentary on villagers' appreciation of the relative investment values of garden crops for urban sale and copra production.

Further details on changes in village gardens during the 1957-67 period are given in Map 8 which illustrates changes in the location of Gaile and Dagoda village gardens over these ten years.

In 1957 the Gaile village gardens were located mostly along the banks of the Vailala River about 2½ miles north of the village. Garden lands used and abandoned before 1957 lay to the north of Uruma Creek. Combined garden acreage per head of resident population in Gaile and Dagoda in 1957 was about 0.14 acres.

By 1967 the large areas of garden on the lower Vailala flats had been abandoned, and the only gardens remaining in that area were isolated clearings probably made by Dagoda villagers. Most Gaile village gardens were now in the Uruma Creek valley, on flat land fallowed before 1957. A second large area lay on flat land nearer the village. Both major blocks were astride the Rigo road. On the south bank of Uruma Creek an area of garden land shown as abandoned in the 1967 and 1957 photos was being prepared for gardens again in 1968. Garden acreage per head of resident population in 1967 was 0.21 acres.

Table 8

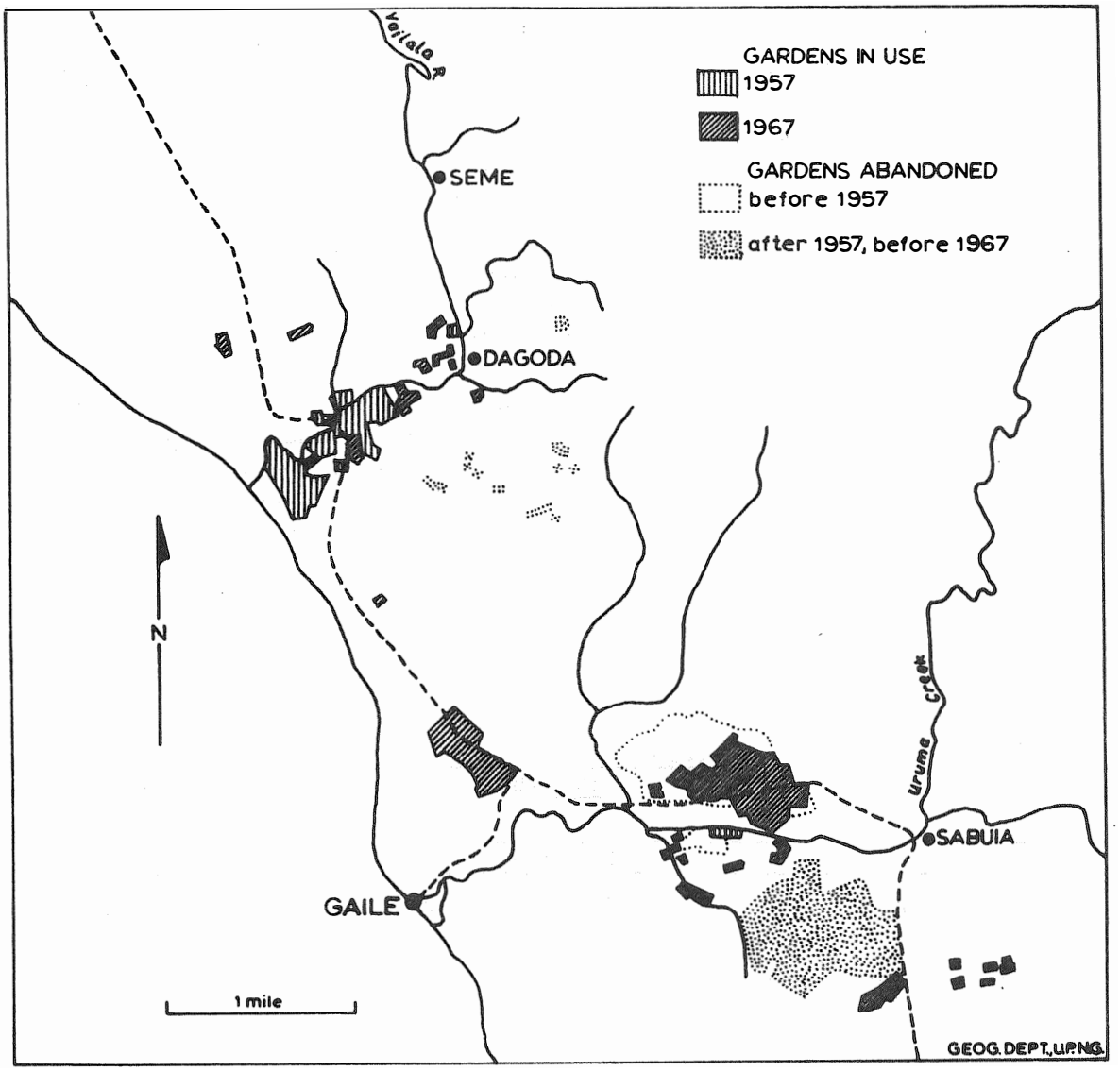
Gaile and Dagoda villages: changes in gardens and population, 1957-67

	1957	1960	1967	1968	Percentage increase
Garden acreage	128		248		93.8 (1957-67)
Total population	-	886	-	1,154	30.2 (1960-68)
Acreage per capita	0.14		0.21		50.0

The increase in acreage over ten years is about three times greater than the population increase, and hence acreage per capita has increased, indicating a surplus production available for sale. The population census figures reported for Gaile in patrol reports indicate a steady increase over the past ten years. There is no evidence to indicate

[1] This estimate is above the generally accepted estimate of 2.2 per cent per annum for the country as a whole, but appears to be realistic for the area.

whether garden acreage has also increased gradually over this period or whether it has occurred mostly in the last two or three years. The latter seems more likely.



Map 8. Gaile and Dagoda village gardens, 1957 and 1967

Field enquiries failed to show that any particular garden was planted primarily to sell its produce. Villagers appeared to be planting gardens a little larger than they might have done before the road was built, with the dual purpose of meeting their family's subsistence needs and of selling any surplus produce for cash in Port Moresby.

Questions regarding the proportion of crops sold rather than consumed drew a wide range of replies. Some villagers estimated that they sold up to three-quarters of the bananas they produced, while other crops were grown largely for consumption at ceremonies and not sold at all. The only valid generalisation seems to be that if there is a surplus which would otherwise waste, or if there is a felt need for cash, an effort will be made to market the produce.

It appears that as yet there is no change in either the nature or the methods of village gardening. Although the crops grown include a number of early European introductions (e.g. pumpkins and squashes, corn, tomatoes, etc.), the basic starch staples of banana, yams, taro, tapioca and sweet potato continue to be the dominant crops. Probably bananas in many varieties form the largest single item produced in the coastal village gardens, while yams probably predominate in the inland Rigo villages. Betel nut figures more prominently as a market crop as the distance from Port Moresby increases, as, for example, in the hill villages of the upper Kemp Welch, and in some villages such as Niuiruka nearer the coast. Villagers continue to garden by customary methods, although some have bought tractors which are used for cultivation, and others arrange for machine cultivation of village lands to be done on contract by some European farmers. European hand tools such as forks, spades and axes are common. As far as can be ascertained no fertiliser is applied and no insecticides or other modern aids are used.[1] Very little extension work seems to have been done by the Department of Agriculture in this area, and it seems obvious from the amount of food the village farmers produce solely on their own initiative that an organised and thorough campaign could increase production for sale considerably.

Information about the amount of village garden produce moving into Port Moresby comes from our survey of village trucks.[2] The produce being carried in a sample week in November-December 1967 included bananas, pumpkins, sweet potato, fish, yams, sago, pineapples, pawpaws, betel nut, coconuts, taro, tomatoes, onions, Chinese cabbage, and sugar cane.[3] The survey indicated that 34 tons of produce moved into Port

---

[1] Although such aids may be uncommon in village agriculture in Papua-New Guinea, it is relevant to note that virtually every Fijian banana farmer used insecticides on bananas intended for sale and export from Fiji in the 1950s.

[2] See Appendix 4.

[3] Observations and enquiries throughout the year at Koki market indicate that other crops such as mangos, melons of various sorts, tapioca, oranges, saporos (a small citrus fruit), peanuts, cucumbers, 'five corners' (Averrhoea carambola), pumpkin shoots, chokos, artichokes, okra, and breadfruit are brought in season to the market by Rigo people.

Moresby along the Rigo road in village trucks during the sample week. Seasonal fluctuation in the supply of produce to Koki market is known to exist. The only evidence at present available has been interpreted to imply that a sample week in November or December would be about 14.3 per cent higher than the average week for the year (Project Planning Team 1965a:10). When the sample figure is lowered by this percentage to allow for seasonality, scaled up by 1.74 (on the assumption that the 57 per cent sample is a true indication of the total village truck movement) and multiplied for a fifty-week year, the total inwards freight of village garden produce is 2,549 tons per year. This figure can be compared with an estimate of 432 tons of garden produce as the contribution of the Rigo area to the annual turnover of Koki market in 1962-63 (Project Planning Team 1965:9). About another 300 tons of vegetables annually are supplied under contract to institutions in Port Moresby by European farmers located on the Rigo road.

The estimated volume of produce coming in to Port Moresby in 1967 can be valued at an average price of 10 cents per lb,[1] giving a gross income from garden produce of $570,976 or $32 per capita. This increase is known to have started some time before the road was finally built but there is little doubt that main upsurge of garden production for sale has been brought about by its construction. To have raised the gross income in the area in a few years by $32 per capita, from probably no more than an average of $10 per capita, must be regarded as a worthwhile result of the expenditure on the road.

Effects on European agriculture[2]

Table 9 shows the change in European-controlled acreage under plantation crops and in cultivation between 1957 and 1967. Figures for 1957 are derived solely from aerial photographs, while those for 1967 are from aerial photographs, supplemented by interview with the farmers.

There has been an increase of about 90 per cent in the area under cultivation or crop. The largest increase is shown in the land under 'general cultivation', much under food crops such as rice at the Bautama Seventh Day Adventist mission school. The area concerned here has not apparently changed very much in ten years, but land growing vegetables and sorghum near Mirigeda and Barakau has come into cultivation only in the last few years. On the other hand, European land under cultivation for sorghum and food crops near Kapa Kapa was under European cultivation several decades ago, but not apparently when the 1957 photos were taken. Of the Kemp Welch River estates, Gobaragere

---

[1] See p.59.

[2] The term European agriculture includes plantations on the Kemp Welch River, mixed farms (i.e. livestock and crop production) along the road, and a mission school farm at Bautama, near Bootless Bay.

Table 9

European-controlled acreages under cultivation and crops, 1957 and 1967

	1957	1967	Percentage increase 1957-67	Average annual rate of increase
In vicinity of Tupuseleia and Barakau	nil	151		
Kapa Kapa	16	194		
Sub-total	16	345	2,056.3	205.6
Kemp Welch River plantations	1,564	2,558	63.4	6.3
Tavai Creek forest area	nil	92		
Total	1,580	2,995	89.6	9.0

was developed in the early decades of the century and showed little change in the last decade. As mentioned,[1] most of the others have been undergoing a period of redevelopment, with new crops such as peanuts being produced in recent years (though not in 1967). New plantings of coconuts, cocoa and some rubber have been made on some plantations in the last few years, but there is no evidence of a consistent planting policy being carried out in the pre-road period.

Almost all the European farmers in the area had either begun to build up cattle herds or were about to do so. Some also raise a considerable number of pigs, for which they find a ready village market, and two raise poultry on an intensive basis, selling eggs in Port Moresby. In addition, two Europeans run small sawmills to handle timber felled on their land, for sale both locally and in Port Moresby.

While the old rubber and copra plantings of the Kemp Welch River estates long pre-dated the road, it is clear that some enterprises such as vegetable and poultry production developed only with certain access to Port Moresby. In the benefit-cost study[2] the value contribution of only a part of the new plantings of rubber and coconuts are included, since it must be assumed that some might have occurred without the new road.

The Tavai Creek teak plantation

On the coast some 40 miles east of Port Moresby, between the villages of Manugoro and Kapa Kapa, is a 2,000-acre block of Crown land which in about 1964 was taken over as the site of a teak plantation by the Department of Forests on behalf of the Rigo local government council. It was originally intended that village labour would clear the land and

[1] See p.13.

[2] See Chapter 8.

plant garden crops, through which teak seedlings would be regularly planted under the supervision of a forestry officer. This system, known as the taungya system, was developed decades ago in the hills of Burma to integrate shifting cultivators into the forest cycle in a productive way. In Papua-New Guinea, where pressure on land was perhaps not so intense, village labour proved rather unreliable, and although some acres were cleared and planted by villagers, the Department of Forests had to revert to contract work. In late 1967 about 95 acres had been cleared and 56 planted. It is hoped to average 25 acres of clearing and planting a year. The silvicultural cycle for each year's planting will last for about sixty years, during which time the villagers ideally will take garden crops in the first and second years, there will be a continuing yield of firewood (which is not a very profitable operation at the present rate of production), and every seven years there will be a thinning of teak trees. The first thinning will have no commercial value, but as the girth of the saplings increases the timber production will become increasingly valuable. Once all these operations are taking place simultaneously each year, the scheme will become increasingly economic.

Beyond its direct economic value, however, the scheme and the teak nursery at Kwikila have introduced a new and potentially valuable timber tree throughout the Rigo area, including the hill villages inland of Kwikila. Although small numbers of scattered teak trees will probably never be commercially millable, they will provide good house timber, and may stimulate future planting schemes on accessible lands.

Fishing

No special study was made of the indigenous fishing industry in the course of this work. It is worth noting, however, that fishing continues to be an important money earner for coastal villages such as Tupuseleia, Barakau, Gaile, Kapa Kapa, Bonanamo, Gabone, Irupara and Hula. Fishing takes place for domestic consumption only by people from other villages near the coast, and some inland villagers exchange garden produce for fish with some coastal villagers.

Some fish is transported to Port Moresby by truck (from Barakau, for example, or from the beach at the head of Bootless Bay by Tupuseleia villagers) but most still travels by canoe. Some canoes carry ice-boxes which are filled with ice in Port Moresby, and stocked with fish at Hula and other fishing grounds, the ice having half melted by then. Other fishermen nearer Port Moresby fish on the way and bring their catch directly to town. Fish arrives in Koki market in reasonably fresh condition, and there is a strong demand for it, especially at weekends. The facilities for storing and handling fish at Koki have been improved, and further improvements are anticipated. There has not, however, been any extension work to encourage the villagers on either side of Port Moresby to improve their techniques or equipment.

