Land Resource Study

18 Land Resources of the Solomon Islands Volume 7 San Cristobal and adjacent islands

Land Resources Division, Ministry of Overseas Development

CORRECTION
LAND RESOURCE STUDY 18 VOLUME 4

Owing to an error in collation, the texts of pages 55 and 165 were interchanged:

for page number 55 *read* 165
for page number 165 *read* 55

The pages cannot be physically exchanged, as the reverse sides are in the correct position. It is suggested that readers should photocopy these two pages and enter the photocopies in their correct positions.

The British Solomon Islands Protectorate

Volume 7

San Cristobal and adjacent islands

The after-effect of cyclone Ursula in December 1971 on the forest near Star Harbour, San Cristobal. The forest canopy has been completely destroyed and the foliage and finer woody material has been removed by the winds which were estimated to have reached 185 km/h. (Photo: BSIP Information Service)

Land Resources Division

The British Solomon Islands Protectorate Volume 7 San Cristobal and adjacent islands

J R F Hansell and J R D Wall

Land Resource Study 18

Land Resources Division, Ministry of Overseas Development
Tolworth Tower, Surbiton, Surrey, KT6 7DY, England
1975

THE LAND RESOURCES DIVISION

The Land Resources Division of the Ministry of Overseas Development assists developing countries in mapping, investigating and assessing land resources, and makes recommendations on the use of these resources for the development of agriculture, livestock husbandry and forestry; it also gives advice on related subjects to overseas governments and organisations, makes scientific personnel available for appointment abroad and provides lectures and training courses in the basic techniques of resource appraisal.

The Division works in close co-operation with government departments, research institutes, universities and international organisations concerned with land resources assessment and development planning.

List of volumes

Title:	Land resources of the Solomon Islands, Volumes 1-8 J R F Hansell and J R D Wall
Volume 1	Introduction and Recommendations
Volume 2	Guadalcanal and The Florida Islands
Volume 3	Malaita and Ulawa
Volume 4	New Georgia Group and The Russell Islands
Volume 5	Santa Island
Volume 6	Choiseul and The Shortland Islands
Volume 7	San Cristobal and adjacent islands
Volume 8	Outer Islands

Volumes 2, 3, 4 and 7 have already been published. Volumes 5, 6, 8 and finally 1, will appear later.

During the course of production of these reports the name of the British Solomon Islands Protectorate was changed to the Solomon Islands. The former name has been used throughout Volumes 2 and 3, in the text in Volumes 4 and 7, and not at all in the remaining volumes.

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Part 1

Introduction

PREFACE

Volume 7, covering San Cristobal and the adjacent islands of Santa Ana, Santa Catalina, Three Sisters, Ugi and Bio, is one of a series of volumes describing the land resources of the British Solomon Islands Protectorate. Each volume is concerned with a major island or island group and incorporates the results of fieldwork, the subsequent land classification and the assessment of its agricultural potential. Reports are issued on an island-by-island basis to simplify district planning and to facilitate access to the recommendations.

Landforms and soils are described in this volume as together they form the basis of the land classification, but other aspects of the physical environment such as geology, climate and vegetation are given only cursory attention having been more fully described in Volume 1. Similarly, aspects of the cultural environment are only discussed in this volume where they are unique to San Cristobal and a full discussion of population and subsistence agriculture, for example, can be found in Volume 1. With this method of presentation, unnecessary repetition is avoided, and it is possible to separate primary information gathered during the fieldwork from information derived largely from already published material.

The system of measurement used in the report is metric, with the exception of the sample area studies in Appendix 4 for which original measurements were in the imperial system. Parallel versions in imperial units are given of tabulated areal data only where they deal with opportunity areas.

ABSTRACT

San Cristobal and adjacent islands occupy approximately 3160 km^2. The area has been studied on a reconnaissance basis and the physiography, landforms, soils and present land use are mapped and described below. There are five land regions subdivided into 15 land systems and each land system and its component facets are described in detail with areal measurements. The agricultural potential of the land regions is discussed and four Agricultural Opportunity Areas totalling 200 km^2, are mapped. These have a large proportion of land suitable for large-scale agriculture.

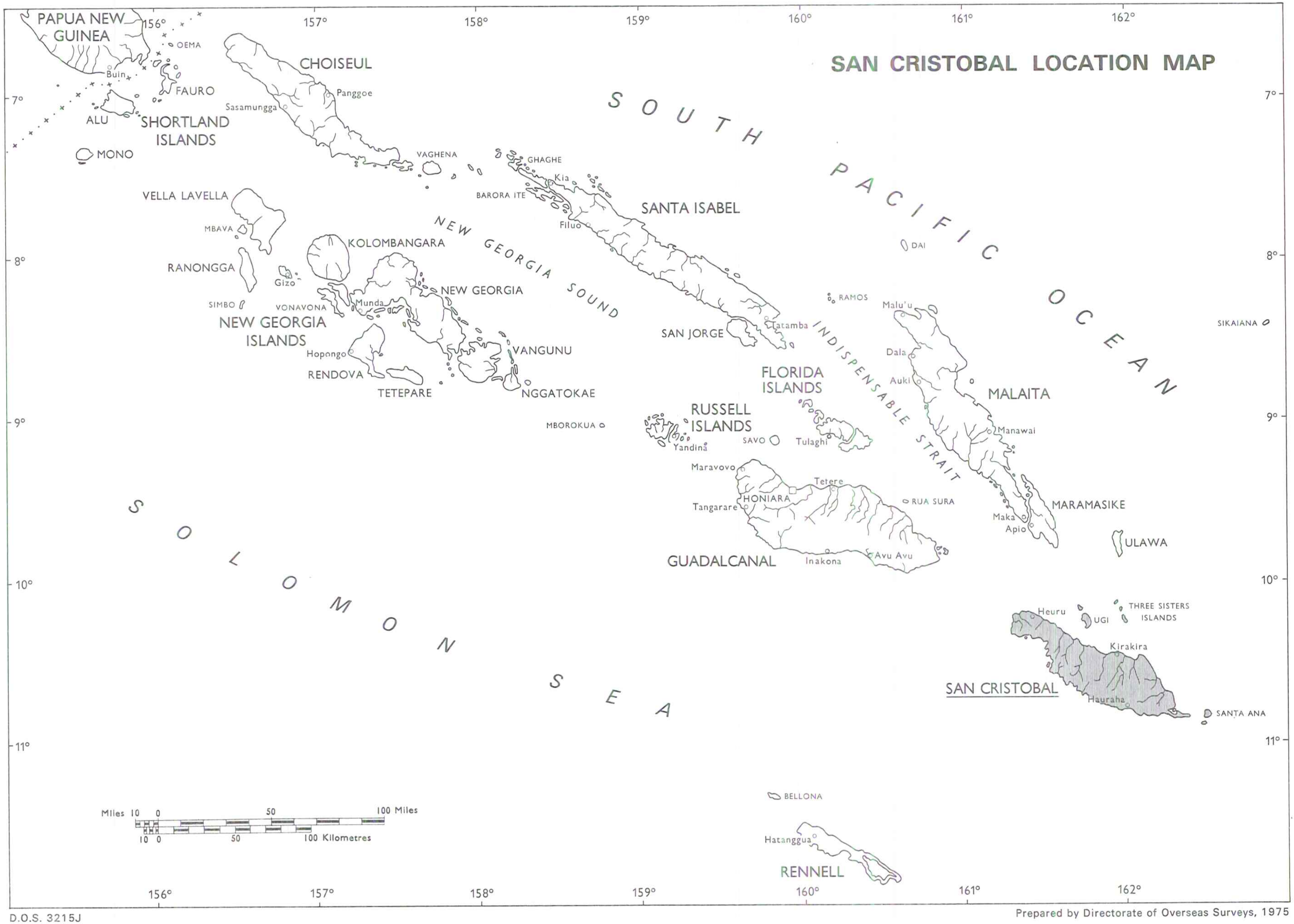
RÉSUMÉ

Ce volume fait partie d'une série dévouée aux îles Salomon. On a fait une première étude de l'île San Cristobal et les îles voisines dont la superficie est environ 3160 km^2; la physiographie, la topographie, les sols et l'emploi actuel des terres de ces îles sont décrits et présentés en forme de cartes. On a divisé les îles en cinq régions comprenant 15 zones écologiques (land systems). On décrit et calcule la superficie des élements constitutifs (land facets) de chaque zone écologique. On discute les ressources agricoles des diverses régions et on établit quatre Zones d'Aptitude Spéciale peu utilisées et montant à 200 km^2, chacune desquelles possède une importante partie de terres adaptées aux besoins des grandes exploitations agricoles.

DESCRIPTORS FOR CO-ORDINATE INDEXING

British Solomon Islands (San Cristobal, Santa Ana and Ugi Island) geomorphology, land classification, land region, land system, landform, land facet, soil survey, soil classification, soil Great Groups, soil profile, soil erosion, land capability, land use (current), potential land use, subsistence farming, cash cropping, forest mapping, coconut palm, yam, sweet potato, *Colocasia esculenta,* cattle.

Text Map 17


SAN CRISTOBAL LOCATION MAP
SOUTH PACIFIC OCEAN
SOLOMON SEA
NEW GEORGIA SOUND
INDISPENSABLE STRAIT
PAPUA NEW GUINEA
Buin
OEMA
FAURO
ALU
SHORTLAND ISLANDS
MONO
CHOISEUL
Panggoe
Sasamungga
VAGHENA
GHAGHE
Kia
BARORA ITE
Filuo
SANTA ISABEL
SAN JORGE
Tatamba
VELLA LAVELLA
MBAVA
RANONGGA
Gizo
SIMBO
VONAVONA
KOLOMBANGARA
NEW GEORGIA
Munda
NEW GEORGIA ISLANDS
Hopongo
RENDOVA
TETEPARE
VANGUNU
NGGATOKAE
MBOROKUA
RUSSELL ISLANDS
Yandina
SAVO
FLORIDA ISLANDS
Tulaghi
Maravovo
Tetere
HONIARA
Tangarare
GUADALCANAL
Inakona
Avu Avu
RUA SURA
RAMOS
DAI
Malu'u
Dala
Auki
MALAITA
Manawai
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Apio
MARAMASIKE
ULAWA
SIKAIANA
Heuru
UGI
THREE SISTERS ISLANDS
Kirakira
SAN CRISTOBAL
Hauraha
SANTA ANA
BELLONA
Hatanggua
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Miles 10 0 50 100 Miles
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Part 2

The environment

INTRODUCTION

Factors in the determination of potential land use (Parts 2-4)

In Part 2 are described the physical and human aspects of the environment which play a dominant role in determining the agricultural potential of specific types of land.

In Part 3 the specific types of land are identified: the landscape is analysed and described in detail, the land being divided into land systems each of which is characterised by a uniform pattern of geology, landform, soils, vegetation and land use. These land systems are grouped into land regions which are generally dispersed, not discrete areas, constitute "regions" only in an abstract sense and are essentially an analytical tool for the determination of potential land use described in Part 4. The same land region may be found in many different islands.

Environmental factors (Part 2)

In Part 2, after a brief account of the location of the islands, the environment is first described in broad and traditional terms, that is by physiographic regions which are readily related to regional aspects of development planning. They represent a geographical division of land into discrete, coherent areas defined by altitude, shape and drainage, each region being a unique entity not recurring elsewhere. The physiographic regions are not synonymous or necessarily conterminous with the land regions defined above and described in Part 3.

The account of the physiographic regions is followed by a description of those environmental factors which have to be considered in conjunction with landscape analysis in arriving at a classification of land according to potential land use.