The warm shallow coastal waters and mudflats offer good opportunities for the development of marine industries producing large volumes of protein food, such as prawns, shellfish, crustaceans and other fish, for which a market undoubtedly exists in Port Moresby, and with potential for export.

Potential agricultural development

European-controlled agriculture in the area served by the Rigo road is likely to continue expanding its total volume of production over the next few years. It seems unlikely, however, that there will be much increase in the acreage of plantation crops such as coconuts, rubber or cocoa, since planters claim there are difficulties obtaining enough suitable labour, and the economic inducements are not, in my opinion, very great. It does seem likely that their cattle herds will increase to as large a size as the carrying capacity of their lands will permit.[1] Further diversification of European enterprises seems likely.

It is likely that indigenous agriculture will continue to expand and diversify. Of the total area of flat or slightly sloping valley bottom land within the area served by the Rigo road, over 5,000 acres are within two miles of the main road or a feeder road. Under present agricultural usage this land is fallowed for a period which may be as short as three years. Hence on this land alone village gardening could increase to at least 1,200 acres under cultivation at any one time. More potentially first class land exists to the south of Kwikila and along the Kemp Welch River, in areas which are not covered by the air photos, and hence it is not included in these estimates.

In addition to extension of the area under cultivation, it seems likely that the use of fertilisers, pesticides, supplementary irrigation systems, and selected plant varieties would increase yields. Although there has been no systematic agricultural research in this area to test this, experience elsewhere shows that improvement is at least likely. In the light of the spontaneous large increase in food production in this area over four to five years, and in view of the area's ready accessibility to rapidly growing Port Moresby, it would be well worth making the investment of trained people and money necessary to establish facts and educate villagers in this particular area.

Finally there is considerable potential for intensive indigenous poultry production and cattle raising. As yet only a few individuals have become interested in the former and these are outside the area concerned, although on the outskirts of Port Moresby. Enterprising

[1] At the time of writing a possible large European cattle project for the grasslands of the southern Ormond, east of the lower Kemp Welch, was being discussed.

villagers could set up small-scale units with a view to selling eggs, either raw or hard-boiled, firstly in the villages, and later perhaps in Port Moresby. There is also considerable potential for an indigenous cattle industry on the dry hills and grasslands which occupy much of the area: from the air photos it has been roughly calculated that there are 686,000 acres of suitable land which could be utilised. The estimated carrying capacity of this land is about one beast to 10 acres, so that in time a large cattle population could be built up. Such a development would require a shift in the interest of D.A.S.F. towards increasing the skills of indigenous people as cattle raisers.[1]

The construction of the Rigo road has had a marked effect on both indigenous and European agriculture, although there remains considerable scope for expansion, diversification and intensification of production in both sectors. The main market in the near future is likely to remain Port Moresby, but in the longer term it is possible to foresee export commodities being produced from this area.

[1] Details of the returns which could be expected are given on pp.72-4.

Chapter 6

Transport costs and charges

Prior to the opening of the Rigo road the only regular transport to Port Moresby was a service of coastal boats ('K' boats) from Kapa Kapa which covered the 33 mile journey in a few hours, for a freight charge of $8.30 per ton,[1] or approximately 25 cents per ton mile. There is no written record of the additional costs of handling on Kapa Kapa wharf, and the overland carriage from the Kemp Welch River (about 16 road miles away) or other inland origins, but the real costs must have been considerable.

Table 10 shows shippers' estimates of freight costs from four plantations in the Rigo and Kemp Welch areas before and after the road was opened.

Estimates of freight costs by sea and by road vary considerably. Only one planter (no.2) thought that he had experienced little change in freight costs since the road was opened. In fact, since the road mileage is longer than the direct sea route, his costs are four cents per ton mile cheaper overland. If the planters' estimates are correct, it would seem that for all of them there has been a real decline in freight costs since the coming of the road. For two (Nos 1 and 4) this brought a saving of over 50 per cent on costs by road and sea. The real costs involved are, however, notoriously difficult to estimate in such cases, and no great reliance should be placed on the figures except as an indication that European planters feel their costs have been lessened by the building of the road.

There is no doubt that the road has brought very real improvements in convenience, certainty, and time used. With sea transport there were always difficulties of cargo storage at the Kapa Kapa wharf (where there were a number of sheds for the purpose); of available labour when the boat came in; of uncertain arrival times; and of strong south-easterly weather conditions which could make the wharf unworkable.

---

[1] This figure refers to 1967 quotations. There is some indication that the rate was higher before the road was opened, and that it was dropped to this figure in 1965. Coastal ships no longer call at Kapa Kapa.

Table 10

Freight costs before and after 1965

A. Before 1965: by road and sea transport

Plantation	Distance from Port Moresby (miles)	Freight costs	
		$/ton	Cent/ton mile
1	16 + 33 = 49	10	20
2	16 + 33 = 49	16	33
3	17 + 33 = 50	-	-
4	2 + 33 = 35	12	34

B. After 1965: by the Rigo road

Plantation	Distance from Port Moresby (miles)	Freight costs		
		$/ton	Cents/ton mile	Change cents/ ton mile
1	56	5	9	-11
2	56	16	29	-4
3	57	15	26	?
4	46	8	17	-17

Source. Personal interview, November 1967. (The figures are estimates made independently by the planters concerned.)

Since a bridge on Sirowai Creek (between Kapa Kapa and Old Rigo) was washed out and replaced by a ford, there were occasional days of flood (perhaps eight per year) when the ford could not be crossed.

Available information on the costs of canoe voyages or journeys by the few indigenous-owned trucks operating before 1965 is very scanty. Enquiries made during our survey produced the following canoe data for three villages.

Table 11

Charges made for canoe journeys before 1965

Village	Approx. miles by sea to Port Moresby	Passenger fare ($)	Cents/mile	Freight charge per bundle (cents)
Gabone	42	2.00	5	nil
Gaile	22	1.00	5	10
Alewai	58	2.00	3.5	nil

The figures indicate a tapering off in charges per mile with increasing distance from Port Moresby, which is apparent also in present day

truck charges. The custom of charging 'per bundle' for freight which is almost always accompanied, has been carried over to carriage by truck.

Passenger and freight charges on indigenous-owned trucks

Our survey of indigenous-owned trucks in 1967 provides some information about current charges for passengers and freight. The fare systems emphasise the payment of a passenger fare, with a nominal charge for freight, based on a 'per bundle' basis.[1] Table 12 and Figure 7 show freight charges in relation to distance, estimated by totalling the weight of inwards cargo from villages and relating this to the total charges paid.

Table 12

Estimate of freight charges on indigenous-owned truck sample

Village	Ton miles inwards freight	Estimated total freight charges paid ($)	Approximate freight charge per ton mile (cents/ton mile)
Tupuseleia	6.3	nil	nil
Barakau	9.5	nil	nil
Gaile	65.8	nil	nil
Gomore	47.7	15.00	31
Ginigolo	183.0	19.20	11
Kapa Kapa	130.8	7.40	6
Gunugau	27.6	2.30	1
Kemaia	61.7	10.30	17
Saroa	45.6	nil	nil
Gidobada	71.0	14.40	20
Sarokei	136.2	36.60	27
Karekodobu	144.0	15.80	11
Imagolo	124.0	15.20	12
Boregaina	70.1	11.25	16
Bore	157.5	15.50	10
Niuiruka	125.8	12.30	10
Kemabolo	50.3	9.00	18
Tauruba	117.7	40.80	35
Seba	51.3	5.10	10
Bonanamo	9.6	4.55	48
Hula	132.8	9.20	7
Kalo	157.3	nil	nil

[1] Details of the variations in passenger fares with distance are given in Appendix 2.

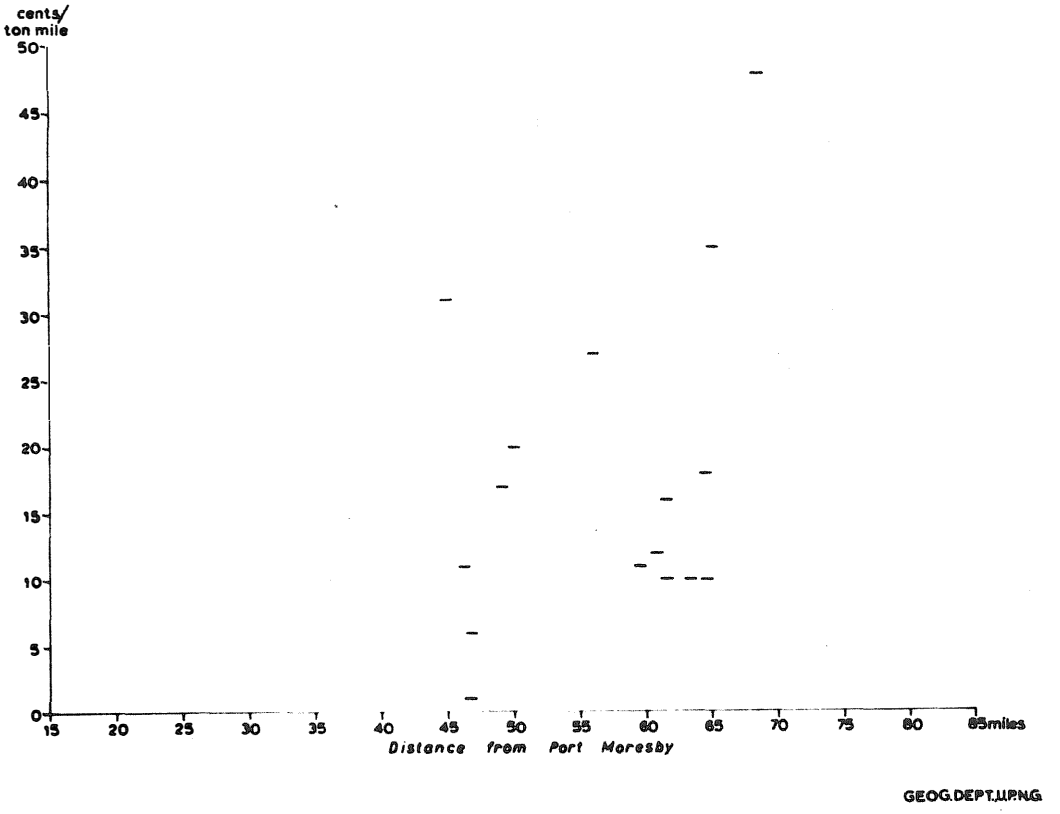


Fig. 7. Inwards freight charges, village to Port Moresby

On the basis of the information gathered in the survey, there is only a very loose relationship between freight rates and distance (see Figure 7). There appears to be no consistent pattern in determining charges for freight, and this is largely because freight rarely travels unaccompanied to market. When a more economically rational system of marketing is developed for the garden produce of the area presumably a more regular pattern of freight rates will operate.

The main gain for indigenous producers has been in the reliability and speed with which the journey may be made from their village to Port Moresby. Access roads to all villages are not uniformly good, and vehicles are liable to become bogged during the wet season. Minor investment in eliminating these 'bad patches' and improving access roads so that all villagers can reach the main road under all weather conditions is a most pressing need. Once onto the main road system, some village trucks can make two return journeys to Port Moresby per day. At present there is unused capacity in these trucks, especially for freight, which could be overcome in a number of ways.

Chapter 7

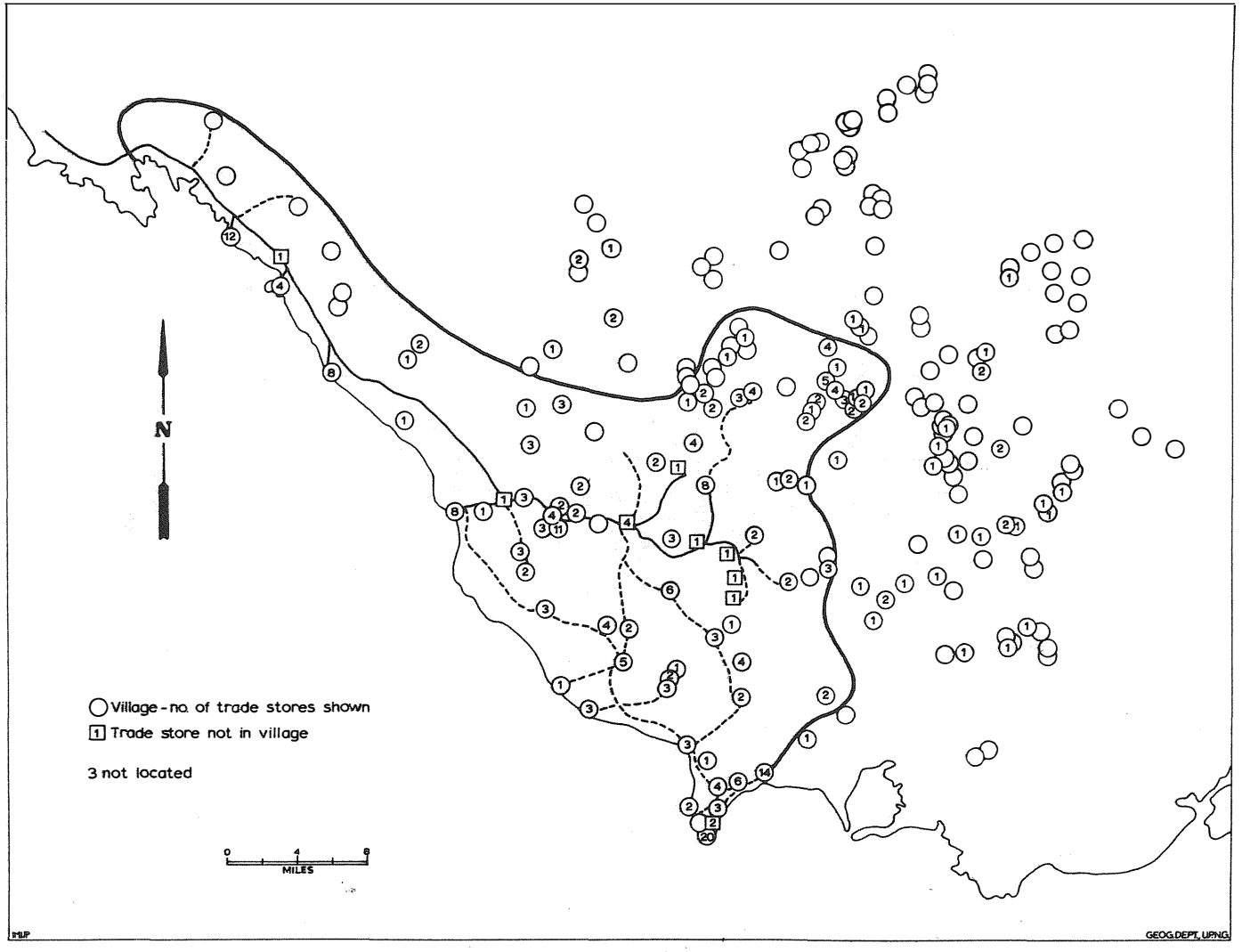
Effects on retail trading

The presence of trade stores in villages is a useful indicator of accessibility to a larger supply centre, financial capability of villagers to buy food and other goods, and awareness on the part of entrepreneurs of the potential returns of trade store operations. The registration records of trade stores in the Rigo sub-district and the East Coast, Central District, show that there were some 300 trade stores registered in August-September 1967 (see Map 9). Unfortunately figures for earlier years are not available, hence it is not possible to make precise comparisons of any increase that may have been stimulated by the road.

The distribution shows a remarkable concentration of trade stores in villages directly influenced by, and accessible from, the Rigo road. There were 259 trade stores in this area in 1967, all in villages except for seven on plantations, one in the deserted streets of Old Rigo, and one on the Rigo road itself, near the village of Barakau. In the remaining parts of the Rigo sub-district, which have no alternative means of access except by foot-track beyond the Rigo road system, there were only 35 trade stores registered. On a density basis there was one trade store to every 70 people in the accessible area, and one to every 171 people outside it.

Within the accessible area, most villages had at least one trade store, the exceptions (18 out of 88 villages) being mostly small, remote hill villages. On the other hand, outside the area influenced by the Rigo road, there is rarely more than one trade store in a village, and the villages which have trade stores tend to be relatively close to the accessible area, or along well-defined walking tracks leading on from the road-heads.

The trade stores range from the comparatively large and well-stocked shops run by Europeans in Kwikila and on some plantations to single counters within houses, or the specially built 6 ft by 6 ft structure in Matairuka village carrying small stocks of a very few basic commodities such as flour, sugar, tinned meat, rice, tobacco and kerosene. Because of this variability in size, comparisons on a per capita basis between villages are of limited validity, but the range is from one store to 20 people in Bonanamo to one to about 110 people in the large coastal villages.



Map 9. Registered trade stores, 1967

An attempt was made to interview trade store operators in the course of our village survey in November-December 1967. Replies were received from thirty-two operators located in seventeen villages, in Kwikila, on one estate, and on the road. The following five questions were deliberately limited to supplement information on the use of the road, rather than to investigate trade stores in their own right:

1. How often are goods brought out from Port Moresby?
2. Whose vehicles are used?
3. What are the freight charges?
4. What are the retail prices of kerosene, rice, tinned fish, tinned meat, bread, flour, sugar?
5. List as nearly as possible the goods brought out for the store from Port Moresby during the previous week.

Answers to the first question ranged from twice a week for the European-run stores, to once in two months for more remotely located, small indigenous operators. Many operators showed about twelve invoices for the previous year, but often the intervals between them were six to eight weeks in the first few months of the year, falling to two or three weeks in November and December.

The vehicles used included the trade store owner's own conveyance, a truck owned in the village in question or a neighbouring one, and, in the case of Hula-Alewai, canoe or outboard motor.

Replies to the question, 'What are the freight charges?' ranged from 'None' (an answer frequently given when the vehicle used belonged to the owner of the trade store, or to a friend) through a precise listing of 10 cents for a 25 lb bag of flour, 20 cents for a 50 lb bag of rice, and 30 cents for a 70 lb bag of sugar, to the actual freight charges paid on the last shipment of goods received. An attempt has been made in Table 13 to analyse these answers by translating them, where possible, into a 'cents per ton mile' figure.

There is a steady decline of charges per ton mile with distance from Port Moresby. Manugoro seems to be out of line, since it is located very near the main road and should not incur any serious costs for a poor access road. The costs to Kokorogoro and other similarly located hill villages are made up of a truck charge from Port Moresby to the closest possible road-head and a charge paid for human porterage to the village. Hence the charges are understandably high. Since Debadagoro is also an inland village beyond the road-head, its low costs seem widely discrepant. If these sample figures are typical of the overall situation throughout the area, the truck operators would seem to have assessed the cost of transporting goods out from Port Moresby very well in relation to the number of miles travelled. Such a scale of charges, however, may be too low to allow an adequate reserve for maintenance and depreciation on vehicles.

The retail prices of a number of commonly sold goods appear not to reflect the transport costs involved in bringing them to the local

Table 13

Sample freight charges on trade store supplies

Location	Road miles ex Port Moresby	Cents/ton mile
Manugoro	37	30.3
Saroa	49	18.3
Kwikila Town	53	16.9
Poligolo Estate	58	17.3
Karekodobu	59.5	14.2
Tauruba	65	10.3*
		13.8*
Riwalirupu	66	10.2
Kokorogoro	68	23.5*
		24.4*
		44.3*
Debadagoro	69	13.0
Hula	83.5	8.0*
		10.7*

* Different operators within the same village.

consumer. With the exception of the European-controlled store on Poligolo plantation (the owners of which, incidentally, had the clearest appreciation of the concept of transport costs of anyone interviewed in the entire study), rice is sold throughout the area at a uniform price of 10 cents per pound, the same as the Port Moresby price. (Poligolo store price was 11 cents per pound.) Actual transport charges on rice seemed to be 0.3 to 0.4 cents per pound from Port Moresby to most places in the area. Similarly, charges for tinned fish and tinned meat seemed to be fairly standard throughout the area (appreciably higher in Kokorogoro), while replies for other goods were not sufficiently comprehensive to allow comparisons.

Answers to the final request, to list goods brought from Port Moresby in the previous week, emphasised the range of imported foodstuffs being consumed in the villages at the present time. Obviously there is a considerable variation between trade stores in the size and complexity of their orders from Port Moresby. Two sample orders are given below.

To a store in Alewai, Hula, week of 20 November 1967:

1 x 70 lbs sugar	$ 4.30
4 gallons kerosene	2.50
10 sticks tobacco	1.40
14 fire crackers	0.70
3 empty copra bags	1.95
1 carton of Gold Leaf cigarettes	3.00
Betel nut from Port Moresby for store	6.00
	$19.85

To a store at Karekodobu, week of 13 November 1967 (an above average shipment following an interval of one month since the previous shipment):

10 bags of white rice (56 lbs)	$48.80
5 bags of brown rice (40 lbs)	17.15
4 bags of sugar (70 lbs)	14.72
27 bags of flour (25 lbs)	36.48
10 bags of white rice (56 lbs)	48.80
3 cartons of Sao biscuits	20.58
36 tins of beefsteak of 16 oz	12.51
2 six-pound lumps of tobacco	12.12
36 Okapi knives	4.50
1 set of aluminium pans	5.75
12 Okapi knives	1.50
	$222.91

In the area affected by the Rigo road there were more than 250 trade stores in 1967. A proportion of these would have been established even without the road, but its construction has enabled trade store owners to capitalise on ready access to Port Moresby to maintain their own stocks and on the increased village incomes brought about by the relatively easy sale of garden produce in Port Moresby. Villagers beyond effective access to the Rigo road show through their support of 35 trade stores that they, too, are willing to purchase imported, manufactured foods and other goods. However, this is probably on a much reduced scale, since their inaccessibility reduces their opportunities to increase cash incomes through garden produce sales in Port Moresby.

Chapter 8

Benefit-cost analysis of the Rigo road

A benefit-cost analysis has been carried out to examine the investment made in constructing the Rigo road. Those economic activities initiated or expanded by its construction are identified, and streams of primary benefits accruing from them are projected into the future. The benefits are counted as the net return to the producer after production and marketing costs have been deducted. Price levels are, perhaps unrealistically, assumed to remain constant over the 25-year period chosen. These values for future years are discounted to present-worth values. The costs, which provide the denominator of the ratio, are the cost of construction and maintenance costs over the same period, also reduced to a present-wroth value.

The model used is of the form:

$$\frac{B}{C_{(t=25)}} = \frac{\sum_{t=1}^{25} \sum_{j=1}^{9} E_{tj} \left(\frac{100+r_1}{100} \right)^{-t}}{E_{tj10} + E_{tj12} + \sum_{t=1}^{25} E_{tj11} \left(\frac{100+r_2}{100} \right)^{-t}}$$

where t = the assumed useful life of the road (25 years)

r_1 = interest rate for private capital (6.5 per cent p.a.)

r_2 = interest rate for public capital (6.0 per cent p.a.)

$E_{tj(1-9)}$ = estimated benefits from various economic activities (detailed below)

E_{tj10} = initial capital cost of road construction

E_{tj11} = recurring maintenance cost on the road

E_{tj12} = five-sixths of cost of Kapa Kapa wharf

Calculation of benefit series

The following were identified as having been stimulated by the construction of the Rigo road: village gardening, new rubber on estates,

cattle raising on estates, European vegetable growing, teak production, new copra on estates, large-scale poultry farming, and timber milling on estates. The contribution of each of these activities is examined below. While there were, at the time of study, no public plans for any other forms of development, whether private or government sponsored, the area does have potential for at least two other activities, namely indigenous cattle farming and indigenous poultry farming.[1] The ninth benefit term is the maintenance expenditure on Kapa Kapa wharf, which theoretically must be regarded as a saving brought about by the road construction.

Village gardening

By far the largest share of the benefits generated by the road comes from the increase in village gardening. The evidence on which the calculations of the projected benefits are based derives from the results of the questionnaire to indigenous truck owners in November-December 1967,[2] and from the examination of aerial photos taken in 1957 and 1967 to discover the increase in the land used for village gardening and hence a rate of potential expansion, and to determine the potential limits to garden land.

The questionnaire showed that 34.2 tons of garden produce were transported into Port Moresby for sale at Koki market by the trucks sampled in the sample week. The only evidence relating to seasonal variations in these sales suggests that values in November and December are 14.3 per cent higher than the average for the year (Project Planning Team 1965a:10). Hence, to provide an average weekly figure for the year, this value is reduced to 29.3 tons.

The average price of the type of produce sold at Koki from the Rigo area approximates 10 cents per lb,[3] hence the gross return for the average week is $6,563. From this the sellers' marketing costs must be deducted and the best measure of these is passenger fares during the sample week. These are lowered by 14.3 per cent for seasonality and then amount to $2,444. A proportion of this amount accrues as profit to truck owners within the area served by the Rigo road. Secondary benefits of this kind have not been included in the calculations because of the difficulty of ascertaining the amounts involved. If included, they would increase the final benefit-cost ratio. It is

---

[1] These are not included in the present simplified version, but calculations of the potential benefits to be gained from indigenous cattle farming are included on pp.72-4.

[2] See Appendix 4.

[3] This figure is based on the results of S. Epstein's survey of Koki market during May-June 1968.

assumed that opportunity costs of labour involved in producing and selling the produce are nil, on the basis that a considerable amount of unemployment exists in both Port Moresby and Papua-New Guinea generally, and that full employment seems unlikely in the foreseeable future.[1] Hence the net return to the producers in the average week is $4,119, and this converts to an annual benefit figure for 1967 of $358,353.

Examination of the aerial photographs of 1957 and 1967 indicates an annual growth rate for land under village gardens of 11.1 per cent. It has been shown in Chapter 5 that population growth rate in the area is 3.8 per cent per annum. Hence the rate of expansion over and above that needed to keep pace with population growth is 7.3 per cent per annum. This rate of increase is therefore applied to the annual benefit figure of $358,353 for 1967.

The total area of flat or slightly sloping, valley-bottom land within one mile of the road was measured,[2] and found to total approximately 5,064 acres. Enquiries made in the villages indicate that this type of land may be re-used for gardens after three years fallow. While there may well be local variations in soil, water supply or other factors which lower the use of specific areas within this 5,000 acres, it seems that there is potential for almost doubling the present village garden area of about 700 acres on this sort of land. (There are, of course, extensive areas of relatively gently sloping hill land available within easy distance of the road.) The assumption is therefore made that garden land will expand to a total of 1,231 acres, at the assumed rate of 7.3 per cent per year.[3]

The projection of the returns from village garden produce sold in Koki market assumes that prices for such produce remain constant in the market over 25 years. At first sight this may seem an unrealistic assumption, but comparison with Koki prices of 1950-51 (when the town's population was about one-third that of 1968) indicates that there has been virtually no decline in prices since then, and that in some cases prices have risen (Table 14).

The tabulation for the benefits derived from this source (E_{tjl}) is given in Table 15.

---

[1] It is recognised that this assumption is debatable, as are most others made in this chapter, but it is felt that variations in the estimates caused by changing the assumptions are unlikely to alter the dominant order of benefits obtained from village gardening as opposed to the other activities examined.

[2] On the 1967 air photographs, at scale 1:20,000.

[3] The possibility of increasing production by the use of artificial fertilisers or irrigation is not considered here.

Table 14

Prices at Koki market, 1950-51 and 1968

	1950-51*	1968**	1968***
Areca nut	12 for 10c	20c/lb	6 for 10c
Bananas	20c a hand	6c/lb	20c/hand
Sweet potato	6 for 20c	7c/lb	3 for 10c
Yams and taitu	4 for 20c	-	2 for 10c
Coconuts	5c each	-	10c each

* Prices (converted to decimal currency) from Belshaw 1952:33.
** Average prices from market survey by S. Epstein, May-June 1968.
*** Prices observed by Ward, October 1967-October 1968.