The first factor described is *landform,* the major landforms of the islands (for instance fluvial plains or volcanic cones) being the features used in landscape analysis and consequently the most overt and consistent constituents of land systems.

Individual *soils* are next described in detail and at the scale of mapping used are grouped into soil associations. Soil like the landform has a very obvious role in determining potential land use.

The third environmental factor described is *current land use,* representing an interaction between biophysical and specifically human factors. Like landform and soil, it is taken into consideration in determining the agricultural potential of land regions which is described in Part 4.

LOCATION

San Cristobal, together with the nearby islands of Santa Ana, Santa Catalina, Three Sisters, Ugi and Bio, covers an area of 3160 km^2. The main island occupies 3090 km^2 and lies at the southern end of the double line of islands which form the British Solomon Islands Protectorate (Text Map 17). Its length is 140 km and the width varies from 12 to 39 km, with the extremities lying between 10° 11′ and 10° 51′S, and 161° 16′ and 162° 22′E. The seven small islands included in this report lie within 17 km of the north and east coasts of San Cristobal: the largest, Ugi, is only 42 km^2 and all are part of the administrative sphere of Eastern District headquarters at Kirakira. Ulawa Island is 65 km to the north of San Cristobal and, although part of Eastern District administratively, has close cultural and environmental ties with nearby Malaita. For these reasons it is included with Malaita for reporting purposes.

PHYSIOGRAPHIC REGIONS

San Cristobal has clear structural and lithological affinities with Guadalcanal. Both islands are underlain by intensively faulted basement basalts and have an asymmetric hilly to mountainous watershed lying close to and parallel with the southern coast. This is flanked to the north by sedimentary successions which, in turn, form high ridges with accordant summits, cuestas, terraces and isolated flood plains. Four physiographic regions are identified on San Cristobal and a fifth comprises the similar but scattered offshore terraced islands (Map 7a).

Western Terraces and Hills

This region of 40 km^2 occupies the western extremity of San Cristobal. It is formed of gently dipping calcareous sedimentary rocks resting on basement basaltic lavas and bordered at the coast by raised coral reef. The maximum height of the low hills and short ridges inland is 400 m and this decreases gradually seawards to the terraces, whose main surface varies in height from 40 to 160 m. The region incorporates all of what is sometimes referred to as the Arosi Plateau and is effectively divided into more or less equal halves by the Eteria River.

The region is the source of several west-flowing streams which have incised their courses deeply at the coast in contrast to the lightly dissected areas inland. The terraces have no surface drainage, all rainwater passing to subsurface karstic drainage systems. The coastline is fringed by onshore reef, then deep water.

Northern Foothills and Plains

The total area of this region is 645 km^2. It extends as a narrow strip along the northern coast of San Cristobal from the Eteria River to the easternmost tip of the island at Naghora Point, and consists of steep-sided hills, ridges and dissected cuestas developed from mainly sedimentary rocks. These decrease in height coastwards where rolling hills of less than 100 m height are widespread locally. Fluvial plains have developed in several areas, separated by low hilly headlands, and extend for several kilometres inland along the major rivers. Extensive sandy beaches in the major shallow bays testify to rapid bay-infilling with reworked riverine deposits. Shallow swamps have developed behind many of the beaches on the plains.

Several subregions can be distinguished, specifically those centred on Star Harbour, the Harigha River, Wanione Bay and Maghoha Bay. The drainage of the region consists of small short streams deriving from anddraining the major part of the region, and widely scattered large rivers whose sources are far inland and which traverse the area but drain comparatively little of it. There is scattered onshore reef at headlands but none in bays.

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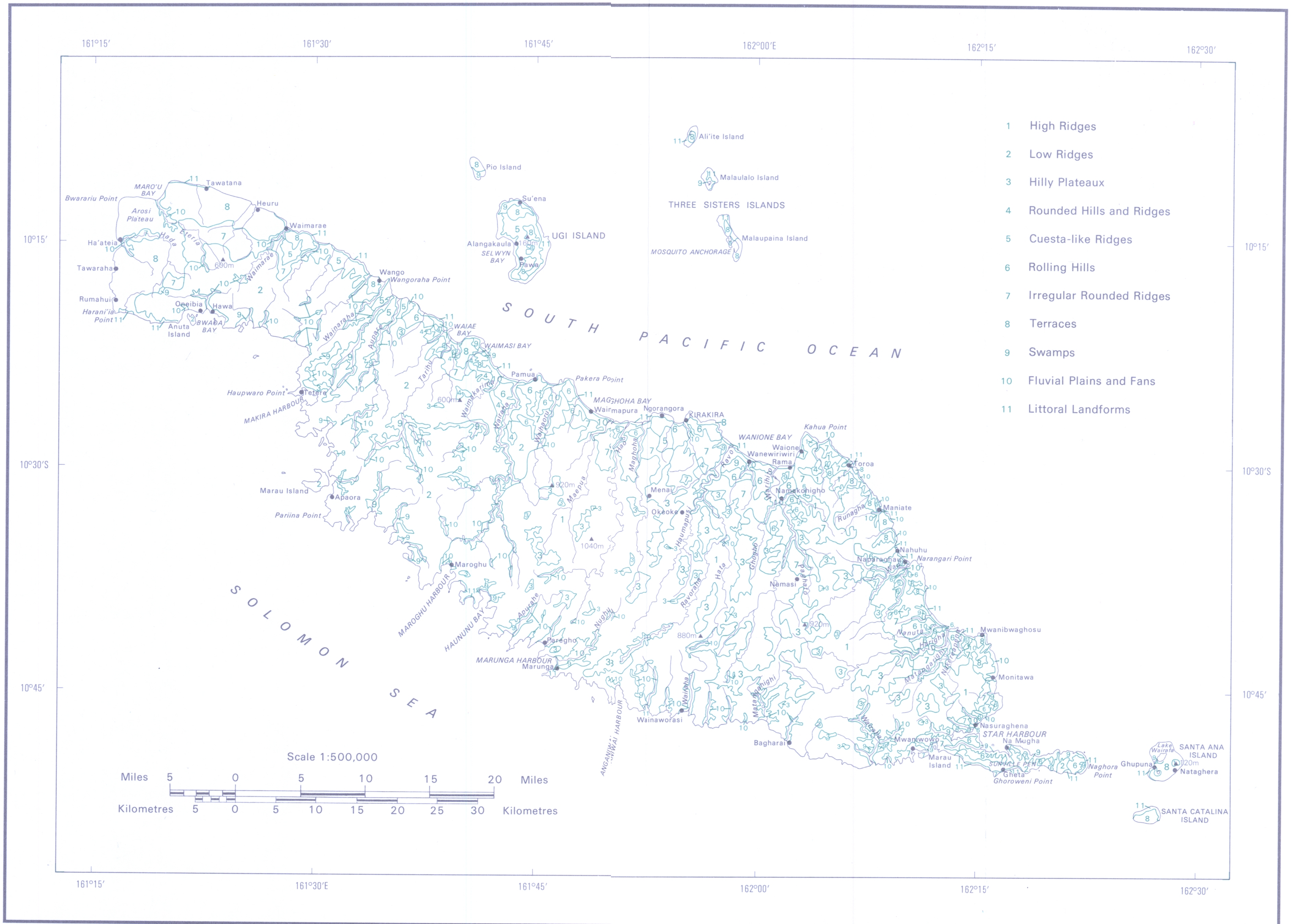
1:500,000 British Solomon Islands Protectorate

LANDFORMS

SAN CRISTOBAL TEXT MAP 18



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Prepared by Directorate of Overseas Surveys, 1974. Printed for D.O.S. by the Ordnance Survey.
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Western Lowlands and Ridges

The region covers an area of 875 km^2 and forms the bulk of the western part of San Cristobal. It is delimited clearly from the Central Uplands by a presumed fault line completely crossing the island from southwest to northwest, and from the Northern Foothills and Western Terraces and Hills by differences in height, landform and rock type.

Beneath the Western Lowlands and Ridges are primarily basement basalts which, though intensively faulted and tilted, have not been folded. Limestones are incorporated between pillow lavas as disconnected small lenses but they have not produced distinctive surface landforms detectable on air photographs. Low ridge systems occur throughout the region. The highest peaks reach 560 m, but this is rare and there appears to be a general accordance of summits at around 400 m. Broad valleys containing swamps separate the ridge systems. The swamps extend in interrupted segments across most of the island and are separated by incised valley sections with relatively steep and irregular river profiles. Such large inland swamps are almost unknown elsewhere in the Solomon Islands and their presence in western San Cristobal is attributable mainly to regional block tilting and warping on a large scale, such that base levels of erosion are raised and valleys become filled with sediment or are drowned.

The southern coastline is strongly indented and ria-like, bearing all the signs of recent submergence. The main island watershed is strongly asymmetric, with the extreme headwaters of the 17 km-long Wainaraha River, for example, lying at an altitude of only 60 m and within 200 m of the south coast at Makira Harbour (Separate Map 7b) Coral reef on the south coast occurs at sea level in a few small bays which do not receive drainage water from large rivers. Elsewhere the headlands and harbours are formed of basaltic rocks. Bay heads are formed of narrow, predominantly volcanic, sand or gravel beaches. There is no offshore barrier reef formation.

Central Uplands

There is a clear contrast between the Central Uplands and Western Lowlands and Ridges, the former comprising land that is mostly above 400 m, reaching 1 000 m in places, while the latter is mostly below 400 m. In addition, the Central Uplands summit areas are formed of accordant lightly dissected rolling hills or small ridges of the Ravoraha Land System which constitute the relics of a former erosion surface. They contain sedimentary rocks in large part, while the adjacent main deep valley flanks are eroded into basement basalts or gabbros. The more or less linear boundary between the two regions, crossing the island from northeast to southwest, is presumed to be a deep-seated line of crustal weakness between two relatively rigid blocks.

The drainage system of the region, as in the Western Lowlands and Ridges, is asymmetric, with some north-flowing rivers rising close to the south coast. Swampy inland valleys do not occur, although stranded floodplains of the Waimasi Land System are mapped at altitudes of 400 – 600 m. Main, roughly parallel rivers cross the island from southwest to northeast. They tend to be deeply incised with steep gradients alternating with gently graded sections. At the south coast, the short rivers have steep headwaters flowing almost directly into broad, gently sloping, usually swampy valleys which terminate in bays flanked by pronounced volcanic ridges – the general appearance of a recently submerged coastline. There is no offshore barrier reef, but onshore reef flanks some of the smaller bays. The area of the region is 1080 km^2

Eastern Hills and Ridges

In some respects this region, which totals 440 km^2, is similar to the Central Uplands. Both are formed of volcanic ridges, the highest of which lie between 800 and 1 000 m and which in many cases have broad sedimentary summits, but the Eastern Hills and Ridges have a different aspect resulting in an east-flowing drainage system. Except for the westernmost watershed, the ridges tend to lie below 600 m, falling to less than 200 m in several coastal localities.

The ridges, aligned roughly east-west, comprise basaltic volcanics with small, ultramafic intrusions in the north near Wanione Bay. They are deeply incised by main rivers to produce steep flanks and narrow crests. In many areas, however, the relics of a former erosion surface remain, identified by the broad, rolling crestal areas of the Ravoraha Land System and a general accordance of summits in an easterly-tilted plane. These areas are largely composed of sedimentary rocks including cherty limestones, but may consist entirely of volcanic rocks.