Table 15

Net benefits derived from village gardening

Year	t=	Average acreage	E_{tjl} ($)
1966	1	-	332,193
1967	2	700	358,353
1968	3	751	384,513
1969	4	806	412,582
1970	5	865	442,700
1971	6	928	475,017
1972	7	996	509,693
1973	8	1,069	546,901
1974	9	1,147	586,825
1975	10	1,231	629,663
1976	11	1,231	629,663
1977	12	1,231	629,663
1978	13	1,231	629,663
1979	14	1,231	629,663
1980	15	1,231	629,663
1981	16	1,231	629,663
1982	17	1,231	629,663
1983	18	1,231	629,663
1984	19	1,231	629,663
1985	20	1,231	629,663
1986	21	1,231	629,663
1987	22	1,231	629,663
1988	23	1,231	629,663
1989	24	1,231	629,663
1990	25	1,231	629,663

New rubber on estates

A total of 445 acres of new rubber had been planted on estates along the Kemp Welch River by 1967, and a further 30 acres was expected in 1968. Half of this new planting is arbitrarily assumed to have resulted from the Rigo road, the other half, it is assumed, would have been planted anyway. For convenience, planting is assumed to have taken place evenly over the preceding four years. Table 16 shows the amount of rubber which these plantings can be expected to yield, and evaluates the net farm income from this source at two alternative price levels (16 and 10 cents per lb). To simplify the calculations for this and other (European-produced) crops or products, the benefits (E_{tj2}) are taken to be the primary benefits of total net farm income after production costs, establishment costs, depreciation and interest on capital have been deducted from farm-gate prices for the product. While it is recognised that there may be secondary benefits such as the injection into the local economy of a proportion of the wages and salaries earned, these are excluded from the present calculations since no detailed study of consumption and spending in the area is available.

Estate cattle

All the managers of European estates or farms in the area voiced strong interest in cattle raising. It is possible that this would have been so even without the road, though its existence undoubtedly encouraged farmers to introduce cattle on to all but one remote European holding by 1967. All managers indicated their intention to build up their herds to a specified total size. Using these estimates of intended size (and taking the conservative option where alternatives were stated), Table 17 has been constructed.

The rates of growth of the composite 'herd' are adapted from tables of projected herd growth prepared by the Department of Agriculture, Stock and Fisheries.[1] From Table 17 it can be seen that (theoretically) in seven years herd numbers would stabilise at 600 breeders, with a total carryover of 1,056 cattle. On this basis, the net farm income from this source is calculated for two price levels and half of it counted as a benefit from the road (see Table 18).

Vegetable growing on European farms

Approximately 205 acres are under vegetable crops (largely sweet potato, pumpkins and water melons) on European farms. Most of the produce is sold in bulk to institutions and does not enter the open market in Port Moresby. On the assumptions of an average yield of 1½

[1] DASF Field Manual, 31-2A-9, 'Projected Herd Growth', Konedobu.

Table 16

Net benefit derived from new rubber on estates

Year	t=	Acres planted	Immature acreage	Acreage bearing*	Production (lbs)**	Low price assumption							High price assumption						
						Value at 10c/lb ($)	Cost of planting ($)	Production costs ($)	Depreciation ($)	Repayment ($)	Cumulative debt at 106.5% p.a. ($)	Net farm income ($)	Value at 16c/lb ($)	Cost of planting (at $492/ac.)*** ($)	Production costs≠ ($)	Depreciation ($)	Repayment ($)	Cumulative debt at 106.5% p.a. ($)	Net farm income ($)
1963	-	50	50	-	-	-	24,600	-	-	-	26,199	-	-	24,600	-	-	-	26,190	-
1964	-	50	100	-	-	-	24,600	-	-	-	54,101	-	-	24,600	-	-	-	54,101	-
1965	-	50	150	-	-	-	24,600	-	-	-	83,817	-	-	24,600	-	-	-	83,817	-
1966	1	50	200	-	-	-	24,600	-	-	-	115,464	-	-	24,600	-	-	-	115,464	-
1967	2	22	222	-	-	-	10,824	-	-	-	134,497	-	-	10,824	-	-	-	134,497	-
1968	3	15	237	-	-	-	7,380	-	-	-	151,099	-	-	7,380	-	-	-	151,099	-
1969	4	-	237	-	-	-	-	-	-	-	160,921	-	-	-	-	-	-	160,921	-
1970	5	-	187	50	50,000	5,000	-	4,500	1,000	-	171,913	-	8,000	-	4,500	1,000	2,500	168,718	-
1971	6	-	137	100	100,000	10,000	-	6,000	1,000	3,000	179,892	-	16,000	-	6,000	1,000	9,000	170,100	-
1972	7	-	87	150	150,000	15,000	-	7,500	1,000	6,500	184,662	-	24,000	-	7,500	1,000	15,500	164,649	-
1973	8	-	37	200	200,000	20,000	-	9,000	1,000	10,000	186,015	-	32,000	-	9,000	1,000	22,000	151,921	-
1974	9	-	15	222	222,000	22,200	-	9,600	1,000	11,600	185,752	-	35,520	-	9,600	1,000	24,920	135,256	-
1975	10	-	-	237	249,500	24,950	-	10,200	1,000	13,750	183,182	-	39,920	-	10,200	1,000	28,720	113,461	-
1976	11	-	-	237	262,000	26,200	-	10,200	1,000	15,000	179,114	-	41,920	-	10,200	1,000	30,720	88,119	-
1977	12	-	-	237	274,500	27,450	-	10,200	1,000	16,250	173,450	-	43,920	-	10,200	1,000	32,720	59,000	-
1978	13	-	-	237	287,000	28,700	-	10,200	1,000	17,500	166,087	-	45,920	-	10,200	1,000	34,720	15,208	-
1979	14	-	-	237	292,500	29,250	-	10,200	1,000	18,050	157,659	-	46,800	-	10,200	1,000	15,208	-	31,592
1980	15	-	-	237	296,250	29,625	-	10,200	1,000	18,425	148,284	-	47,400	-	10,200	1,000	-	-	47,400
1981	16	-	-	237	296,250	29,625	-	10,200	1,000	18,425	138,300	-	47,400	-	10,200	1,000	-	-	47,400
1982	17	-	-	237	296,250	29,625	-	10,200	1,000	18,425	127,667	-	47,400	-	10,200	1,000	-	-	47,400
1983	18	-	-	237	296,250	29,625	-	10,200	1,000	18,425	116,343	-	47,400	-	10,200	1,000	-	-	47,400
1984	19	-	-	237	296,250	29,625	-	10,200	1,000	18,425	104,283	-	47,400	-	10,200	1,000	-	-	47,400
1985	20	-	-	237	296,250	29,625	-	10,200	1,000	18,425	91,439	-	47,400	-	10,200	1,000	-	-	47,400
1986	21	-	-	237	296,250	29,625	-	10,200	1,000	18,425	77,760	-	47,400	-	10,200	1,000	-	-	47,400
1987	22	-	-	237	296,250	29,625	-	10,200	1,000	18,425	63,192	-	47,400	-	10,200	1,000	-	-	47,400
1988	23	-	-	237	296,250	29,625	-	10,200	1,000	18,425	47,677	-	47,400	-	10,200	1,000	-	-	47,400
1989	24	-	-	237	296,250	29,625	-	10,200	1,000	18,425	31,153	-	47,400	-	10,200	1,000	-	-	47,400
1990	25	-	-	237	296,250	29,625	-	10,200	1,000	18,425	12,728	-	47,400	-	10,200	1,000	-	-	47,400

* The rubber is assumed to come into production after seven years.

** Yields are approximated at 1,000 lb per acre for the first five years of the rubber's producing life, and 1,250 lb per acre thereafter.

*** The cost of establishment at $492 per acre is obtained from DASF 1966.

≠ Production costs were calculated on the basis of one man per 10 producing acres, plus an additional ten men, at a nominal figure of $300 per year per man. As they stand, these figures indicate a decreasing cost of production per lb over ten years, from approximately 6 to 3 cents per lb, which may well be necessary for rubber to remain competitive. These estimates of production costs are lower than those given in DASF 1966 (Table 17) which in 1963-64 ranged from 13 to 22 cents per lb, with a weighted average of 15.5 cents at a time when the price of rubber averaged 21.5 cents per lb. By 1968 the price had fallen to about 16 cents per lb, suggesting that unless planters had reduced production costs there would be little profit in producing. The effect of the lower costs used here is to make the benefit-cost ratio slightly more favourable than it should be.

Table 17

Projected growth of cattle numbers on European holdings

Year	t=	Herd growth			Calves		Steers		Bulls	Sub-total	Turn-off			Sub-total	Head carried over into succeeding year
		Breeders bought in	Natural increase	Total	M	F	1-2 yrs	2-2½ yrs			Culled cows and heifers	Breeding heifers	Steers		
1966	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1967	2	200	-	200	70	70	-	-	10	350	-	-	-	-	350
1968	3	50	-	250	87	88	68	-	13	506	-	-	-	-	506
1969	4	50	68	368	130	130	84	63	18	793	6	-	63	69	724
1970	5	50	76	494	173	173	125	80	25	1,070	10	-	80	90	980
1971	6	-	106	600	210	210	166	121	30	1,337	108	19	121	248	1,089
1972	7	-	-	600	210	210	204	161	30	1,415	108	96	161	365	1,050
1973	8	-	-	600	210	210	204	198	30	1,452	108	90	198	396	1,056

Table 18

Benefits derived from cattle on estates

Year	t=	Cost of stock bought at $50/head ($)	Farm development costs at $50/head of natural increase* ($)	Maintenance cost at $10/head of carryover* ($)	Total establishment and production costs ($)	Sales at average price $120/beast ($)	Cumulative debt at 106.5% interest ($)	Net farm returns ($)	Half counted as road benefits ($)
				(a) Low price assumption					
1966	1	-	-	-	-	-	-	-	-
1967	2	10,000	-	3,500	13,500	-	14,378	-	-
1968	3	2,500	-	5,060	7,560	-	23,364	-	-
1969	4	2,500	3,400	7,240	13,140	8,280	30,059	-	-
1970	5	2,500	3,800	9,800	16,100	10,800	37,657	-	-
1971	6	-	5,300	10,890	16,190	29,760	25,653	-	-
1972	7	-	-	10,500	10,500	43,800	2,353	-	-
1973	8	-	-	10,560	10,560	47,520	-	34,607	17,303
1974	9	-	-	10,560	10,560	47,520	-	36,960	18,480
1975	10	-	-	10,560	10,560	47,520	-	36,960	18,480
1990	25	-	-	10,560	10,560	47,520	-	36,960	18,480
				(b) High price assumption					
1966	1	-	-	-	-	-	-	-	-
1967	2	16,000	-	3,500	19,500	-	20,768	-	-
1968	3	4,000	-	5,060	9,060	-	31,767	-	-
1969	4	4,000	3,400	7,240	14,640	11,040	37,666	-	-
1970	5	4,000	3,800	9,800	17,600	14,400	43,522	-	-
1971	6	-	5,300	10,890	16,190	39,680	21,334	-	-
1972	7	-	-	10,500	10,500	58,400	-	26,566	13,283
1973	8	-	-	10,560	10,560	63,360	-	52,800	26,400
1974	9	-	-	10,560	10,560	63,360	-	52,800	26,400
1975	10	-	-	10,560	10,560	63,360	-	52,800	26,400
1990	25	-	-	10,560	10,560	63,360	-	52,800	26,400

* Obtained from D.A.S.F. Field Manual, 31-2A-9.

tons per acre, and a net return to the grower of 1½ cents per lb, the annual farm returns from this source amount to $10,349 per annum. Since the growers did not state any intention to expand this acreage, this figure is left constant through the 25-year period. (It is halved for the year 1966.) The yield figures assumed are conservative (they relate to virtually exhausted soil), and the actual yield could be raised considerably with irrigation and the application of fertiliser. One grower claims yields of 2 to 3 tons per acre, with occasional yields of up to 12 tons per acre.

Teak production

As mentioned, 2,000 acres of Crown land near Tavai Creek is being developed for the Rigo local government council as a teak plantation under the taungya system.[1] The villagers receive profits from the sale of food crops (mostly bananas) during the second year after clearing and planting, and the teak is thinned at 7 year intervals, yielding an increasing volume and value of timber at each stage. The first thinnings at 7 years have no commercial value. Returns will extend over 50 to 60 years, and the project is contingent upon the existence of the road. The calculations for the net benefits are given in Tables 19 and 20.

Table 19

Teak: returns from thinning, per acre

Thinning	Forest year	Est. vol. extracted per acre (s/ft)*	Value of sawn produce at $20 per s/ft ($)	Less cost of thinning at $1 per 100 s/ft (sawn) ($)	Less cost of conversion at $10 s/ft (sawn) ($)	Net return per acre ($)
II	15	3,860 (1,287 s/ft sawn equivalent at 33% recovery)	257.40	12.87	128.70	115.83
III	22	3,830 (1,915 s/ft sawn equivalent at 50% recovery)	385.00	19.15	191.50	174.35

* Super feet.

[1] See pp.45-6.

Table 20

Net benefit from teak

Year	t=	New area planted (acres)	Establishment costs at $80/acre	Maintenance costs first 15 yrs av. $4.27/acre/year	Maintenance costs 15-22 yrs av. $3/acre/year	Maintenance costs 23-30 yrs av. $3/acre/year	Total costs	Net returns from bananas	Net returns from second thinning av. $115.83/acre	Net return from third thinning av. $174.35/acre	Total return	Net benefit
			($)	($)	($)	($)	($)	($)	($)	($)	($)	($)
1964	-	20	1,600	85	-	-	1,685	-	-	-	-	-
1965	-	13	1,040	56	-	-	1,096	3,000	-	-	3,000	219
1966	1	23	1,840	98	-	-	1,938	1,950	-	-	1,950	12
1967	2	39	3,120	167	-	-	3,287	3,450	-	-	3,450	163
1968	3	25	2,000	107	-	-	2,107	5,850	-	-	5,850	3,743
1969	4	25	2,000	107	-	-	2,107	3,750	-	-	3,750	1,643
1970	5	25	2,000	107	-	-	2,107	3,750	-	-	3,750	1,643
1971	6	25	2,000	107	-	-	2,107	3,750	-	-	3,750	1,643
1972	7	25	2,000	107	-	-	2,107	3,750	-	-	3,750	1,643
1973	8	25	2,000	107	-	-	2,107	3,750	-	-	3,750	1,643
1974	9	25	2,000	107	-	-	2,107	3,750	-	-	3,750	1,643
1975	10	25	2,000	107	-	-	2,107	3,750	-	-	3,750	1,643
1976	11	25	2,000	107	-	-	2,107	3,750	-	-	3,750	1,643
1977	12	25	2,000	107	-	-	2,107	3,750	-	-	3,750	1,643
1978	13	25	2,000	107	60	-	2,167	3,750	-	-	3,750	1,583
1979	14	25	2,000	107	39	-	2,146	3,750	2,317	-	6,067	3,921
1980	15	25	2,000	107	69	-	2,176	3,750	1,506	-	5,256	3,080
1981	16	25	2,000	107	117	-	2,224	3,750	2,664	-	6,414	4,190
1982	17	25	2,000	107	75	-	2,182	3,750	4,517	-	8,267	6,085
1983	18	25	2,000	107	75	-	2,182	3,750	2,896	-	6,646	4,464
1984	19	25	2,000	107	75	-	2,182	3,750	2,896	-	6,646	4,464
1985	20	25	2,000	107	75	60	2,242	3,750	2,896	3,487	10,133	7,891
1986	21	25	2,000	107	75	39	2,221	3,750	2,896	2,267	8,913	6,692
1987	22	25	2,000	107	75	69	2,251	3,750	2,896	4,101	10,656	8,405
1988	23	25	2,000	107	75	117	2,299	3,750	2,896	6,800	13,446	11,147
1989	24	25	2,000	107	75	75	2,257	3,750	2,896	4,359	11,005	8,748
1900	25	25	2,000	107	75	75	2,257	3,750	2,896	4,359	11,005	8,748

Estate copra

Of a total of 300 acres of young coconuts on estates in 1967, half is attributed to the improvement of the road. For convenience, this acreage is assumed to have been planted evenly over the years 1964-66, and to come into bearing in the sixth year. Yields are calculated at 3 cwt per acre for the first three bearing years, 5 cwt per acre for the next three, and 8 cwt per acre from then on. Two price levels are used, $250 and $200 per ton. The net returns from this activity are shown in Table 21.