At the south coast, recent submergence of the land has drowned the lower valleys, leaving broad spreads of swampy alluvium extending inland for several kilometres. There appears to be a limit to the line of submergence at Star Harbour, for east of this, in the Northern Foothills and Plains Region, the land has recently emerged, stranding coral platforms above sea level near Naghora Point. In addition, there is a continuous line of onshore coral reef around the Surville Peninsula which disappears west of the Mwaniwowo area. Offshore barrier reef has not developed.

Northern and Eastern Islands

The islands of Santa Ana, Santa Catalina, Ugi, Bio and Three Sisters are physiographically similar, although widely separated. They consist of raised coral reef platforms, which in places surround low hills of volcanic or sedimentary rocks. It may be justifiable to consider them as one region, but because of the proximity of Santa Catalina and Santa Ana to the Surville Peninsula, for example, it is arguable that they could be considered as part of a separate region that encompasses the Peninsula as far as or slightly beyond Star Harbour, especially as there are similar coral terraces near Naghora Point.

The islands do not exceed heights of 160 m. They are compact, have little or no surface drainage and, although consisting mainly of limestone, have no offshore barrier reef. The area of this region is 80 km^2.

LANDFORMS

A variety of landforms on San Cristobal and adjacent islands partly reflects a broad range of lithology, varying from volcanic pillow lavas and ultramafic rocks to non-calcareous and calcareous sedimentary rocks to Recent sediments. Intensive and continuing structural movements have elevated reefs to coral terraces and stranded former level or rolling surfaces on ridge summits and small plateaux: elsewhere, downwarping has submerged coastlines and drowned valleys. Erosional processes vary from place to place and in duration, but the erosive agents are more or less uniform throughout. The distribution of the main landforms is shown in Text Map 18, from which it can be seen that their boundaries are the basis of units in the land system and soil maps. The definitions of landform parameters can be found in Appendix 2.

High Ridges

The differentiation between High Ridges and Low Ridges is not absolute, and the intent is to separate ridges associated largely with the Wakora Land System from those of the Wainari'i Land System. The former group comprises mainly high ridges, but some of low altitude and amplitude are found towards the east,

Figure 7.1

GEOLOGY	LANDFORM	LAND SYSTEM
Recent alluvium and colluvium	Beaches Fans Fluvial plains	TENARU KOPIU WAIMASI
Plio-Pleistocene sediments	Rolling Hills Irregular rounded ridges Hilly plateaux	BWAROO HURO RAVORAHA
Mesozoic basalts with (a) intrusive gabbro and (b) ultramafics	High ridges	WAKORA
fault		

Fgure 7.1 Cross-section of San Cristobal showing inferred relationship between land systems, geology and landforms

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in particular; the Wainari'i Land System similarly contains small patches of high ridges in otherwise large areas of low ridges.

The High Ridges attain beights of about 1 000 m in the Central Uplands of San Cristobal where the amplitude of relief reaches 500 m in places. Further east, their height decreases to 400-600 m and amplitude to 200 m or less. They are even in height, long, either curved or straight in plan and have narrow to broad summits. Their flanks are long, steep and mostly straight; the associated valleys are narrow, with irregular profiles.

Basaltic rocks underlying this landform have been subjected to continual stress from structural movements, resulting in widespread faulting. Ridge alignment is a result of faulting, in the sense that ridges represent land that remains between fault-aligned streams and gullies which exploit lines of weakness. Stream headwaters, in particular, exhibit many linear segments which indicate a large degree of structural control and which therefore affect intervening ridge alignment. Main rivers, however, seem to have partially overcome the effects of structural control and, while several main valley sections have been influenced by faulting, the overall impression is that, where rivers are exerting some lateral as opposed to almost entirely vertical erosion, there is a preponderance of dendritic rather than angular river nets (Stereopair 7.1)

Erosion is not interrupted by dry seasons or cold periods and has probably proceeded for many millenia, resulting in prolonged and intense dissection in the landscape. Periodic uplifts of the land have produced a regional base level of erosion 800-1 000m below the highest ridges, which stimulates intense vertical erosion in headwaters and upper valleys. In these areas, ridges tend to be narrow where gully-heads join; debris avalanches commonly occupy gully-head sites.

Slopes of main ridges tend to be long, steep and straight, if undissected by gullies, but a fine network of incising streams or gullies produces many minor convexities on spurs and minor ridges. Lower slopes are commonly the steepest of all and are precipitous or even cliffed over many small areas as a result of oversteepening by vigorous stream erosion. Most upper slopes are formed of short convex segments, which in some areas merge into gently rounded summit areas, too small to be mapped as Hilly Plateaux on Text Map 18. Surface wash produces a terracetted microrelief on steep slopes behind surface roots, tree buttresses and rocks.

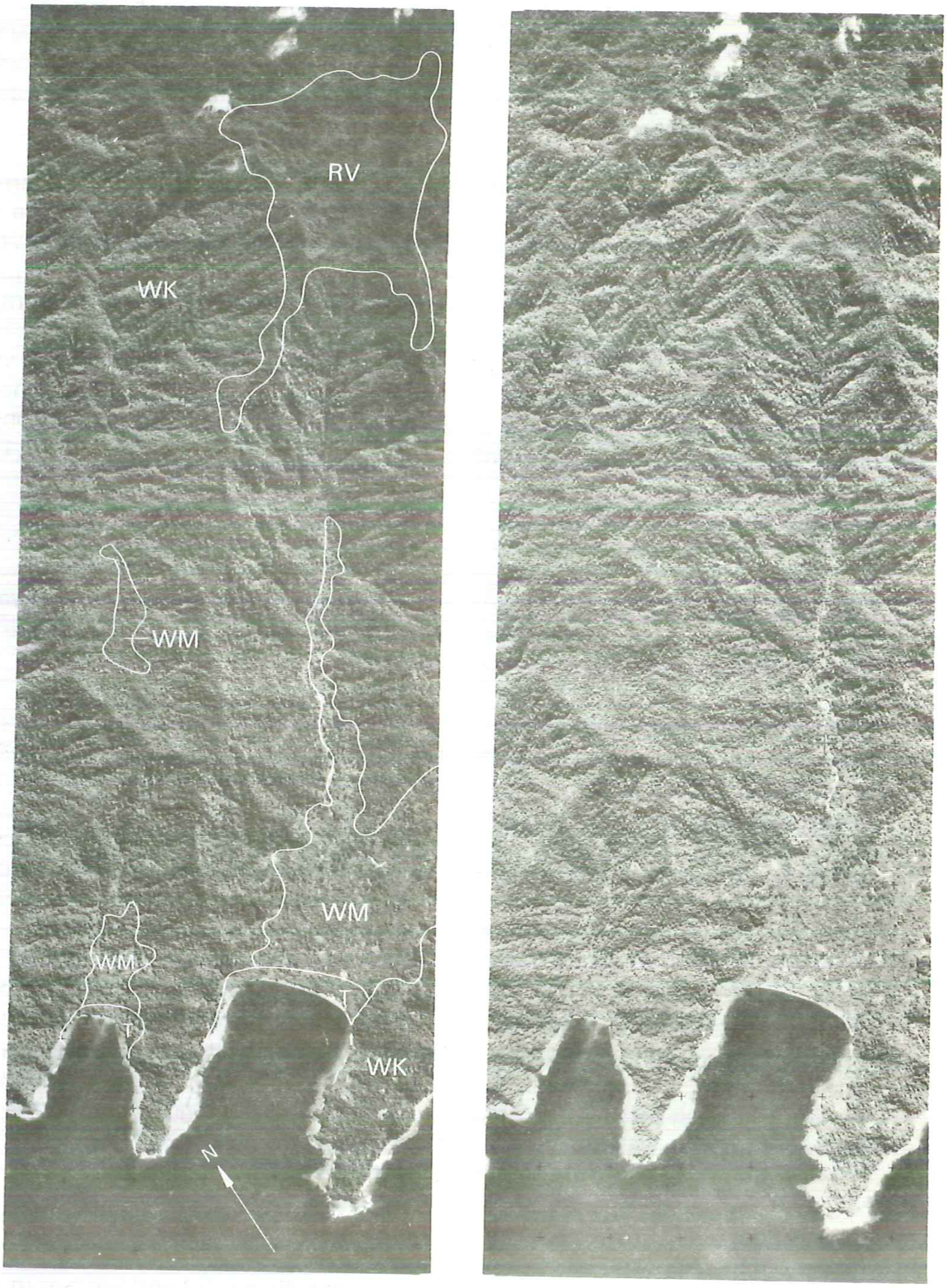
Valley floors among the High Ridges are similarly affected by the predominance of vertical erosion, and tend to be narrow with little or no floodplain. However, small floodplains occur between 400 and 600 m in the headwaters of a few rivers near the south coast, and are believed to lie at heights of former regional base levels of erosion. Between these gently sloping valley sections are segments where the valley profile is marked by rapids and deeply incised meanders. The overall major river profiles of the area are,therefore, gently stepped.

Low Ridges

This landform coincides predominantly with the Wainari'i Land System in the Western Lowlands and Ridges of San Cristobal. It comprises distinct volcanic ridge systems, most of which reach 400 m but with an amplitude of relief of mainly less than 200 m (Stereopair 7.2). Small areas of low-relief ridges of the Wakora Land System are also mapped in the Surville Peninsula.

A distinctive feature of the Low Ridges is that their crest lines are rarely long and usually uneven. There are a few places where the summits broaden into level areas exceeding widths of 150 m; the Ravoraha Land System which is so common among the High Ridges is rare.

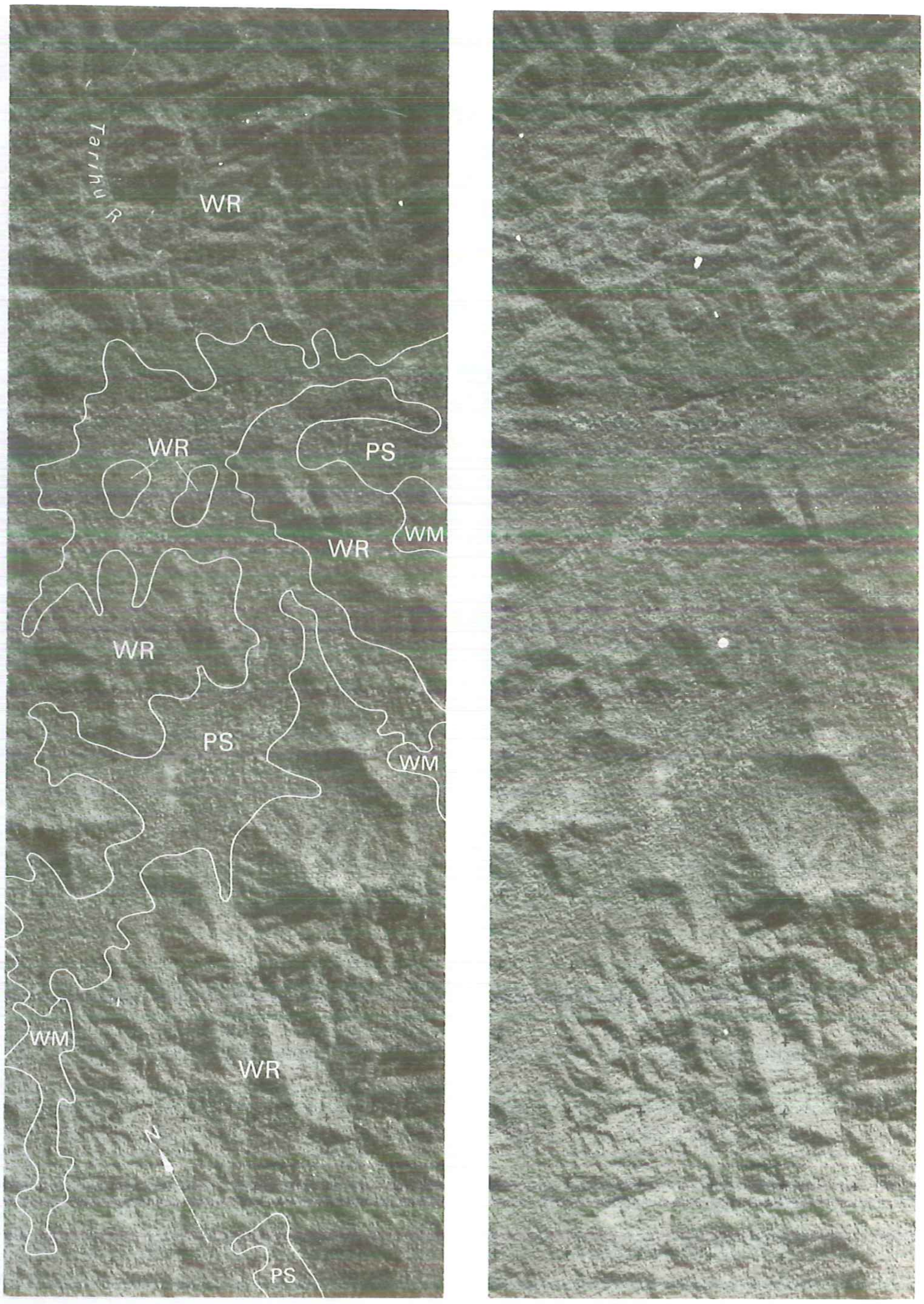
STEREOPAIR 7.1



The southern, indented, ria-like coastline of San Cristobal with broad, drowned valleys of the Waimasi (WM) LS and narrow bay-head beaches of the Tenaru (T) LS. Inland is stranded high level alluvium (WM) associated with lightly dissected relics of a former erosion surface, Ravoraha (RV) LS, and eroded basaltic rocks of the Wakora (WK) LS.

Prepared by the Directorate of Overseas Surveys, 1975

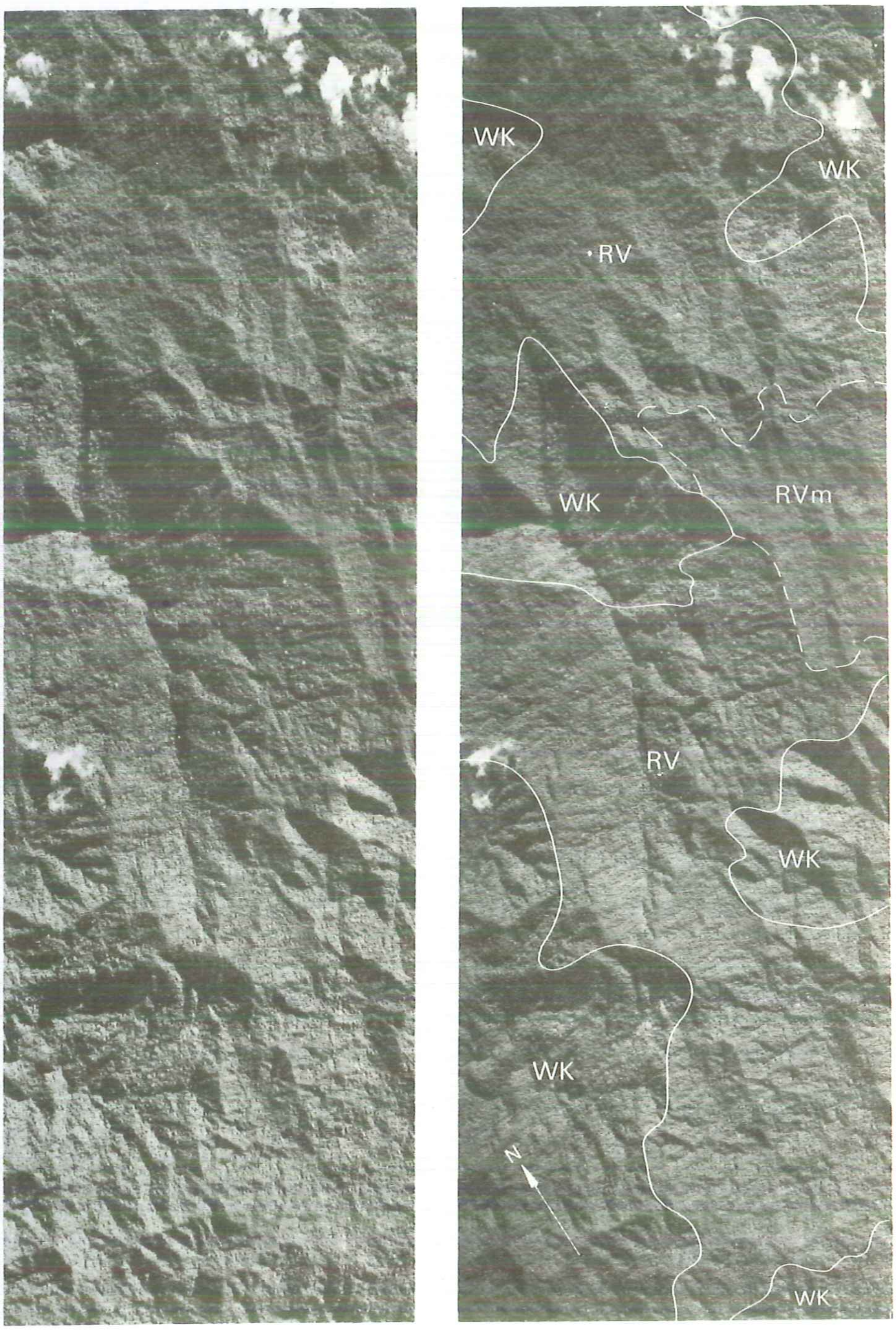
STEREOPAIR 7.2



The Western Lowlands and Ridges of San Cristobal comprise low, narrow basaltic ridges of the Wainari'i (WR) LS, amongst which are wide, swampy, stranded valleys containing the Pusuraghi (PS) and Waimasi (WM) Land Systems. The swamps in this stereopair drain north into the incised Tarihu River via a nick point.

Prepared by the Directorate of Overseas Surveys, 1975

STEREOPAIR 7.3



The interior of San Cristobal showing lightly dissected, residual erosion surfaces of Ravoraha (RV) LS. These are considered to consist largely of sediments and overlie deeply eroded basaltic rocks of the Wakora (WK) LS. The facet RVm is distinguished by the presence of medium-height, small-crowned lowland forest.

Prepared by the Directorate of Overseas Surveys 1975

The slopes are varied in length, shape and steepness, but are mostly medium in length, straight and moderately steep. Valleys range from short, steep, angular, fault-guided gullies to broad floodplains. These are described separately below. Many footslopes adjacent to the floodplains are gently concave, contrasting with steep, convex or straight footslopes of incising streams and gullies.

Dissection of the landscape has been intense and by the same agents of erosion as on the High Ridges. Their lower height is attributed mainly to regional lowering of the Western Lowlands and Ridges *en bloc* in the past. This has diminished the power of erosion of the large rivers by effectively raising the base level of erosion. Recent submergence along the south coast has reduced the power of river erosion in these areas even more, but it may be compensated for in the north and west by comparable emergence of the land.

Hilly Plateaux

In San Cristobal, much of the highest land consists of the Ravoraha Land System, scattered areas of up to 40 km^2 of rolling hills and low ridges. They form disconnected, somewhat hilly plateaux above deeply dissected, ridged landscapes and have developed from mixed basement volcanics and residual sedimentary rocks, which are presumed to have once covered large areas of the eastern half of the island at least (Stereopair 7.3).

The hills and ridges of the plateaux, although occurring at altitudes of up to 1 000 m, have low relief of little more than 100 m. They have mostly narrow, unorientated, even-profiled and straight or curved crests less than 3 km long; some summits are broad to very broad and gently rounded. Slopes vary widely, but are commonly short, moderately steep and straight. Many lower slopes are oversteepened, especially towards the plateaux margins, and in some areas, long, gently convex upper slopes merge with broadly rounded crests.

Streams and rivers are short, with gradients that are too low to be effective in erosion. The local available relief rarely exceeds 100 m, and stream headwaters have little catchment area or water volume to generate great erosive power. The plateaux slowly diminish in area as more powerful streams with greater catchments outside the plateaux gradually extend headwards. From map analysis it appears that there have been phases of relatively rapid uplifts separated by lengthy periods of stability during which rivers have had time to adjust to new base levels of erosion and form floodplains. The land has not risen uniformly, but has tilted or warped to the east and south to the extent that submergence has occurred on the southern coastline.

Rounded Hills and Ridges

Although covering only small areas of San Cristobal, the short, gently rounded ridges with steep lower slopes are clearly seen on airphotographs. This may be due in part to the distinctive vegetation associated with it (Separate Map 7h)

The rock type is largely serpentinized peridotite with minor gabbro and basalt, and the landforms occur as disconnected, linear features. Hill or ridge summits are convex with gentle, long slopes merging with moderate middle slopes. Footslopes tend to be steep and generally short only where small streams have incised deeply. Surface boulders and rock outcrops are widespread.

The drainage of the landforms is not well developed and largely consists of small incised streams and short gullies with an angular joint-controlled pattern. Intervening spurs are therefore confined to small areas on the lower slopes of main ridges where gullies are deepest. Major, allochthonous rivers have dissected what once may have been a continuous line of rounded hills and ridges in the west.

Cuesta-like Ridges

This landform is prevalent in the Northern Foothills within the Bwaroo Land System. The ridges are described as cuesta-like because, although their similarity to cuestas is apparent in many places, dissection by rivers and streams has modified their earlier asymmetry. They are best preserved west of Kirakira where scarp slopes facing south and west oppose northeast-facing dipslopes.

The landforms are less than 400 m high and lie mostly between sea level and 200 m. Scarp slopes are generally steep, 40 to 200 m in length and are irregular in shape with many rock outcrops. Dipslopes, on the other hand, comprise broadly rounded, gently or moderately sloping areas, 1-3 km in length, with lightly incised streams.

The sediments which form the ridges are mostly of marine or littoral origin and are calcareous. They rest on basement basalts and began to be deposited presumably as a result of major land uplift to the south. Subsequent warping and faulting has resulted in the strata being tilted in a northeasterly direction. Erosion of the sediments has been selective with structural patterns emerging as streams exploit faults and fractures. Lithological dissimilarities are emphasised in time, and rocks which are more resistant to erosion stand out and form protective cap rocks. Limestone and conglomerate are particularly effective in this respect while sandstones and finer grade siltstones are less resistant.

Valleys within the Cuesta-like Ridges are poorly developed and consist chiefly of low-amplitude features caused by small dipslope streams. Rivers draining inland volcanic ridges have caused deep dissection on cuesta margins, however, and deep, V-shaped re-entrants into the southern line bounding their occurrence. It is the scarp slopes flanking the valleys which are longest and steepest.

Rolling Hills

The main area of this landform is in the Northern Foothills east of Waimasi Bay where the Bwaroo Land System occurs. The hills are low and unorientated and have developed from sedimentary rocks.

The highest areas are less than 300 m above sea level and there is a low amplitude of relief of 40-100 m. Hill summits are mostly broad and rounded and flanking slopes are mostly moderate or moderately steep and only lightly dissected. Some long slopes gradually merge into colluvial-alluvial footslopes of broad valleys but there are in addition shorter, steeper slopes with common rock outcrops.