Poultry

Two European farmers in the study area raised poultry as part of their farming operations. The average production of their combined flocks is about 102 dozen eggs a day. On the assumption that the net return to the producer is 15 cents per dozen from a retail price of about 75 cents per dozen, the annual net benefit from this source is approximately $4,590. Since poultry raising has only taken place since the road was built, the figure for the year 1966 is put at $2,295, and since no increase is anticipated, the benefit is held constant throughout the period under consideration.

Timber milling

Two small mills on European estates produced about 240,000 super feet (s/ft) of logs in 1966, and 576,000 s/ft of logs in 1967. Converted at a 40 per cent recovery rate, production approximated 96,000 and 230,000 s/ft of dressed timber in those years respectively. The sale value approximates $17 per 100 s/ft, and the net return to the producers is estimated at $1,958 for 1966 and $4,700 for 1967. Since the supply of millable forest is limited, the return is tapered off to zero after ten years.

To the contributions made by the above eight activities must be added an additional benefit, the annual maintenance cost on the Kapa Kapa wharf, which is no longer used for the transport of goods or passengers. This amounts to $1,000 per year, though the actual expenditure in 1967 was $2,000.

The benefit terms are tabulated, summed and discounted at 6.5 per cent per annum in Table 22. High and low price assumptions are made for the terms representing estate rubber, estate cattle and estate copra. A constant price level has been assumed for these and other products over the period.

The cost terms of the ratio are made up of the initial cost E_{tj10} amounting to $646,000, and the maintenance cost per year discounted back to its present worth of 6.0 per cent per annum (Table 23).

Table 21

Net benefits derived from new coconuts on estates

Year	t=	Acres planted	Immature acreage	Acreage bearing	Production (tons)	Low Price assumption: Value at $200/ton ($)	Cost of planting at $300/acre (assumed) ($)	Production costs ($)	Depreciation ($)	Repayment ($)	Cumulative debt at 106.5% p.a. ($)	Net benefit ($)	High Price assumption: Value at $250/ton ($)	Cost of planting at $300/acre (assumed) ($)	Production costs ($)	Depreciation ($)	Repayment ($)	Cumulative debt at 106.5% p.a. ($)	Net benefit ($)
1964	-	50	50	-	-	-	15,000	-	-	-	15,975	-	-	15,000	-	-	-	15,975	-
1965	-	50	100	-	-	-	15,000	-	-	-	32,988	-	-	15,000	-	-	-	32,988	-
1966	1	50	150	-	-	-	15,000	-	-	-	51,107	-	-	15,000	-	-	-	51,107	-
1967	2	-	150	-	-	-	-	-	-	-	54,429	-	-	-	-	-	-	54,429	-
1968	3	-	150	-	-	-	-	-	-	-	57,967	-	-	-	-	-	-	57,967	-
1969	4	-	100	50	7½	1,500	-	1,050	1,000	-	62,321	-	1,875	-	1,050	1,000	-	61,921	-
1970	5	-	50	100	15	3,000	-	2,100	1,000	-	66,478	-	3,750	-	2,100	1,000	650	65,254	-
1971	6	-	-	150	22½	4,500	-	3,150	1,000	350	70,426	-	5,625	-	3,150	1,000	1,425	67,978	-
1972	7	-	-	150	27½	5,500	-	3,150	1,000	1,375	73,539	-	6,875	-	3,150	1,000	2,725	69,494	-
1973	8	-	-	150	32½	6,500	-	3,150	1,000	2,350	75,816	-	8,125	-	3,150	1,000	3,975	59,128	-
1974	9	-	-	150	37½	7,500	-	3,150	1,000	3,350	77,176	-	9,375	-	3,150	1,000	5,225	57,407	-
1975	10	-	-	150	45	9,000	-	3,150	1,000	4,850	77,027	-	11,250	-	3,150	1,000	7,100	53,577	-
1976	11	-	-	150	52½	10,500	-	3,150	1,000	6,350	75,271	-	13,125	-	3,150	1,000	8,975	47,501	-
1977	12	-	-	150	60	12,000	-	3,150	1,000	7,850	71,803	-	15,000	-	3,150	1,000	10,850	39,033	-
1978	13	-	-	150	60	12,000	-	3,150	1,000	7,850	68,110	-	15,000	-	3,150	1,000	10,850	30,015	-
1979	14	-	-	150	60	12,000	-	3,150	1,000	7,850	64,177	-	15,000	-	3,150	1,000	10,850	20,411	-
1980	15	-	-	150	60	12,000	-	3,150	1,000	7,850	59,988	-	15,000	-	3,150	1,000	9,561	-	1,289
1981	16	-	-	150	60	12,000	-	3,150	1,000	7,850	55,527	-	15,000	-	3,150	1,000	-	-	10,850
1982	17	-	-	150	60	12,000	-	3,150	1,000	7,850	50,776	-	15,000	-	3,150	1,000	-	-	10,850
1983	18	-	-	150	60	12,000	-	3,150	1,000	7,850	45,716	-	15,000	-	3,150	1,000	-	-	10,850
1984	19	-	-	150	60	12,000	-	3,150	1,000	7,850	40,327	-	15,000	-	3,150	1,000	-	-	10,850
1985	20	-	-	150	60	12,000	-	3,150	1,000	7,850	34,588	-	15,000	-	3,150	1,000	-	-	10,850
1986	21	-	-	150	60	12,000	-	3,150	1,000	7,850	28,465	-	15,000	-	3,150	1,000	-	-	10,850
1987	22	-	-	150	60	12,000	-	3,150	1,000	7,850	21,955	-	15,000	-	3,150	1,000	-	-	10,850
1988	23	-	-	150	60	12,000	-	3,150	1,000	7,850	15,022	-	15,000	-	3,150	1,000	-	-	10,850
1989	24	-	-	150	60	12,000	-	3,150	1,000	7,850	7,638	212	15,000	-	3,150	1,000	-	-	10,850
1990	25	-	-	150	60	12,000	-	3,150	1,000	-	-	7,850	15,000	-	3,150	1,000	-	-	10,850

Table 22

Calculation of the benefit term
($)

Year	t=	E_{tj1} (village gardening)	E_{tj2} (estate rubber)	E_{tj3} (estate cattle)	E_{tj4} (European vegetables)	E_{tj5} (teak)	E_{tj6} (estate copra)	E_{tj7} (European poultry)	E_{tj8} (timber milling)	E_{tj9} (Kapa Kapa wharf)	$\sum_{j=1}^{9} E_{tj}$	$\sum_{j=1}^{9} E_{tj(1.065)^{-t}}$
						(a) Low price assumption						
1966	1	332,193	-	-	5,175	12	-	2,295	1,958	1,000	342,633	321,721
1967	2	358,353	-	-	10,349	163	-	4,590	4,700	1,000	379,155	334,352
1968	3	384,513	-	-	10,349	3,743	-	4,590	4,200	1,000	408,395	338,075
1969	4	412,582	-	-	10,349	1,643	-	4,590	3,720	1,000	433,884	337,128
1970	5	442,700	-	-	10,349	1,643	-	4,590	3,240	1,000	463,522	338,090
1971	6	475,017	-	-	10,349	1,643	-	4,590	2,760	1,000	495,359	339,287
1972	7	509,693	-	-	10,349	1,643	-	4,590	2,280	1,000	529,555	340,550
1973	8	546,901	-	17,303	10,349	1,643	-	4,590	1,680	1,000	583,466	352,335
1974	9	586,825	-	18,480	10,349	1,643	-	4,590	1,080	1,000	623,967	353,723
1975	10	629,663	-	18,480	10,349	1,643	-	4,590	600	1,000	666,325	354,617
1976	11	629,663	-	18,480	10,349	1,643	-	4,590	120	1,000	665,845	332,756
1977	12	629,663	-	18,480	10,349	1,643	-	4,590	-	1,000	665,725	312,400
1978	13	629,663	-	18,480	10,349	1,583	-	4,590	-	1,000	665,665	293,244
1979	14	629,663	-	18,480	10,349	3,921	-	4,590	-	1,000	668,003	276,263
1980	15	629,663	-	18,480	10,349	3,080	-	4,590	-	1,000	667,162	259,092
1981	16	629,663	-	18,480	10,349	4,190	-	4,590	-	1,000	668,272	243,717
1982	17	629,663	-	18,480	10,349	6,085	-	4,590	-	1,000	670,167	229,509
1983	18	629,663	-	18,480	10,349	4,464	-	4,590	-	1,000	668,546	214,967
1984	19	629,663	-	18,480	10,349	4,464	-	4,590	-	1,000	668,546	201,856
1985	20	629,663	-	18,480	10,349	7,891	-	4,590	-	1,000	671,973	190,523
1986	21	629,663	-	18,480	10,349	6,692	-	4,590	-	1,000	670,774	178,587
1987	22	629,663	-	18,480	10,349	8,405	-	4,590	-	1,000	672,487	168,122
1988	23	629,663	-	18,480	10,349	11,147	-	4,590	-	1,000	675,229	158,504
1989	24	629,663	-	18,480	10,349	8,748	212	4,590	-	1,000	673,042	148,345
1990	25	629,663	-	18,480	10,349	8,748	7,850	4,590	-	1,000	680,680	140,869

$$\sum_{t=1}^{25} \sum_{j=1}^{9} E_{tj(1.065)^{-t}} = 6,758,632$$

						(b) High price assumption						
1966	1	332,193	-	-	5,175	12	-	2,295	1,958	1,000	342,633	321,721
1967	2	358,353	-	-	10,349	163	-	4,590	4,700	1,000	379,155	334,352
1968	3	384,513	-	-	10,349	3,743	-	4,590	4,200	1,000	408,395	338,075
1969	4	412,582	-	-	10,349	1,643	-	4,590	3,720	1,000	433,884	337,128
1970	5	442,700	-	-	10,349	1,643	-	4,590	3,240	1,000	463,522	338,090
1971	6	475,017	-	-	10,349	1,643	-	4,590	2,760	1,000	495,359	339,287
1972	7	509,693	-	13,283	10,349	1,643	-	4,590	2,280	1,000	542,838	349,092
1973	8	546,901	-	26,400	10,349	1,643	-	4,590	1,680	1,000	592,563	357,828
1974	9	586,825	-	26,400	10,349	1,643	-	4,590	1,080	1,000	631,887	358,213
1975	10	629,663	-	26,400	10,349	1,643	-	4,590	600	1,000	674,245	358,832
1976	11	629,663	-	26,400	10,349	1,643	-	4,590	120	1,000	673,765	336,714
1977	12	629,663	-	26,400	10,349	1,643	-	4,590	-	1,000	673,645	316,117
1978	13	629,663	-	26,400	10,349	1,583	-	4,590	-	1,000	673,585	296,733
1979	14	629,663	31,592	26,400	10,349	3,921	-	4,590	-	1,000	707,515	292,603
1980	15	629,663	47,400	26,400	10,349	3,080	1,289	4,590	-	1,000	723,771	281,623
1981	16	629,663	47,400	26,400	10,349	4,190	10,850	4,590	-	1,000	734,442	267,849
1982	17	629,663	47,400	26,400	10,349	6,085	10,850	4,590	-	1,000	736,337	252,170
1983	18	629,663	47,400	26,400	10,349	4,464	10,850	4,590	-	1,000	734,716	236,243
1984	19	629,663	47,400	26,400	10,349	4,464	10,850	4,590	-	1,000	734,716	221,835
1985	20	629,663	47,400	26,400	10,349	7,891	10,850	4,590	-	1,000	738,143	209,284
1986	21	629,663	47,400	26,400	10,349	6,692	10,850	4,590	-	1,000	736,944	196,204
1987	22	629,663	47,400	26,400	10,349	8,405	10,850	4,590	-	1,000	738,657	184,664
1988	23	629,663	47,400	26,400	10,349	11,147	10,850	4,590	-	1,000	741,399	174,037
1989	24	629,663	47,400	26,400	10,349	8,748	10,850	4,590	-	1,000	739,000	162,883
1990	25	629,663	47,400	26,400	10,349	8,748	10,850	4,590	-	1,000	739,000	152,939

$$\sum_{t=1}^{25} \sum_{j=1}^{9} E_{tj(1.065)^{-t}} = 7,014,516$$

Table 23

Maintenance costs of Rigo road

Year	t=	E_{tj11} ($)	$(1.06)^t$	$E_{tj11}(1.06)^{-t}$ ($)
1966	1	62,250	1,060	58,726
1967	2	62,250	1.124	55,383
1968	3	62,250	1.191	52,267
1969	4	62,250	1.262	49,326
1970	5	62,250	1.338	46,525
1971	6	62,250	1.418	43,900
1972	7	62,250	1.503	41,417
1973	8	62,250	1.593	39,077
1974	9	62,250	1.689	36,856
1975	10	62,250	1.790	34,777
1976	11	62,250	1.897	32,815
1977	12	62,250	2.011	30,955
1978	13	62,250	2.132	29,198
1979	14	62,250	2.260	27,544
1980	15	62,250	2.396	25,981
1981	16	62,250	2.540	24,508
1982	17	62,250	2.692	23,107
1983	18	62,250	2.854	21,812
1984	19	62,250	3.025	20,579
1985	20	62,250	3.207	19,411
1986	21	62,250	3.399	18,314
1987	22	62,250	3.603	17,277
1988	23	62,250	3.819	16,300
1989	24	62,250	4.048	15,378
1990	25	62,250	4.291	14,508

$$\sum_{t=1}^{25} E_{tj11}(1.06)^{-t} = 795,941$$

In addition, the cost of the Kapa Kapa wharf is included as a negative benefit (E_{tj12}). A nominal figure of $46,667 is derived from the construction cost less five years use, on the assumption that the wharf has no residual value after thirty years. The benefit-cost ratio is then, for the low price assumption:

$$\frac{B}{C} = \frac{\sum_{t=1}^{25}\sum_{j=1}^{9} E_{tj}(1.065)^{-t}}{E_{tj10} + \sum_{t=1}^{25} E_{tj11}(1.06)^{-t} + E_{tj12}} = \frac{6,758,632}{646,000 + 795,941 + 46,667} = 4.5$$

and for the high price assumption:

$$\frac{B}{C} = \frac{7,014,516}{1,488,608} = 4.7$$

Benefit-cost ratio including indigenous cattle raising

Since indigenous cattle raising in the area appears a likely future land use, a set of benefits which could be derived from this has been calculated. A model development farm budget for cattle farming on this class of country has been prepared by the Project Planning Team, and data from this source is used in estimating potential benefits.

From the air photos, of the total area accessible from the Rigo road some 1,643 square miles, or 1,051,520 acres, were counted as physically suited for cattle, that is, the land is of generally low or moderate slope, covered with savannah or grass. From this has been deducted 5,000 acres of potential agricultural land (i.e. flat valley bottoms) and a further 30 per cent as being unsuitable for less obvious reasons such as possible difficulty in providing adequate water. This leaves some 686,000 acres for potential development as indigenous cattle farms.

Following the specifications prepared by the Project Planning Team, each farm is assumed to be 440 acres of natural grassland of carrying capacity of one beast-equivalent to 10 acres (i.e. a herd of about 25 breeders, with other stock). For the purpose of the present calculations, it is assumed that 25 farms are commenced each year starting in 1970. This would imply that by 1990, 500 farms would have been established, occupying 220,000 acres. The budget for a sample farm is given in Table 24, and this is scaled up for the hypothetical 500 farms in Table 25.

The sum over twenty-five years of the present worth of the net benefits derived from indigenous cattle is $181,945. This can be incorporated into the main benefit-cost ratios to give the following values for the low price assumption:

$$\frac{B}{C} = \frac{6,758,632 + 181,945}{1,448,608} = \frac{6,940,577}{1,448,608} = 4.8$$

and for the high price assumption:

$$\frac{B}{C} = \frac{7,014,516 + 181,945}{1,448,608} = \frac{7,196,461}{1,448,608} = 5.0$$

Social benefits

No account has so far been taken of the social benefits deriving from the Rigo road. It has undoubtedly had a marked effect, most

Table 24

Model budget for one indigenous cattle farm*

Year	Project year	Outflow of funds ($)	Repayment of debt ($)	Total costs ($)	Gross farm income ($)	Net surplus ($)
	1	964	-	964	-	-
	2	1,354	-	1,354	-	-
	3	781	44	825	825	-
	4	376	174	550	550	-
	5	196	296	492	640	148
	6	196	266	462	595	133
	7	196	303	499	650	151
	8	196	303	499	650	151
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17	196	303	499	650	151
	18	196	220	416	650	234
	19	196	0	196	650	454
	20	196	0	196	650	454

* Based on Project Planning Team 1965b, Budget 4.1.

obviously in the shorter time now required to travel from any village in the study area to Port Moresby, in greater convenience and comfort than before. Probably only from the nearest village (Tupuseleia) could a return journey have been made in a day by sea before the road was built. Previously, visits to Port Moresby from the study area were infrequent and lasted for days or weeks at a time. The fact that more than 1,500 passenger return journeys were counted in the sample week of the truck survey is one indication of the change the road has brought. Another way of expressing the same figure is that, on the basis of the truck sample, the population in the area affected by the Rigo road travelled 615 miles per capita in 1967, and this could be extended to imply that on average each person in the area visited town about once a month.

Theoretically it would be possible to put a value on the time saved in this way. In the present context there are so many uncertainties involved that any estimate can be no more than a guess. Since the

Table 25

Net benefits from indigenous cattle farms
($)

Year	t=	Net surplus income from farms started in year																	Total net benefits E_{tj13}	Present worth at 6.5% p.a. discount
		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986		
1970	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1971	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1973	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	9	3,700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,700	2,098
1975	10	3,325	3,700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7,025	3,739
1976	11	3,775	3,325	3,700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10,800	5,397
1977	12	3,775	3,775	3,325	3,700	-	-	-	-	-	-	-	-	-	-	-	-	-	14,575	6,840
1978	13	3,775	3,775	3,775	3,325	3,700	-	-	-	-	-	-	-	-	-	-	-	-	18,350	8,084
1979	14	3,775	3,775	3,775	3,775	3,325	-	-	-	-	-	-	-	-	-	-	-	-	22,125	9,150
1980	15	3,775	3,775	3,775	3,775	3,775	3,325	3,700	-	-	-	-	-	-	-	-	-	-	25,900	10,058
1981	16	3,775	3,775	3,775	3,775	3,775	3,775	3,325	3,700	-	-	-	-	-	-	-	-	-	29,675	10,822
1982	17	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,325	3,700	-	-	-	-	-	-	-	-	33,450	11,455
1983	18	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,325	3,700	-	-	-	-	-	-	-	37,225	11,969
1984	19	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,325	3,700	-	-	-	-	-	-	41,000	12,379
1985	20	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,325	3,700	-	-	-	-	-	44,775	12,695
1986	21	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,325	3,700	-	-	-	-	48,550	12,926
1987	22	5,850	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,325	3,700	-	-	-	54,400	13,600
1988	23	11,350	5,850	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,325	3,700	-	-	65,750	15,434
1989	24	11,350	11,350	5,850	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,325	3,700	-	77,100	16,994
1990	25	11,350	11,350	11,350	5,850	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,325	3,700	88,450	18,305

$$\sum_{t=1}^{25} E_{tj13}(1,065)^{-t} = 181,945$$

benefit-cost ratio indicates high benefits brought by the road on economic grounds alone, it is not felt necessary to do more than note that added social benefits have occurred.

Chapter 9

Conclusion

This study of the economic effects of the construction of the Rigo road is the first of its kind in Papua-New Guinea. Cost-benefit studies have been undertaken in other countries before the new road was constructed. As such studies have often been made by engineering consultants who were later to build the road, they have tended to be over-optimistic. This study of the Rigo road was not conceived until two years after the project was completed. This had the disadvantage that adequate data were unavailable for the situation before the road was built, but the advantage that some measure of economic changes that the new road induced could be made.

Many changes were predictable. The rapid growth in vehicle ownership is likely to prove typical of many areas accessible to urban centres and with a similar development potential. Perhaps the most interesting aspect of vehicle ownership is the evidence in Map 7 that the effect of the road extends for several miles beyond vehicle access to it. This spontaneous development supports the view that investment in a major road of good quality should be supplemented by subsidiary investment in the improvement and extension of access roads.

The rapid increase in traffic on the new Rigo road was also to be expected. As yet there is no indication that the rate of increase is flattening out, but it would be surprising if it did not eventually do so. Nevertheless, traffic volumes elsewhere in Papua-New Guinea are growing at rates faster than was earlier anticipated, and the location of the Rigo road in relation to rapidly expanding Port Moresby is likely to result in continued increases for some time. The weekend recreational use of the road by residents of the capital may be regarded as a bonus to its primary function of linking the Rigo area to Port Moresby. The recreational use also made of the other exists from Port Moresby (to the Sogeri plateau, Brown River and Idler's Bay) suggests that similar use will be made of further extensions or improvements to the Central District road network.

The effects of the new road in stimulating indigenous agriculture to produce for commercial sale in Port Moresby have been greater than were anticipated. The most striking aspect of this commercial expansion in village agriculture is that it has taken place with virtually no

assistance or encouragement from any of the Administration's agencies which might have been expected to take an active interest. This lends support to the case for unified regional planning. Investment of a major sum in such a facility as the Rigo road generates far-spreading consequences, which should be gratefully accepted and supplemented in appropriate directions. The most obvious needs here are in hydrological survey and agricultural extension work to improve the quality and quantity of crops produced; in a marketing system which would promote indigenous middlemen and economise on time and costs of marketing produce; and in the establishment of small indigenous-run services, such as petrol stations, motor vehicle repair workshops, restaurants, and even accommodation facilities for travellers.

The few European farmers in the area have benefited considerably from the new road. They have shown considerable enterprise in undertaking new activities such as poultry and cattle raising and in setting up large trade stores. The easy access to Port Moresby produced by the road has also probably encouraged European teachers and health officers to work at Kwikila and in the villages, thus indirectly helping to raise standards of education and health.

The evidence on changes in transport costs is fairly meagre. It does appear, however, that real costs have decreased slightly, both for European freight and for indigenous passenger fares. The present rather uneven passenger and freight charges have developed without any long-term planning or control and probably do not reflect the actual costs of the operators. Further education of indigenous truck operators in the financial (as well as the mechanical) side of running their businesses can only be beneficial both to themselves and to the population they serve.

The benefit-cost assessment of the Rigo road made in Chapter 8 is based as closely as possible on actual production over the first two years, coupled with conservative projections of future growth rates. It shows that the net value of village garden produce sold in Port Moresby from the area over the first three years alone was greater than the cost of construction of the road; that the value of village garden production far outweighs that from any other single activity in the area, even under optimistic assumptions of high prices; and that cattle farming on European estates and indigenous farms is likely to be the second most profitable farming operation. Hence, there is a strong argument for promoting indigenous cattle raising as a supplementary source of income, and as an appropriate form of land utilisation for the dry lower hills of the area. Again this would supplement the investment in a major facility to improve the overall return from it.

The economic benefits from this particular road have been considerable, even in a comparatively short time. No attempt has been made to put a money value on certain less tangible consequences, including greatly increase accessibility to Port Moresby for 18,000 people. This

manifests itself perhaps most dramatically in the ability to bring serious medical cases quickly to Port Moresby. The more frequent movement of people to and from the capital must be having marked consequences in the rapid spread of ideas and information.

The gathering of material for this study left a strong impression of the marked lack of systematic organisation by any authority of either the collection of what should be basic statistical data (e.g. population counts) or of developmental planning for the area. In view of the proximity of the Rigo area to Port Moresby, and of the considerable changes which have taken place there in the last three years largely because of the injection of one significant development project, it would seem that this area could well be made the site of an experimental project in regional planning, which could later be extended to the rest of the country. Essential features of such a scheme would include direction probably by an executive officer responsible to a Regional Planning Council, through whom all government or other agencies would be required to act. The council itself should be able to request action by appropriate bodies. It could provide a desirable means of communication upwards to national authorities for the felt wants of the local population, and as well, ensure coordination between various agencies operating in an area so that major investment in one field was not ignored by others. The district development structure in Malaya could well be taken as the model for Papua-New Guinea.[1] The political possibilities which the structure has provided in Malaya should not be lost on either the present Administration or politicians concerned with the development of Papua-New Guinea.

[1] See, for example, Ferguson 1965 and Ness 1967.

Appendix 1

Monthly and annual rainfall

Rigo[1] 9°44'S, 147°44'E; 200 feet; 34 complete years; last year on record 1963.

Mean monthly rainfall in points:

J	F	M	A	M	J	J	A	S	O	N	D
650	519	632	666	347	227	173	179	231	162	250	413

Mean annual rainfall 44.49 inches; 1,130 mm.

Coefficient of variation 30 per cent.

Kemp Welch[2] 9°50'S, 147°45'E; height not given; 33 complete years; last year on record 1955.

Mean monthly rainfall in points:

J	F	M	A	M	J	J	A	S	O	N	D
743	698	785	856	430	349	166	217	237	307	512	668

Mean annual rainfall 59.68 inches; 1,515 mm.

Source. Brookfield and Hart 1966.

---

[1] The station was moved about 10 miles inland to the east from 'Old' Rigo to Kwikila in 1960. The years 1961-63 show considerably higher rainfall totals, but exert only a small influence on the 34-year average.

[2] The record refers to Gobaragere Plantation on the west bank of the Kemp Welch River from 1909 to probably about 1948, after which that recording station was changed to Kapogere, DASF, about one mile east across the river. There would be little difference in rainfall between the two sites.

Appendix 2

Land systems of the East Coast area

Coastal hill zone

Ridges:

Ha - Hanuabada. Limestone ridges with alkaline dark lithosols and foot-slopes with texture contrast soils and brown clay soils; savannah (Themeda australis - Eucalyptus sp., Ophiuros sp. - Eucalyptus alba) and derived grassland.

Ko - Kopu. Southern part: branching ridges with neutral brown lithosols and foot-slopes with red gravelly or brown clay soils; semi-deciduous thicket (Garuga sp. - Rhodomyrtus sp.).

Kb - Kabuka. Rounded ridges with red lithosols; foot-slopes with gravelly texture contrast soils; savannah (Themeda australis - Eucalyptus sp.).

Lowlands:

Bc - Bomana Creek. Foot-slopes and rounded hills with savannah (Themeda australis - Eucalyptus sp., Ophiuros sp. - Eucalyptus alba) and undulating plains with tall grassland (Saccharum spontaneum - Imperata sp.); brown clay soils. Ridges; lithosols; savannah (Themeda australis - Eucalyptus sp.).

Wd - Ward. Lower foot-slopes; texture contrast soils; savannah (Themeda australis - Eucalyptus sp.). Plains dark cracking clay soils; savannah (Ophiuros sp. - Eucalyptus alba) or semi-deciduous thicket. Drainage floors; dark cracking clay soils; tall grassland (Saccharum spontaneum - Imperata sp.).