The general impression is of poorly defined, irregular low hills and valleys. The hills bear a resemblance in places to the Cuesta-like Ridges as there are some indications of scarp and dipslopes. Dissection here has produced less clear results, either because the structure and lithology is dissimilar or because erosion has been less effective: it is suspected that indurated, potential cap rocks are fewer, limestone beds are more scattered and that the dip of strata is less steep than equivalent-age beds in the west beneath the Cuesta-like Ridges.

Valleys are weakly defined and, because streams in many places have not incised their courses more than a few metres, cannot be seen clearly on air photographs. There is karstic underground drainage in places. Rivers deriving from inland volcanic areas dissect the Rolling Hills and commonly are responsible for short, rather steep terracetted slopes adjacent to their floodplains.

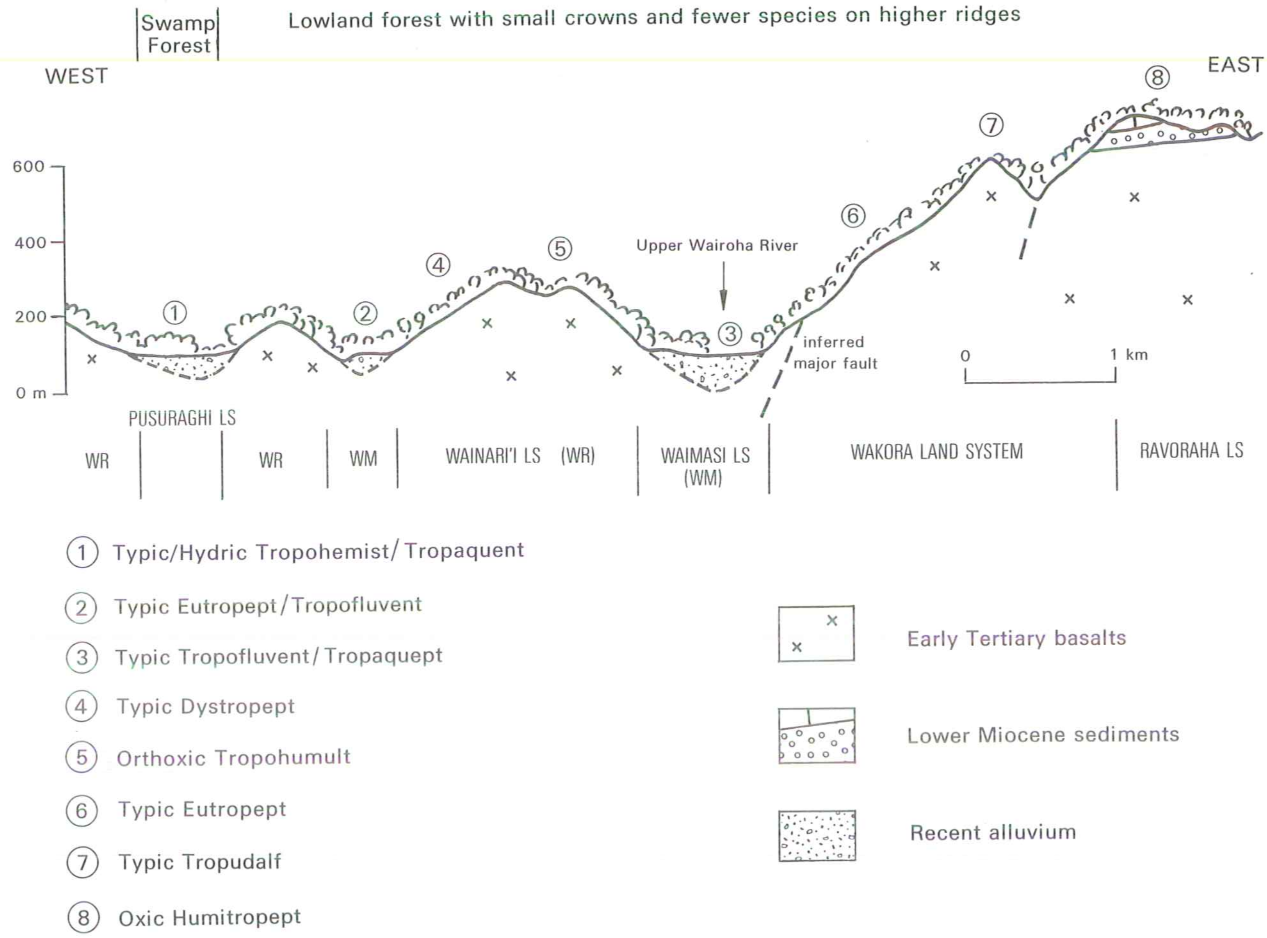


FIGURE 7.2 Diagrammatic cross-section of land systems of central San Cristobal, showing lithology/landform/soil/vegetation relationships

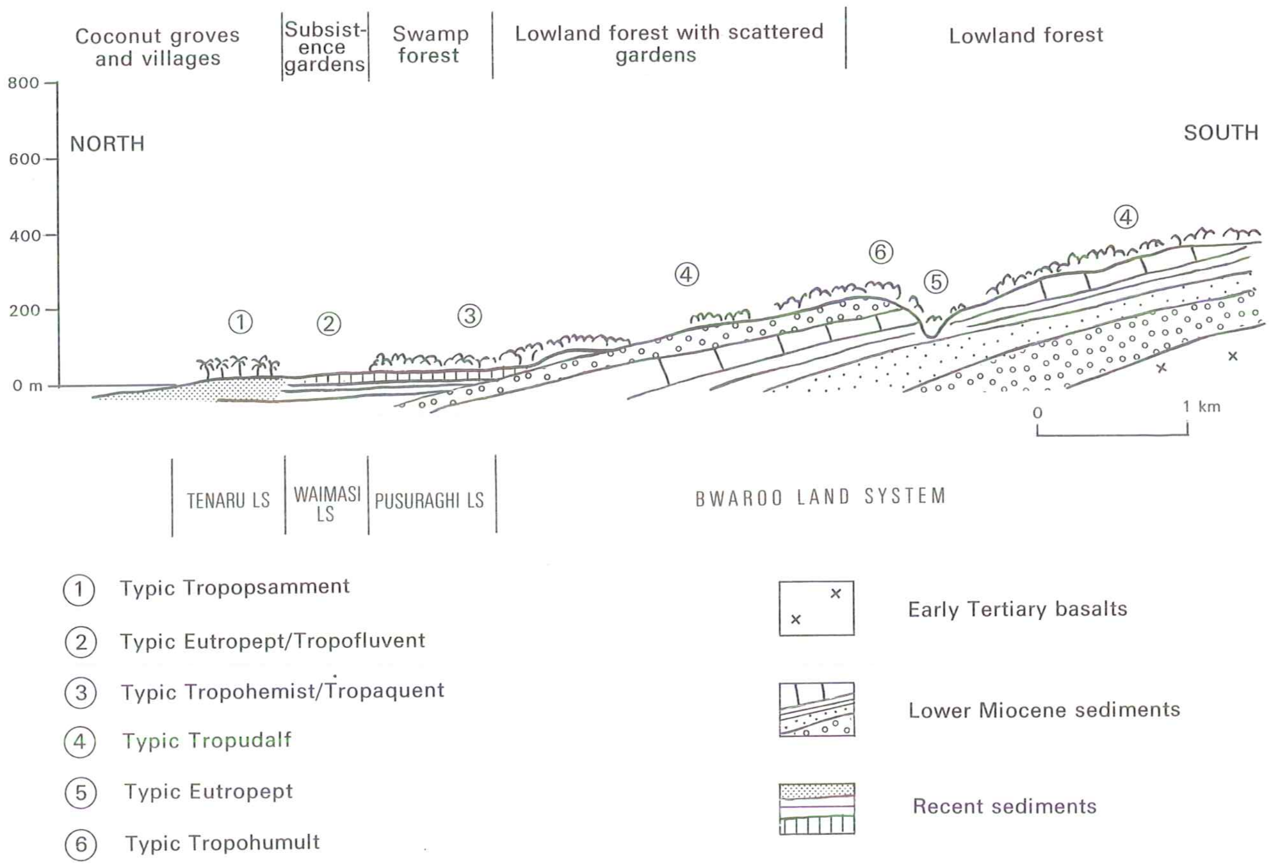


FIGURE 7.3 Diagrammatic cross-section of Wanione Bay area showing lithology/landform/soil/vegetation/land use relationships

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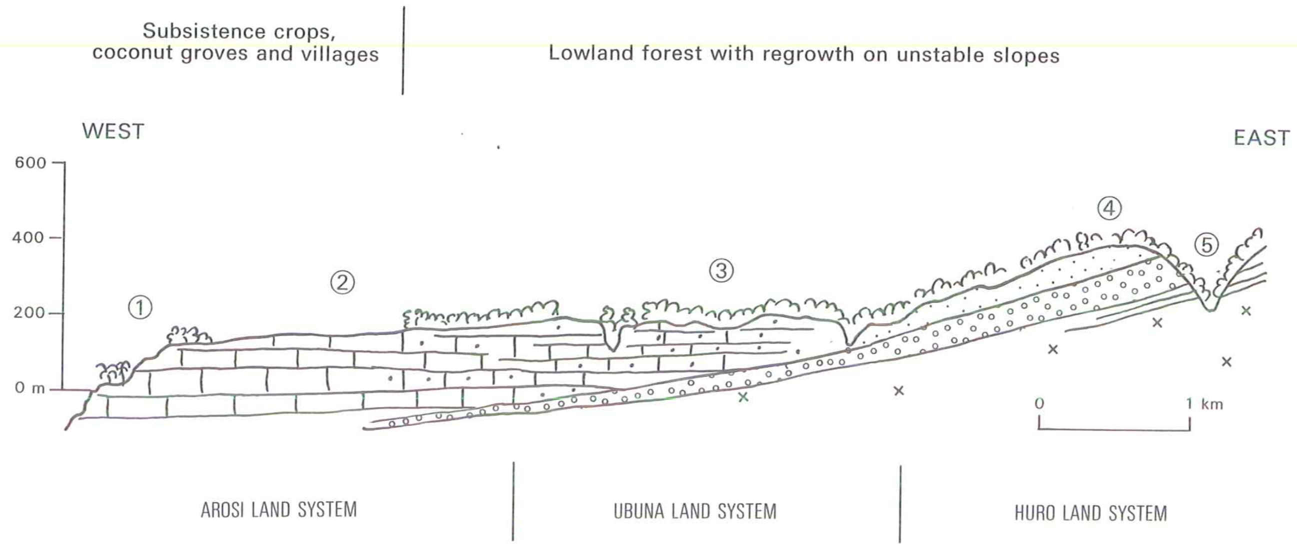
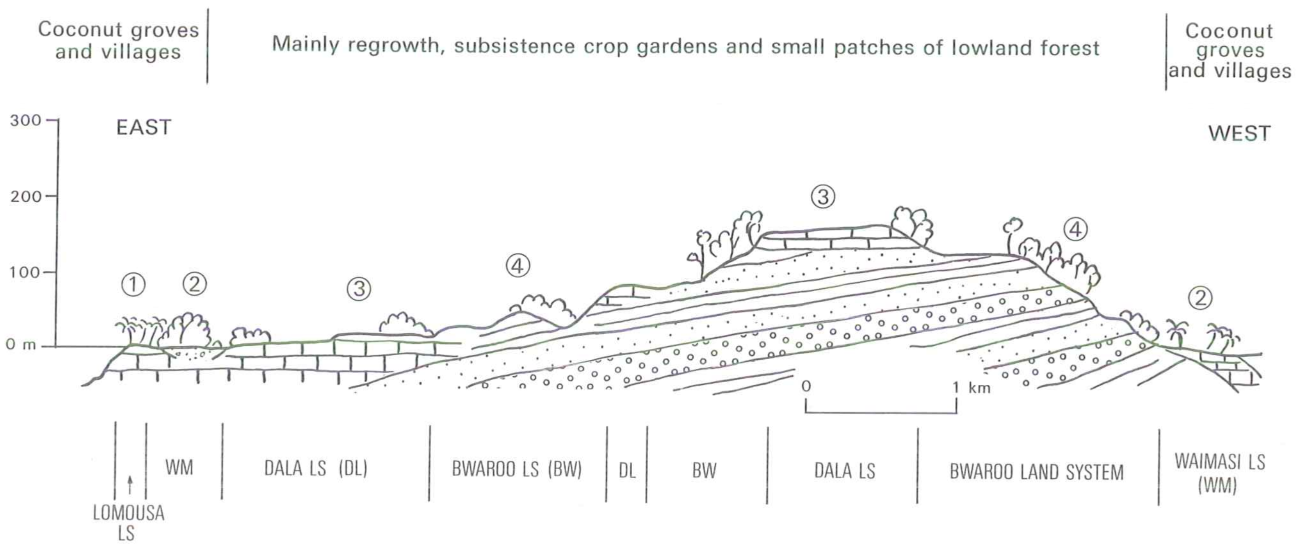