Minor alluvial plains:

Bo - Boroko. Higher plains with savannah and derived grassland; lower plains with tall grassland (Saccharum spontaneum - Imperata sp.) and slightly deciduous forest (Planchonia sp. - Adenanthera sp.); dark cracking clay soils. Flood-plains; olive silty clays; tall evergreen forest (Octomeles sp. - Ardocarpus sp.) and tall grassland.

Foothill zone

Southern foothills:

Ro - Rouna. Gabbro ridges and spurs; neutral brown lithosols; slightly deciduous forest (Albizia sp. - Canarium sp.) with minor savannah (Ophiuros sp. - Eucalyptus tereticornis). Bare agglomerate cliffs.

Du - Dubuna. Ridges; neutral brown lithosols; savannah (Themeda australis - Eucalyptus sp., Themeda novoguineensis - Eucalyptus sp.). Lower spurs; mainly brown clay soils; savannah (Ophiuros sp. - Eucalyptus alba).

Littoral plains zone

Tidal flats:

Pp - Papa. Outer tidal flats; grey sandy peats; stunted evergreen forest (Rhizophora sp. - Brugeiera mangrove). Sandy beach ridges and plains; Premna sp. - Scaevola sp. scrub. Inner tidal flats, grey clayey peats with low evergreen forest (Avicennia sp. - Ceriops mangrove): brown sticky clays, bare or with salt grassland.

Appendix 3

Estimated 'resident' village population within area affected by Rigo road, c.1966*

(See Map 3)

Village	Population	Village	Population
Alebagu	39	Gobuia	35
Alewai	169	Gogorokomana	52
Alumarupu	191	Gomoredobu	206
Babaga	116	Goulupu	128
Babaka	367	Gunugau	248
Babakarupu	160	Iaromenomu	33
Barakau	482	Imagolo	215
Bigairuka	81	Irupara	248
Bokukomana	61	Hula	1,700
Bolakomana	49	Kalo	723
Bonanamo	156	Kamali	372
Bore	51	Kapa Kapa	842
Boregaina	373	Kaparoko	317
Bulidobu	41	Karaikomana	137
Dagoda	57	Karekodobu	153
Dirinomu	64	Kemaia	145
Diromkokila (Efaika)	231	Kerekadi	27
Dobunari	58	Kemabolo	319
Eho	18	Kobaroka	148
Gabone	294	Kodogere	28
Gaile	875	Kokorogoro	169
Gamoga	83	Kovorokomana	59
Gavagoro	33	Kuale	100
Gaunomu	114	Kwaibo	118
Gea	35	Kwalemurupu	296
Gegofi	83	Kwikila Town	1,184
Gemo	132	Kwikila Village	45
Geresi	42	Lautakomana	40
Geverogoro (Seba)	97	Libunakomana	259
Gidobada	296	Makirupu	341
Ginigolo	302	Manugoro	147
Girabu	102	Matairuka	118
Gobokomana	76	Meirobu	47

Village	Population	Village	Population
Nafenanomu	26	Sivitatana	161
Nemonomu	33	Tagana	80
Niuiruka	114	Tarunomu	17
Nogomaka	116	Taukomana	37
Rabuka	37	Tauruba	289
Riwalirupu	291	Tobaroka	64
Sabuia	50	Tupuseleia	1,335
Saroa	466	Vaivai	62
Sarokei	138	Wainumu	50
Seme	51	Wairadobu	47
Senunu	52	Walai	65
Sisigolo	41	Wasira	76
		Total	18,025

* Calculated from village census counts (village totals less students and workers away in districts other than Central District). The figures are drawn from DDA file 14-2-1, part 3, f.53-7.

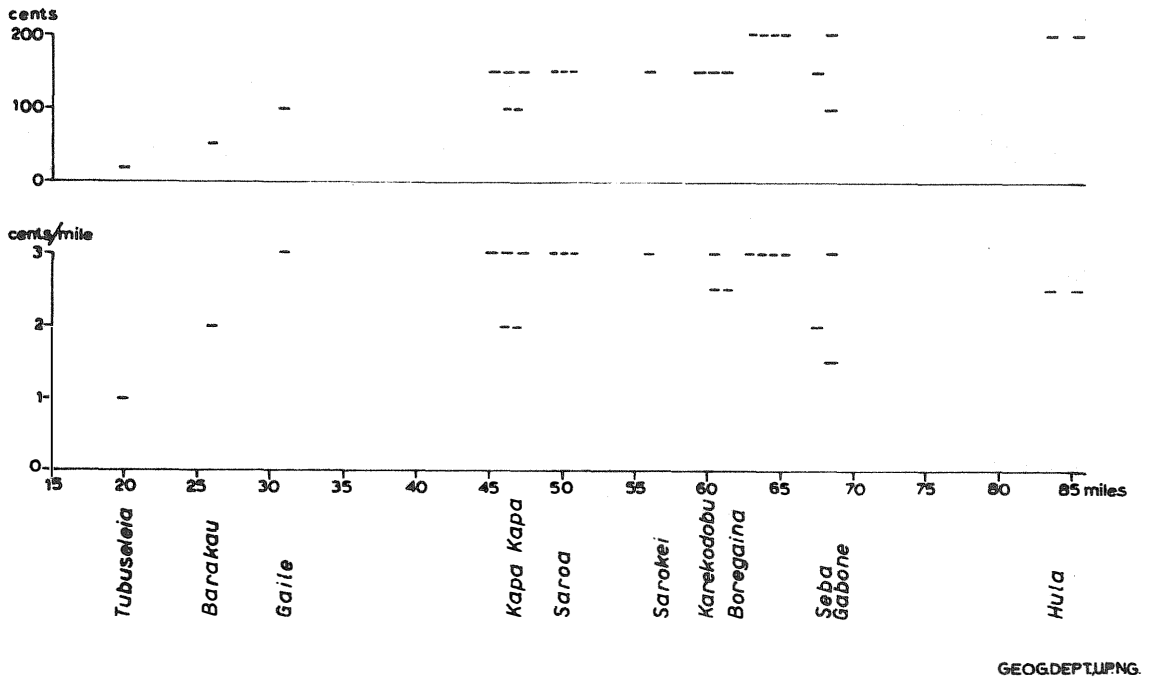


Fig. 8. One-way passenger fares, village to Port Moresby

Appendix 4

Analysis of questionnaire for truck owners

The following set of questions was asked orally of indigenous truck owners or operators during November-December 1967.

Name: .....
Make of vehicle: .....
Size: .....
Month and year bought: .....

In relation to the past week:

How often did the vehicle go to Port Moresby?

How many people travelled on

- Monday?
- Tuesday?
- Wednesday?
- Thursday?
- Friday?
- Saturday?
- Sunday?

Freight carried on

- Monday? .....
- Tuesday? .....
- Wednesday? .....
- Thursday? .....
- Friday? .....
- Saturday? .....
- Sunday? .....

What freight was carried on the return trip to the village on

- Monday?
- Tuesday?
- Wednesday?
- Thursday?
- Friday?
- Saturday?
- Sunday?

What is the fare from the village to Port Moresby:

- Passenger?
- Freight?

Have you bought a truck that has broken down and is not now in use?

How did you get the money to buy the truck?

If you had a loan is it now paid off?

What is the income from running the truck each week?

What are the expenses?

Difference?

Results of questionnaire

1. Numbers. In all 68 questionnaires were returned. Of these, 4 referred to trucks too new to have accumulated any data; 5 referred to trucks bought as long ago as 1959, now out of use for several years or sold; 6 referred to vehicles currently 'broken down' (of these, one seemed likely to be back on the road within a few days, 5 had broken down some months ago and there seemed to be little likelihood they would be repaired); 1 referred to a car used by a teacher for journeys between Tupuseleia and Gaile; 2 referred to tractors, and 3 questionnaires were incomplete.

Hence there were 47 usable questionnaires referring to trucks or utilities in use in the week preceding the survey in November-December 1967. All subsequent figures relate to this total, which represents 44 per cent of all trucks and utilities registered from the area served by the Rigo road, and 57 per cent of all village trucks and utilities in the same area. On the assumption that all village trucks and utilities conform to this sample, a scale-up factor of 1.74 is used for calculating totals.

2. Ownership. Fifteen vehicles (32 per cent) were individually owned; 5 vehicles (10 per cent) were owned collectively by 'the village', a church group within the village, or a village co-operative society; 27 vehicles (58 per cent) were owned by several co-owners within a village. The numbers ranged from 2 to over 20 co-owners.

3. Make of vehicles

	No.	Percentage
Toyota	14	30
Prince	12	26
Isuzu	7	15
International	4	9
Landrover	3	6
Nissan	2	4
Thames Trader	1	2
Bedford	1	2
Holden	1	2
Not stated	2	4
Total	47	100

4. Weight

Weight range	No.	Percentage
Up to 1 ton	7	15
1-1½ tons	6	13
1½-2 tons	14	30
2-2½ tons	14	30
3-5½ tons	3	6
Not stated	3	6
Total	47	100

5. Year bought

Year	No.	Percentage
1964	1	2
1965	4	9
1966	20	42
1967	22*	47
Total	47	100

* In addition four more trucks had been bought immediately before the survey.

6. Journeys to Port Moresby in preceding week

No. of return journeys to Port Moresby from village	No. of trucks	Percentage
1	3	6
2	-	-
3	7	15
4	2	4
5	6	13
6	18	38
7	4	9
8	1	2
Local use only	6	13
Total	47	100

7. Passenger journeys in sample week

Village	Miles to Port Moresby	No. of passengers one way/week*	No. of passenger miles/week
Tupuseleia	19.8	390**	15,444
Barakau	26.3	96	5,050
Gaile	30.9	223	13,781
Gomore	45.0	28	2,520
Tagana	46.2	21	1,940
Ginigolo	46.2	63	5,821
Kapa Kapa	46.7	95	8,873
Gunugau	46.7	26	2,428
Kemaia	49.0	30	2,940
Saroa	49.0	35	3,430
Gidobada	50.0	27	2,700
Sarokei	56.5	17	1,921
Karekodobu	59.5	43	5.117
Imagolo	60.5	30	3,630
Boregaina	61.5	48	5,904
Bore	63.5	71	8,997
Niuiruka	64.5	27	3,483
Kemabolo	64.5	60	7,740
Tauruba	65.0	36	4,680
Seba	67.5	31	4,185
Gabone	68.0	27	3,672
Bonanamo	68.5	42	5,754
Hula	83.5	30	5,010
Kalo	85.5	13	2,223
Total		1,509	127,243***

* Except where otherwise stated by informants, return passengers are assumed equal to inward passengers. Data totalled from the records of individual drivers.

** Of whom 310 were regular daily commuters, i.e. some 50-60 individuals.

*** On the basis of this figure the total number of passenger miles per year is 127,243 x 1.74 x 50 = 11,070,141. This is equivalent to 615 miles/capita/year for the 18,000 people in the area served by the road.

8. Inwards freight during sample week (weight in lbs)*

Village	Bananas	Kaukau	Paw paw	Pine-apple	Pumpkin	Taro	Tomatoes	Yams	Onions	Coco-nuts	Chin. cabb.	Fish	Betel nut	Sago	Fire-wood	Sugar cane	Village total lbs	Village total tons	Value at 10c per lb** ($)
Tupuseleia	450	-	120	-	-	-	-	-	-	-	-	150	-	-	-	-	720	0.32	72
Barakau	120	-	-	-	-	90	-	500	-	90	-	-	-	-	-	-	800	0.36	80
Gaile	1,080	-	-	-	-	-	-	700	-	-	-	3,000	-	-	-	-	4,780	2.13	478
Gomore	1,980	100	120	120	-	-	-	-	-	60	-	-	-	-	-	-	2,380	1.06	238
Ginigolo	3,750	-	780	1,500	2,800	-	20	-	-	15	-	-	-	-	-	-	8,865	3.96	887
Kapa Kapa	1,080	-	-	-	-	-	-	300	-	100	-	1,200	-	-	3,600	-	6,280	2.80	628
Gunugau	210	-	-	240	-	-	60	800	-	-	-	-	-	-	-	-	1,310	0.59	131
Kemaia	2,490	-	-	261	-	-	20	-	20	40	-	-	-	-	-	-	2,831	1.26	283
Saroa	1,140	400	-	36	270	-	-	-	-	40	-	-	180	-	-	-	2,066	0.93	207
Gidobada	1,290	-	240	18	700	270	-	300	-	250	15	-	108	-	-	-	3,191	1.42	319
Sarokei	5,400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5,400	2.42	540
Karekodobu	3,390	1,100	96	165	60	-	-	-	-	80	-	-	504	-	-	-	5,395	2.41	540
Imagolo	4,560	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-	4,580	2.05	458
Boregaina	1,440	-	-	-	800	-	-	-	-	-	-	-	288	-	-	8	2,536	1.14	254
Bore	5,410	-	-	-	-	-	-	-	-	50	-	-	72	-	-	-	5,532	2.48	553
Niuiruka	3,150	-	-	-	200	-	-	900	-	15	-	-	180	-	-	-	4,445	1.95	445
Kemabolo	1,350	-	-	-	-	-	-	-	-	400	-	-	-	-	-	-	1,750	0.78	175
Tauruba	3,300	-	120	-	600	-	60	-	-	-	-	-	-	-	-	-	4,080	1.81	408
Seba	1,410	100	-	-	-	-	-	-	-	80	-	-	108	-	-	-	1,698	0.76	170
Bonanamo	270	-	-	-	-	-	-	-	-	35	-	-	-	-	-	-	305	0.14	30
Hula	450	3,100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,550	1.59	355
Kalo	660	400	-	-	-	-	-	-	-	60	-	-	-	3,000	-	-	4,120	1.84	412
Total	44,380	5,200	1,476	2,340	5,430	360	160	3,500	20	1,335	15	4,350	1,440	3,000	3,600	8	76,614	34.3	7,663

* Data based on driver's records (where charges made) or estimates. (Weight conversions for 'bundles, bags or boxes' of produce were made on the basis of samples weighed at Koki market by S. Epstein in her market survey.)

** Value based on S. Epstein's survey findings.

By scaling up these estimates it appears that in 1967 the area served by the Rigo road supplied 29,841 tons of village garden produce (including small amounts of fish and firewood) to Port Moresby worth approximately $666,681. Calculated as ton-mileage, the sample indicated that 167,527 ton-miles of freight per year were being moved in 1967 to Port Moresby along the Rigo road.