① Rendolls
② Typic Eutrorthox
③ Typic Tropudalf
④ Typic Tropohumult
⑤ Typic Eutropept

Plio-Pleistocene reef-lagoon limestone
Lower Miocene sediments
Early Tertiary basalt

FIGURE 7.4 Diagrammatic cross-section of land systems on Arosi Plateau showing lithology/landform/soil/vegetation/land use relationships



① Typic/Lithic Troporthents
② Typic Fluvaquent/Eutropept
③ Oxic Tropudalf
④ Typic Tropudalf/Eutropept

Lower Miocene sediments
Plio-Pleistocene coral limestone
Recent alluvium

FIGURE 7.5 Diagrammatic cross-section across Ugi Island showing lithology/landform/soil/vegetation/land use relationships

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Irregular Rounded Ridges

Where the Tertiary sediments of the Northern Foothills thin out southwards there are deeply dissected ridges with rounded summits corresponding with the Huro Land System.

The sediments are thin in these areas and are presumably the basal marine sediments which directly overlie basement volcanics and which commonly include conglomerate. Uplift of the land has exposed them to erosion by rivers and they now occupy mainly ridge crests and upper slopes. Basalts are commonly exposed in river beds and on the steep lower slopes.

Ridge crests are long, well-defined and range from narrow to broad. They are mostly even-profiled, rise to a maximum of 600 m and have an amplitude ranging from 50-250 m. Small ridges and spurs form offsets to the major ridges. Short slopes tend to be convex overall, but middle slopes are commonly long and straight giving way to steep, short, lower slopes with many terracettes caused by surface wash. Valleys are deep, narrow and show little floodplain development. The floors are rocky and commonly have stepped profiles. Gullies have formed on many lower and middle slopes, some reaching ridge crests.

Terraces

Included with Dala and Arosi Land System terraces are adjacent areas of the lightly dissected Ubuna Land System now forming an elevated landscape of low ridges and hills, many with flattish summits. They occur largely in the extreme west but are also found in scattered areas along the northern coastline, and on the islands to the north and east.

The height of the terraces ranges from a few metres above sea level to 560 m but it is usual for one terrace level to be dominant in any single area. In the Arosi area, the main terrace extends from the seaward edge over undissected and lightly dissected land for 5 km; elsewhere, the main terrace surface ranges from level to hilly, but the internal amplitude of relief is usually less than 50 m and hill slopes are ultra-short and moderate in steepness with short, unorientated, narrow to broad summits. Slopes are mainly stable and there are few signs of gully-head slips or debris slides.

Beneath the terraces are sedimentary sequences dominated by calcareous strata which becomes purer coastwards where reef limestone occurs. Basalts are exposed in the deepest valleys which dissect the terraces, however, and the content of terrigenous volcanic material in the former lagoonal sediments increases rapidly landwards.

The landforms are of recent origin, having been elevated from beneath the sea since the late Tertiary. Erosion has been selective in the intervening time and superficially has been concentrated into a few gorge-like major valleys with steep, long slopes. Level or gently dipping calcareous strata appear to be particularly resistant to erosion, partly because a great deal of rainwater is absorbed into underground karstic drainage systems, which diminishes the amount of surface water available for erosion. Only large rivers from the interior are capable of cutting deeply into the terraces, the smaller streams generated solely within the terraces rarely reaching the sea; this is especially noticeable on the offshore islands.

At the seaward margin of the terraces are 5-100 m high, single or stepped edges formed commonly of precipitous or cliffed limestone outcrops (Plate 7.1). Such steep slopes can also be found inland flanking both major and minor streams, but only where they pass through limestone. Slopes elsewhere are less steep.

Swamps

San Cristobal contains more inland swamps than any other island in the Solomons group. They are not extensive and occupy mainly broad valley tracts or coastal plains, being scattered more or less throughout the island except in the Central Uplands.

Tidal swamps only occur around Star Harbour, as isolated narrow strips inside some of the bays of the south coast and on the islands to the north. They are associated mainly with coral platforms which have been covered by thin layers of mud and organic debris but which still lie within tidal range. Their topography is flat and their drainage is undeveloped.

Freshwater peat swamps occur on the plains behind Wanione Bay and other north coast bays, trapped between foothills, main river levees and coastal beaches. They occupy several tens of hectares but the peat accumulations are not very deep as the basins they have formed in are only a metre or so below the constraining levees or beaches. Their topography is flat, the margins commonly diffuse and the drainage is undeveloped.

Valley swamps are also of freshwater origin. On San Cristobal they occur in the major valley floodplains at levels up to 80 m where river flow is impeded, chiefly through an insufficiently steep gradient (Stereopair 7.2). Many of those in the west and south are developing rapidly as the level of the land falls and valleys become flooded: these may contain patchy soft deep peat. The largest swamps are 8-10 km long and up to 2 km wide. Their topography is virtually level apart from areas of braided river courses in places: small lakes also occur.

Fluvial Plains and Fans

Fluvial plains are moderately well developed on San Cristobal, partly due to recent block lowering or tilting of large areas which has effectively raised the regional base level of erosion, reduced the load-carrying capacity of rivers and therefore induced large-scale sedimentation. They are found at all levels from sea level to 600 m (Stereopair 7.1). Those above 100 m, such as those in the Central Uplands, are probably relics of former erosion cycles now stranded as a result of regional uplift: these do not contain swamps and tend to be lightly incised in places resulting in low and high terraces which are rarely if ever flooded. They range in length from 1to8 km and are up to 500 m wide.

Fluvial plains close to sea level are more swampy and terraces are rare. Levees are weakly developed also and only the largest rivers have levees higher than 3 m, close to the mouths. The sediments are unconsolidated clays, sands and gravel with no coarse-grade material such as boulders except in remote headwater gullies. Flooding is common and may occur to shallow depths several times in some years.

Colluvial/fluvial fans have formed at the foothill margins of some plains and along the northern coast to the east of Wanione Bay where they form the Kopiu Land System. As on Guadalcanal and the islands of Ranongga and Rendova, they are believed to result partly from a recent slight emergence of land; this has both elevated existing alluvial land and stimulated the deposition of stony fan deposits by reactivating streams and gullies in adjacent steep foothills. These deposits are never flooded deeply but may be marshy in places where gully beds are choked with material so that seepage water is deflected over nearby land.

The topography of the fans comprises almost level to gently rolling surfaces up to 1 km wide and slopes of 1-5°, increasing inland. Small, incised, bouldery streams occur and, at the coast, coral outcrops are common, forming deeply dissected and etched cliffs some 2-5 m high.

Littoral Landforms

Beaches are common around most of the island but because of their narrow width are not possible to map in most places. They are best developed in the large north coast bays where they occupy shoreline strips as much as 500 m wide. Even in these bays, however, they rarely exceed heights of 3 m above sea level and successive beach ridge-swale formations, although visible in places, are largely subdued. Volcanic sand forms these beaches and those of the smaller south coast bays where beach widths rarely exceed 100 m, and where the marine sands are overlapped by riverine sands inland.

In the extreme east and west of San Cristobal and on the islands to the north and east are narrow beaches formed of coral debris. Their widths are narrow and they rest on coral platforms at depths of 1 metre or less.

SOILS

Introduction

San Cristobal comprises piles of basaltic lavas extruded beneath the sea, and minor associated gabbros. They have been uplifted and warped since deposition but this has not been accompanied by renewed volcanic activity with the exception of small extrusions of ultramafics. Exposure of the land surface above the sea through tectonic activity initiated erosion and deposition of sediments in the north in a shallow marine environment. Contemporaneous fringing reefs developed around the northern shoreline and subsequent, phased uplift has stranded the sediments and reefs as extensive terraces both on the mainland and as islands.

The oldest rocks are Mesozoic basement basalts but, because of prolonged and continuing erosion and dissection by rivers, the associated strongly ridged landscape contains common poorly developed young soils on steep slopes. Paradoxically, some of the youngest rocks, such as raised coral reefs, have developed into the most deeply weathered soils because they have formed a stable landscape in which surface erosion is negligible. The same situation obtains for every rock type, namely that the degree of weathering of associated soils is related directly to the stability of the landform they occur on and not to the age of the rocks they have formed from.

The mineralogy of the strata has an important influence on soil fertility and the classification of the soils. It is significant that there are no acidic, siliceous rocks present and the proportion of carbonate-rich rocks among the sediments is high. Volcanic ash may be interbedded with some of the sediments but as the nearest active volcano, Tinakula, is 360 km distant, its influence at the present time is small. Minerals of unknown composition, but probably secondary in origin, are responsible for unusual features of soils (Tropudalfs) on the offshore islands and some mainland beaches.

The effect of man on the soils is limited as no deep cultivation or manuring is practised and the long-term effect of shifting cultivation with adequate fallow periods is superficial. The effect of burning certain vegetation types periodically has led to soil degredation, however; topsoils are destroyed and only the hardiest vegetation survives. The influence of specific vegetation communities on soil development is believed to be minimal.

Unlike the islands of Malaita, Guadalcanal and New Georgia there have been no previous soil surveys on San Cristobal. The only records we can trace of samples having been taken for analysis are of the exploratory work on the western terraces by Conzinc Rio Tinto Australia to determine the nature and distribution of bauxitic earth, and three profiles described and analysed by Lee (1969).

For the present survey, 1419 soil augering profiles were described; a further 39 soils were described and sampled, mainly from pits. These have been classified into 13 great groups which are mapped as 14 soil associations (Separate Map 7d). The average observation density is only 0.5 km^2, including three high-density sample areas. It is possible, therefore, that other soils have been omitted from the lower categories of the classification.

There is not as great a range of lithology as on some of the other large islands but there is a wide variety of soils present. Within the soil classification used (USDA, 1973), six soil orders have been identified in this island group and a seventh order, the Mollisols, are believed to occur in small areas (Table 1).

The soils are described below under great group headings. In addition to these generalised accounts, descriptions and analytical data of key profiles are given in Appendix 1. The classification scheme is widely used throughout the world and, despite some technical drawbacks, enables comparisons to be made with soils in other countries. Subdivisions of the great groups are made on the basis of soil climate, types of sand and clay minerals, drainage, depth and other pedogenetic features (Table 1). Definitions of soil parameters and methods of analysis can be found in Appendix 3.

The USDA soil classification requires precise chemical data and, therefore, mainly sampled profiles have been used to establish soil classes. Augering descriptions are used as supporting data, and where great groups such as Sulfihemists have been established solely on profile morphology, without supporting analysis, they must be regarded as provisional. Soil fertility ratings in the text (defined in Appendix 3, Table 3.1) relate mostly to subsoils, since topsoils, where present, are commonly thin and have a higher nutrient status.

Detailed studies were made in three sample areas of 20-30 ha each, in land systems and areas considered to have reasonable agricultural potential (Appendix 4). Their soil pattern tends to be complex, although there is generally a clear relationship between topography facets and soil type.

TABLE 1 **United States Department of Agriculture (1973) soil classification units and major subunits with local equivalents**

Soil map unit and local equivalent	Order	Suborder	Great Group	Subgroup
A. Deep, very poorly drained, reddish brown peat or muck	Histosol	Hemist	Tropohemist	Typic Tropohemist Hydric Tropohemist
E. Deep to shallow, very poorly drained, saline brownish peat or muck			Sulfihemist	Typic Sulfihemist Lithic Sulfihemist
B. Deep, very poorly drained, grey to bluish green clay	Entisol	Aquent	Tropaquent	Typic Tropaquent
C. Deep, freely to excessively drained, pale to dark loose sands		Psamment	Tropopsamment	Typic Tropopsamment
D. Deep to shallow, excessively to poorly drained, pale stony sands and loams		Orthent	Troporthent	Typic Troporthent Lithic Troporthent
H. Deep to shallow, imperfectly drained, greyish mottled loams and clays		Fluvent	Tropofluvent	Typic Tropofluvent Aquic Tropofluvent
G. Deep to shallow, freely drained, dark brown to yellowish brown loams and clays	Inceptisol	Tropept	Eutropept	Typic Eutropept Lithic Eutropept Fluventic Eutropept
I. Deep to shallow, freely drained, brown to yellowish brown clays and loams			Dystropept	Typic Dystropept Lithic Dystropept Udoxic Dystropept

TABLE 1 Continued

Soil map unit and local equivalent	Order	Suborder	Great Group	Subgroup
O. Deep to shallow, freely to imperfectly drained, humus-rich brown to red loams and clays	Inceptisol	Tropept	Humitropept	Typic Humitropept Lithic Humitropept
L. Deep, freely drained, yellowish brown to red clay	Alfisol	Udalf	Tropudalf	Typic Tropudalf Lithic Tropudalf Oxic Tropudalf
M. Shallow, freely drained, stony dark brown clay overlying limestone	Mollisol	Rendoll	–	Lithic Rendoll
K. Deep, freely drained, strong brown to red, humus-rich clay	Ultisol	Humult	Tropohumult	Typic Tropohumult Humoxic Tropohumult
Y. Deep, freely drained, brown to strong brown clay	Oxisol	Orthox	Eutrorthox	Typic Eutrorthox Tropeptic Eutrorthox
J. Deep, freely drained, yellowish red to red clay			Haplorthox	Typic Haplorthox Tropeptic Haplorthox

A. E. Organic soils with mostly well decomposed peat (Histosols: Hemists)

Although consisting predominantly of peat these soils contain layers or patches of inorganic material and rest at generally shallow depths on rock, coral rubble or alluvium. By definition, the surface peat exceeds a depth of 40 cm or has an upper boundary within 40 cm of the surface. No mineral layer should exceed a thickness of 40 cm within the upper 80 cm of the profile. The soils are saturated for most of the year and are moderately well decomposed so that there are few identifiable plant remains.

A. Deep, very poorly drained, reddish brown peat or muck (Tropohemists)

These are the Hemists that occur in coastal or valley swamps. They are formed largely of decomposing organic matter, commonly interspersed with inorganic materials in the form of thin or discontinuous, silty flood deposits in the valleys. Underlying soil horizons are mostly riverine alluvium of mixed grade.

The coastal swamps of the Northern Plains contain only small areas of peat and even this is shallow. Valley swamp vegetation of the Western Lowlands, however, commonly occupies the full width of a valley floor and in some cases the valleys are believed, from air photograph interpretation, to contain soft (hydric) peat with very low load-bearing capacity, carrying herbaceous vegetation. These inland valleys have not been examined thoroughly in the field and it is not known how extensive the peat is or to what depths it reaches.

Peat soils from San Cristobal have not been analysed, but it is inferred that they have properties similar to those on Guadalcanal, that is, a high cation exchange capacity (CEC) and nutrients mostly in the available form (Volume 2). They are mapped as Soil Association BA.

E. Shallow to deep, very poorly drained, saline brownish peat or muck (Sulfihemists)

The distribution of Sulfihemists is taken to coincide with the distribution of mangrove forest. These swamp soils have not been examined in the field in San Cristobal and the comments below are based on descriptions from other islands.

These are the potentially acid sulphate soils that are dominantly organic. They have sulfidic materials in the surface horizons which, on exposure to air, are converted to sulphuric acid and sulphates, usually of iron and aluminium. They are more or less permanently saturated by seawater, although tides cause a degree of fluctuation of the groundwater. The organic material generally rests directly on coral platforms or coral rubble. The peat is mostly part-decomposed and contains living mangrove roots, and, in San Cristobal, is probably not more than 30 cm thick. At inland margins there is generally an increasingly large proportion of finely mixed inorganic sediment. In the field-wet condition these soils usually have a high pH and salinity, due to the abundance of bases and free salts. Only on draining and exposure to air will pH decrease, to as much as 3.0 in the absence of carbonates.

Soil Association BE contains Sulfihemists, which also occur in small areas of D.

B, C, D, H. Young soils with little or no horizon development (Entisols: Aquents, Psamments, Orthents, Fluvents)

These are young soils developing in recently deposited alluvium and beach sands, on unstable, steep slopes and on rocky outcrops where there has been insufficient time for pedogenesis to form diagnostic horizons, other than a thin, organic-stained topsoil.

B. Deep, very poorly drained, grey to bluish green clays and loams (Tropaquents)

On the alluvial plains of the northern coast, the lowlying valleys of the south coast and the inland floodplains are extensive, poorly or very poorly drained areas of lowlying alluvium and swamp. They are gleyed due to a permanently high watertable with mostly greyish, olive or greenish matrix colours (which closely resemble those of poorly drained Tropaquepts). Textures range from sandy loam to clay; some are stony and others are stratified with fine or coarse sediments resulting from frequent flooding – these are properly classed as Fluvaquents. Many Tropaquents have a dark surface peat or muck horizon a few centimetres thick.

Profiles have not been sampled in San Cristobal but elsewhere the soils are known to be base-rich with a moderate to high CEC (Volume 2). They are weakly acid to neutral, although, when adjacent to some saline swamps, soils may become strongly acid and sulphurous on drying (Sulfaquents).

Tropaquents are dominant in Soil Associations BA and BE.

C. Deep, freely to excessively drained, pale to dark loose sands (Tropopsamments)

Soils developing in young beach deposits are predominantly Tropopsamments. They are characterised by sandy textures, good to excessive drainage and depths greater than 1 m, unless resting directly on rock. Many are light-coloured but those backed by volcanic hills contain a high proportion of dark minerals which give a dark olive or dark greyish-brown overall colour to the soil. The watertable, by definition, is deeper than 50 cm and usually much deeper. At that level, the matrix colour of the profile is commonly lighter and there may be olive or reddish brown mottles.

From one profile analysed (Cristobal 35, Appendix 1), it is clear that the soil has very low exchange capacity and that the rather low levels of bases are sufficient to give a high base saturation. There is little physical impediment to restrict the movement of dissolved bases downwards until the ground watertable is reached and it is only the presence of litter and the organic-rich topsoil that both renews and retains the base status of the upper horizons. The acidity decreases with depth as the exchangeable bases increase, and in the single profile analysed there are good reserves of magnesium and phosphorus. Potassium is low in both available and total form.

Tropopsamments dominate Soil Association C and may occupy small areas of D.

D. Deep to shallow, excessively to poorly drained, pale stony sands and loams (Troporthents)

These soils consist mainly of unweathered coarse material, such as coral debris, boulder scree or some foothill colluvium. In this report they are mapped only where coral debris beaches occur; areas of bouldery Troporthents have been noted among the Rounded Ridges but these are too small to map. The coral beaches occur mainly in the western and eastern extremeties of San Cristobal and on the outlying islands: they are comparatively rare on the southern and mid-northern coasts.

Surface drainage is absent and soil development is minimal and confined almost entirely within the thin topsoil. The depth to the underlying coral platform varies widely from place to place but many profiles are less than 50 cm deep and most do not exceed 1 m. Profile Cristobal 21 (Appendix 1) is representative and shows clearly that fine soil particles are rare and that coarse sand or coral stones are dominant.

Where vegetation has been long established, the topsoil contains considerable well-humified organic matter. Phosphorus is present in the topsoil which also retains considerably more bases than the organic-poor subsoil, except for calcium which saturates the exchange complex of the whole profile. The presence of free carbonates results in an alkaline reaction with pH values of 6.5-8.0 in the topsoil, increasing to >8.6 in the lower subsoil. The level of potassium in all forms is notably low. Because of their location, many Troporthents are believed to contain non-calcareous volcanic minerals brought in by tidal action, which may be present as unweathered grains within the soil profile: pumice has been noted on beaches of the Three Sisters Islands.

Troporthents dominate Soil Association D and small areas are present in C.

H. Deep, imperfectly drained, greyish-mottled loams and clays (Tropofluvents).

These are soils that have formed in recent river-deposited sediments, but not in back-swamps where drainage is poor. They are flooded frequently and are often stratified. so that levels of carbon characteristically fluctuate with depth. The grade of sediments likewise varies both within and between profiles quite markedly. The profiles are generally well drained in the upper 50 cm; below this depth mottling may occur. The nutrient levels are determined largely by the origin of the sediments. In the coastal areas, where Tropofluvents mostly occur, the sediments are derived from basalts and mixed sedimentary rocks including common calcareous strata: profile Cristobal 34 (Appendix 1) is typical of this situation.

The CEC ranges from medium to high and appears to be dependent more on the presence of organic matter than clay; it has been noted in this connection, however, that presumed secondary aggregation of clay into fine sand particles is responsible for unusually high CEC levels in horizons with apparently little or no clay. Magnesium and calcium dominate the exchange complex giving moderate to high levels of saturation (Table 2). Potassium is deficient in both available and total form while phosphorus tends to be low in available but medium to high in total form. Total magnesium is high, probably resulting from the inclusion of considerable volcanic sand grains in the sediments. The profiles analysed are weakly acid, pH tending to increase with depth.

Tropofluvents are only common in Soil Association GH.