9. Outwards freight during sample week (weight in lbs)*

Village	Building materials	Rice	Bread	Sugar	Flour	Canned fish	Canned meat	Biscuits	Tea	Beer	Butter	Lolly water	Sundries	Kero-sene	Petrol	Total lbs	Total tons
Tupuseleia	60	200	40	-	-	-	-	-	-	-	-	-	-	64	-	364	0.16
Barakau	-	-	-	650	500	-	-	-	-	-	-	-	-	-	-	1,150	0.51
Gaile	-	800	-	-	1,875	100	-	-	-	-	-	-	-	-	-	2,775	1.24
Gomore	-	100	8	50	-	25	25	-	-	-	-		50	-	-	258	0.12
Ginigolo	-	200	66	28	-	25	-	5	12	30	10	-	108	-	-	484	0.21
Kapa Kapa	-	200	100	164	125	-	25	-	14	30	-	-	23	-	-	681	0.30
Gunugau	350	500	20	-	-	-	-	-	10	-	-	-	-	-	-	880	0.39
Kemaia	-	-	-	-	50	-	-	-	-	-	-	60	25	-	-	135	0.06
Saroa	-	-	60	-	-	50	-	-	-	-	-	-	-	-	-	110	0.05
Gidobada	480	560	16	-	225	25	50	15	-	-	-	60	25	-	-	1,456	0.65
Sarokei	-	-	8	156	-	-	-	-	-	-	-	-	2	-	-	166	0.07
Karekodobu	-	650	57	1,000	175	-	4	-	-	-	-	2	10	64	-	1,962	0.88
Imagolo	110	250	-	-	-	-	-	-	-	-	-	-	-	-	-	360	0.16
Bore	-	200	-	50	-	-	-	-	-	-	-	-	-	-	-	250	0.11
Niuiruka	-	100	-	50	75	-	-	-	-	-	-	-	-	-	-	225	0.10
Kemabolo	120	200	-	-	25	25	25	-	-	-	-	-	1,200	-	-	1,595	0.71
Tauruba	780	200	-	100	-	-	-	-	-	-	-	-	-	128	-	1,208	0.54
Gabone	-	100	6	-	-	-	25	5	-	-	-	-	-	-	-	136	0.06
Bonanamo	-	50	-	-	-	50	25	5	-	-	-	-	12	-	-	142	0.06
Hula	-	1,550	14	850	275	50	-	50	-	-	-	45	6	128	2,240	5,208	2.32
Kalo	-	300	-	150	75	-	-	-	-	-	-	-	-	-	-	525	0.23
Total	1,900	6,160	395	3,248	3,400	350	179	80	36	60	10	167	1,461	384	2,240	20,070	8.93

* The total outwards freight in the sample weeks was estimated at 8.93 tons. Scaled up, this figure becomes 777 tons per year. On a ton-mileage basis the estimate is 45,327 ton-miles of outwards freight per year. A breakdown of the commodities carried shows 78 per cent of the outwards freight to be imported foodstuffs, 13 per cent fuels, 9 per cent building materials. The sample indicates that inward freight is four times greater than outwards.

10. Passenger fares and freight charges

Village	One-way passenger fare ($)	Miles	Approx. cents/mile	Freight charge/bundle (cents)
Tupuseleia	0.20	19.8	1	nil
Barakau	0.50	26.3	2	nil
Gaile	1.00	30.9	3	nil
Gomore	1.50	45.0	3	20
Ginigolo	1.50	46.2	3	10
Tagana	1.00	46.2	2	10
Kapa Kapa	1.00	46.7	2	10
Gunugau	1.50	46.7	3	10
Kemaia	1.50	49.0	3	10
Saroa	1.50	49.0	3	nil
Gidobada	1.50	50.0	3	10-20
Sarokei	1.50	56.5	3	10-30
Karekodobu	1.50	59.5	2.5	10
Imagolo	1.50-2.00	60.5	3	10
Boregaina	1.50	61.5	2.5	10-20
Bore	2.00	63.5	3	10
Niuiruka	2.00	64.5	3	10
Kemabolo	2.00	64.5	3	10
Tauruba	2.00	65.0	3	30
Seba	1.50	67.5	2	10
Gabone	1.00	68.0	1.5	50
Bonanamo	2.00	68.5	3	20-50
Hula	2.00	83.3	2.5	20
Kalo	2.00	85.5	2.5	nil

The gradual increase of passenger fares with distance is shown in Figure 8. The more distant places, such as Hula, Kalo, Seba and Karekodobu, are paying a lower rate per mile than villages nearer Port Moresby.

Some village fares are out of line with their neighbours and indicate keen competition between truck owners, particularly in the Kapa Kapa area, which appeared to be over-supplied with trucks at the time of the survey.

11. Previous ownership of vehicles. Twelve owners (29 per cent of those questioned) had previously owned 22 vehicles between them during the past seven years.

12. Financing of truck purchase

	No.	Percentage
No loan	10	21
Loan	35	75
No information	2	4
Total	47	100

13. Income and expenditure on the truck. Income ranged between $20 and $100 per week. About 20 trucks were earning between $30 and $70 per week. Earnings were predominantly from passenger fares. Expenditure on most trucks ranged from $10 to $30 per week, for petrol and oil, driver's wages (if employed) and repairs. (Loan repayments which ranged from $20 to $30 per week are not included here.)

Profit/truck. An approximate breakdown of the profits made by the trucks sampled is:

I	Up to $10/week	- 15 trucks
II	$10 to $30/week	- 16 trucks
III	$40 to $90/week	- 14 trucks
	No information	- 2 trucks

The trucks in category I included old trucks now used mainly locally, and also those in the 45 to 55 mile zone where competition was keen at the time of the survey. Those in category III included trucks carrying regular commuters from Tupuseleia to Port Moresby, those owned by well-organised groups from villages where there is little or no competition, and a small number of trucks hired out on contract work.

Bibliography

Angoma, C.O., 1966. 'Criteria for selection of investment projects. A case study of the Ord River irrigation project', M.Ec. thesis, University of Sydney.

Belshaw, C.S., 1952. 'Port Moresby canoe traders', Oceania, 23:1:26-39, Sydney.

British New Guinea, 1901. Annual report, Central division, part II, Rigo District.

-- 1905. Annual report.

Brookfield, H.C. and Hart, D., 1966. Rainfall in the tropical south-west Pacific, A.N.U. Department of Geography Publication G/3, Canberra.

Commonwealth Department of Works, 1968. 'Urgent minor and operational and recurring maintenance to Administration engineering installations'. Mimeo.

Department of Agriculture, Stock and Fisheries, 1966. 'Estate rubber in Papua and New Guinea. A report of an economic survey', Konedobu. Manuscript.

-- Field manual, Konedobu. Continuing issue.

Dutton, T.E., 1967. 'Notes on the languages of the Rigo sub-district'. Mimeo.

-- n.d. 'The peopling of central Papua'. Mimeo.

Ferguson, C.G., 1965. 'The story of development in Malaya (now Malaysia) - some aspects'. Journal of local administration overseas, 4:3:149-64, London.

Fitzpatrick, E.A., 1965. 'Climate of the Port Moresby-Kairuku area' in Mabbutt et al., 1965 (below), pp.83-97.

Heyligers, P.C., 1965. 'Vegetation and ecology of the Port Moresby-Kairuku area' in Mabbutt et al., 1965 (below), pp.146-73.

Hynes, R.A., 1966. 'Aspects of land utilisation along the Kemp Welch River, Papua', field thesis, University of New England, Armidale.

Jones, J.R., 1964. 'Economic benefits from development roads in Thailand', SEATO Graduate School of Engineering, Bangkok, Technical note no.15.

Mabbutt, J.A. et al., 1965. Lands of the Port Moresby-Kairuku area, Territory of Papua and New Guinea, CSIRO Land Research Series no.14, Melbourne.

-- 1965. 'Summary description of the Port Moresby-Kairuku area' in Mabbutt et al., 1965 (above), pp.12-18.

Mabbutt, J.A., Heyligers, P.C., Pullen, R., Scott, R.M. and Speight, J.G., 1965. 'Land systems of the Port Moresby-Kairuku area' in Mabbutt et al., 1965 (above), pp.19-82.

Mabbutt, J.A., 1965. 'Geomorphology of the Port Moresby-Kairuku area' in Mabbutt et al., 1965 (above), pp.106-28.

McCarthy, D., 1967. Australia in the war of 1939-1945. Series One, Army, vol.v, Southwest Pacific area, first year, Kokoda to Wau, Canberra.

Ness, G.D., 1967. Bureaucracy and rural development in Malaysia. A study of complex organisations in stimulating economic development in new states, Berkeley.

Oram, N.D., 1968. 'Culture change, economic development and migration among the Hula', Oceania, 38:4:243-75, Sydney.

Project Planning Team, 1965a. 'Fresh food study - Port Moresby', Department of the Administrator, Konedobu. Mimeo.

-- 1965b. 'Native cattle projects. Some model development farm plans and budgets for specialised cattle raising and mixed farms', Department of the Administrator, Konedobu. Mimeo.

Scott, R.M., 1965a. 'Soils of the Port Moresby-Kairuku area' in Mabbutt et al., 1965 (above), pp.129-45.

-- 1965b. 'Land classes of the Port Moresby-Kairuku area' in Mabbutt et al., 1965 (above), pp.174-9.

Speight, J.G., 1965. 'Geology of the Port Moresby-Kairuku area' in Mabbutt et al., 1965 (above), pp.98-105.

Territory of Papua, 1909. Annual report, 1908-9.

-- 1910. Report of Administrator, 1909-10.

-- 1918. Annual report, 1917-18.

Territory of Papua and New Guinea works programme, 1963-64, Konedobu.

Ward, R.G., 1965. Land use and population in Fiji, London.

Yates, K.R. and de Ferranti, R.Z., 1965. Geology and mineral deposits of the Port Moresby-Kemp Welch area, Papua, Department of National Development, Bureau of Mineral Resources, Geology and Geophysics Records 1965/161.

Index

New Guinea Research Bulletins

Bulletin No. 1	The Erap Mechanical Farming Project by R.G. Crocombe and G.R. Hogbin, April 1963.
Bulletin No. 2	Land, Work and Productivity at Inonda by R.G. Crocombe and G.R. Hogbin, August 1963.
Bulletin No. 3	Social Accounts of the Monetary Sector of the Territory of Papua and New Guinea, 1956/57 to 1960/61 by R.C. White, January 1964.
Bulletin No. 4	Communal Cash Cropping Among the Orokaiva by R.C. Crocombe, May 1964.
Bulletin No. 5	A Survey of Indigenous Rubber Producers in the Kerema Bay Area by G.R. Hogbin, October 1964.
Bulletin No. 6	The European Land Settlement Scheme at Popondetta by D.R. Howlett, April 1965.
Bulletin No. 7	The M'buke Co-operative Plantation by R.G. Crocombe, August 1965.
Bulletin No. 8	Cattle, Coffee and Land Among the Wain by Graham Jackson, December 1965.
Bulletin No. 9	An Integrated Approach to Nutrition and Society: the Case of the Chimbu, ed. E. Hipsley, January 1966.
Bulletin No.10	The Silanga Resettlement Project by Olga van Rijswijck, February 1966.
Bulletin No.11	Land Tenure and Land Use Among the Mount Lamington Orokaiva by Max Rimoldi, April 1966.
Bulletin No.12	Education Through the Eyes of an Indigenous Urban Elite by Karol van der Veur and Penelope Richardson, August 1966.
Bulletin No.13	Orokaiva Papers: Miscellaneous Papers on the Orokaiva of North East Papua, November 1966.
Bulletin No.14	Rabia Camp: a Port Moresby Migrant Settlement by Nancy E. Hitchcock and N.D. Oram, January 1967.
Bulletin No.15	Bulolo: a History of the Development of the Bulolo Region, New Guinea by Allan Healy, February 1967.

Bulletin No.16 Papuan Entrepreneurs: Papers by R.G. Crocombe, W.J. Oostermeyer and Joanne Gray, J.V. Langmore, April 1967.

Bulletin No.17 Land Tenure Conversion in the Northern District of Papua by David Morawetz, May 1967.

Bulletin No.18 Social and Economic Relationship in a Port Moresby Canoe Settlement by N.D. Oram, July 1967.

Bulletin No.19 A Benefit/Cost Analysis of Resettlement in the Gazelle Peninsula by Sumer Singh, September 1967.

Bulletin No.20 New Guinea People in Business and Industry - Papers from the First Waigani Seminar, December 1967.

Bulletin No.21 Teachers in the Urban Community by Penelope Richardson and Karol van der Veur, January 1968.

Bulletin No.22 Papers on the Papua-New Guinea House of Assembly by N. Meller, January 1968.

Bulletin No.23 Mixed-race Society in Port Moresby by B.G. Burton-Bradley, March 1968.

Bulletin No.24 The Organisation of Production and Distribution Among the Orokaiva by E.W. Waddell and P.A. Krinks, September 1968.

Bulletin No.25 A Survey of Village Industries in Papua-New Guinea by R. Kent Wilson assisted by Ross Garnaut, November 1968.

Bulletin No.26 The Contribution of Voluntary Aid Organisations to the Development of Papua-New Guinea, 1966-67 by Micheline Dewdney, January 1969.

Bulletin No.27 New Guinea Entrepreneurs by B.R. Finney, February 1969.

Bulletin No.28 Namasu: New Guinea's Largest Indigenous-owned Company by I.J. Fairbairn, March 1969.

Bulletin No.29 Hohola: the Significance of Social Networks in Urban Adaptation of Women by Lynn Oeser, June 1969.

Bulletin No.30 Inter-tribal Relations of the Maenge People of New Britain by Michel Panoff, July 1969.

Bulletin No.31 Inter-ethnic Marriage in New Guinea by A. Lind, September 1969.

Bulletin No.32 New Guinea Social Science Research and Publications, 1962-67 by Susan C. Reeves and May Dudley, October 1969.

Bulletin No.33 The Rigo Road: a Study of the Economic Effects of New Road Construction by Marion W. Ward, January 1970.

The above, with the exception of No.24, are available at a cost of $1.50 each. No. 24 is available at $2.00 a copy from the A.N.U. Press, The Australian National University, P.O. Box 4, Canberra, A.C.T., 2600, Australia.

An annual payment of $7.00 entitles the subscriber to all bulletins issued in the year.