Figure 7.6

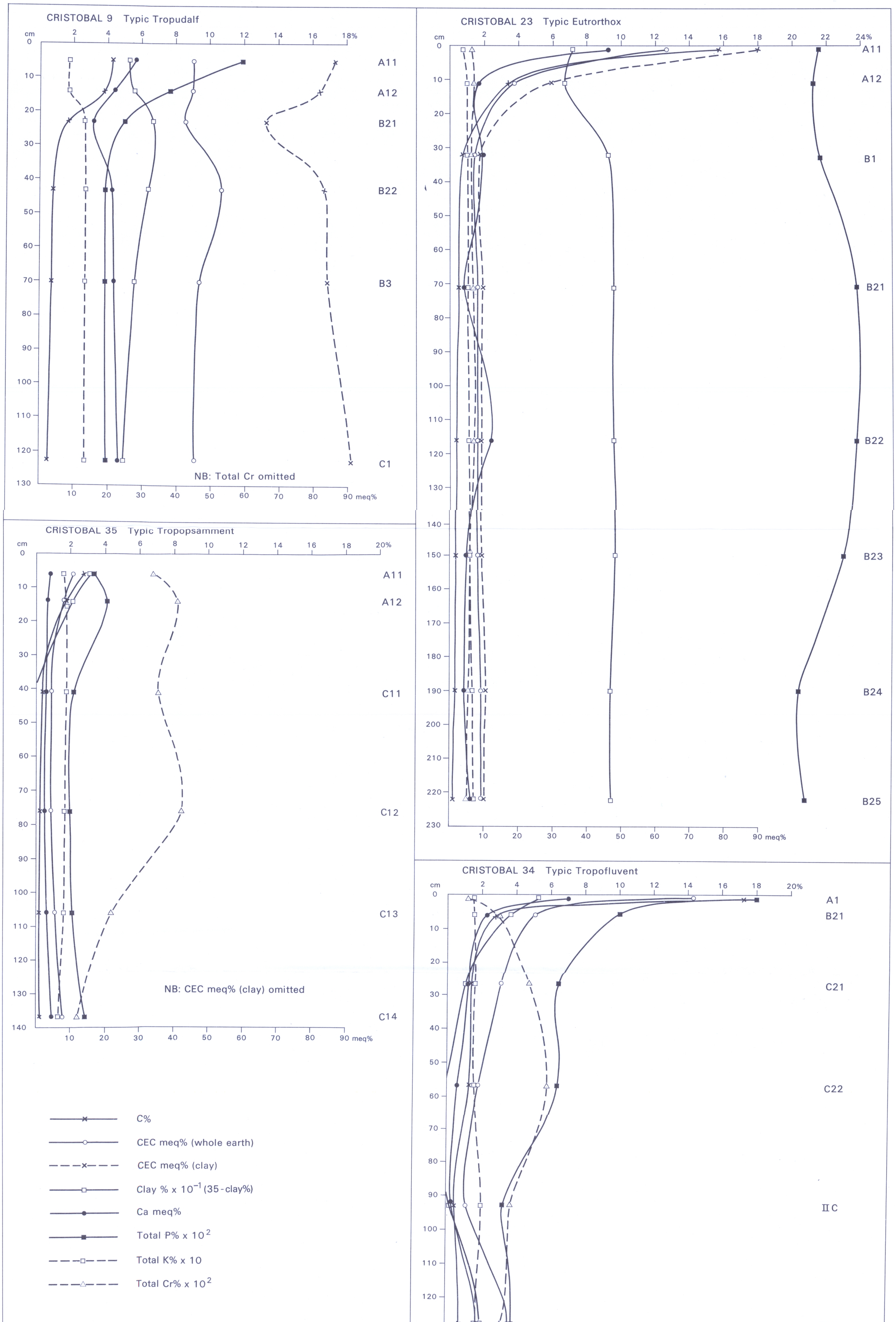

FIGURE 7.6 Changes of soil properties with depth in selected San Cristobal profiles

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TABLE 2 **Mean topsoil and subsoil analyses of three Tropofluvents**

	pH (H_2O)	Exchangeable meq %					Percentage			Total ppm			Available P ppm (Bray)
		Na	K	Mg	Ca	CEC	BS	N	C	P	K	Mg	
Topsoil 0-38 cm	6.0	0.3	0.5	6.1	19.2	34.9	67	0.47	5.6	1 270	1 540	9 075	9.7
Subsoil 38-145 cm	6.6	0.4	0.1	3.4	11.8*	20.4	61*	0.07	0.6	530	1 750	10 330	18.2

*excluding values of profile Cristobal 30 containing free calcium carbonate.

G, I, O. Slightly weathered soils with little horizon development (Inceptisols: Tropepts)

These are young soils associated with a wide range of parent materials. They are weakly structured, medium to fine-textured and, although weathering has altered some of the primary minerals, the resulting bases have not been leached far down the profile.

G. Deep to shallow, freely drained, dark brown to yellowish brown loams and clays (Eutropepts)

Eutropepts are associated with a variety of parent materials and may be found on recent alluvium, colluvial fans, and among the steep ridges of the interior as well as on the less deeply dissected coastal lands. They are largely well drained, rich in bases, dark coloured and tend to be stony.

On the alluvial plains of the northern coast extensive areas of well or imperfectly drained land lie between coastal beaches and backswamps. These are infrequently flooded, if at all, and consist of yellowish brown loams or clays, commonly becoming sandy in the deep subsoil where mottling may also occur. Profile Cristobal 10 (Appendix 1) is an alluvial Eutropept. Its base saturation is high with high exchangeable levels of all bases, and reserve nutrients, except potassium, are moderate to high. Leaching has not been very effective.

Similar soils occur on the colluvial outwash fans of the northern coast (Kopiu Land System). They are more steeply sloping, stonier and darker and are never flooded, but some receive subsoil seepage water from small streams and foothill springs. Cristobal 27 (Appendix 1) typifies this kind of soil and shows rather low cation exchange capacity dominated by calcium and magnesium, low potassium status and high total magnesium reaching 2.3%. The acidity decreases with depth to become nearly neutral in the deep subsoil.

Steeply sloping hillsides in which surface erosion is active contain Eutropepts, particularly where sedimentary rocks outcrop, but also over basalts if sedimentary rocks occur on the summits. They are commonly but not necessarily stony, dark coloured and loamy or clayey. Chemically, the soils are closely similar to those described above but may have higher levels of calcium. There is no great differentiation in properties with depth apart from those linked with organic matter which show gradual decrease from the topsoil to deep subsoil.

From Table 3 it can be seen that the Eutropepts are fertile, with the exception of their potassium status whose availability is further depressed by high values of bases such as sodium and magnesium.

TABLE 3 **Mean topsoil and subsoil analyses of four Eutropepts**

	pH (H2O)	Exchangeable meq %					Percentage			Total ppm			Available P ppm (Bray)
		Na	K	Mg	Ca	CEC	BS	N	C	P	K	Mg	
Topsoil 0-13 cm	6.2	0.6	0.6	11.0	24.7	44.1	78	0.41	5.3	850	1 850	13 300	10.0
Upper subsoil 13-66 cm	6.5	0.6	0.4	13.4	28.6	50.3	85	0.09	1.0	340	1 810	18 000	8.9
Lower subsoil 66-147 cm	6.6	0.7	0.2	11.6	23.1	42.8	84	0.04	0.6	310	2 090	19 600	11.0

Eutropepts are dominant in Soil Associations G, GH and GLO and present in LKG and KOG

I. Deep to shallow, freely drained, brown to yellowish brown loams and clays (Dystropepts)

No profiles analysed from this island group have been classed as Dystropepts. However, on the basis of comparison with the other major islands, it is considered that they are likely to occur over the basement basalts of San Cristobal where slopes are steep, surface wash is active and there is therefore continual rejuvenation of the profile. In addition, one of the chief criteria of Dystropepts is a base saturation of less than 50%. This same feature is present in Humitropepts and Ultisols, both of which are known to occur on San Cristobal.

On the other major islands Dystropepts are brownish, rather shallow, and stony loams or clays. Reserve nutrients are moderate or low, except for magnesium, and the supply of available nutrients is moderate, except for low values of potassium. Profile Guadalcanal 22 (Appendix 1) is an example.

Dystropepts are believed to be common only in Soil Associations JI and KI. They are possibly less common than elsewhere because of the widespread distribution in northern coastal areas and on ridge summits of base-rich sedimentary rocks.

O. Deep to shallow, freely to imperfectly drained, humus-rich, brown to red loams and clays (Humitropepts)

Humitropepts are commonly found at medium to high altitudes where it is presumed that the rate of accumulation of organic matter exceeds the rate of breakdown. On Cristobal profiles occur at 1 000 m and 800 m; a third on Santa Ana lies at only 140 m. They are characterised by high contents of organic carbon in the surface horizons and low base saturation. Depths are varied and their subsoil colours range from yellowish brown to red. They are believed to be widespread in San Cristobal on the broad summit areas of the Ravoraha Land System in the Central Uplands, particularly where low, dense ridge forest occurs (unit Frm on Map 7h).

The nutrient status of these soils is poor, with all exchangeable bases and commonly available phosphorus being low. Reserve phosphorus levels are moderate to high, however, and contrast with low potassium and magnesium, both of which tend to increase with depth. The soils have a strongly acid topsoil with a wide C:N ratio, decreasing in acidity in the lower subsoil where the C:N ratio is narrower. The clay fraction is commonly well weathered, to the extent that they can be classed oxic. Profile Cristobal 11 is considered typical of the Humitropepts (Appendix 1).

Humitropepts are only common in Soil Association GLO.

L. Moderately to strongly weathered and leached soils with high base status (Alfisols: Udalfs)

These are reddish or brownish soils formed mainly on base-rich parent materials and with a base saturation exceeding 50%. They are associated largely with gentle or moderate slopes.

L. Deep, freely drained, yellowish brown to red clay (Tropudalfs).

Tropudalfs appear to be widespread in the Northern Foothills, particularly, and have been identified on the basaltic ridges of the Western Lowlands and Central Uplands, although even on the latter rock types it is believed that there may be admixtures of limestone or other base-rich sediments to account for the high levels of calcium and magnesium. Over marine terraces with stable gentle slopes the oxic, strongly weathered subgroup occurs, while on steep slopes of dissected hills and ridges the typic subgroup is dominant: on steeper slopes surface erosion may have removed the light-textured upper subsoil or topsoil completely so that the required presence of an argillic horizon has to be inferred from descriptions of clay skins in the deeper subsoil.

The Typic Tropudalfs have a wide range of subsoil colours, from yellowish brown to red, although dark reddish brown, dark yellowish brown or brown to dark brown are most common. The textural B horizons are clayey with values between 45-85%, the exceptions being those on the Dala Land System (see oxic subgroup below). Internal drainage is free and profiles are predominantly deep except over limestone where the highly irregular surface of the rock causes patchy shallow soils to occur.

Profile Cristobal 9 (Appendix 1) is considered characteristic of the Typic Tropudalfs; mean chemical values of seven profiles are shown in Table 4 without including those of two profiles whose features are more conveniently discussed with the oxic subgroup. The clay fraction of the soils is not strongly weathered and remains active. The base saturation is high, however, as a result of high calcium values, to the extent that in some topsoils and lower subsoils, the exchange capacity is fully satisfied. Monovalent cations are characteristically low in most profiles, especially potassium. Total magnesium is high and levels of total and available phosphorus range from low to high: there is a distinct accumulation of all forms of phosphorus in the topsoil. The acidity of the topsoil is moderate, but in all profiles decreases with depth to become, in some cases, neutral or weakly alkaline in the lower subsoil, where base saturation is greatest. Levels of carbon are higher than in many soils and are probably responsible for the common dark colours: the carbon is moderately well humified in the topsoil to judge by the C:N ratio, but the ratio narrows even further in the subsoil.

TABLE 4 **Mean topsoil and subsoil analyses of seven Typic Tropudalfs**

	pH	Exchangeable meq %					Percentage			Total ppm			Available	Clay	Clay
	(H_2O)	Na	K	Mg	Ca	CEC	BS	N	C	P	K	Mg	P (Bray) ppm	%	CEC meq %
Topsoil 0-20 cm	6.2	0.4	0.3	7.1	29.8	47.3	85	0.58	6.76	935	1 820	7 575	10.3	46	100.6
Subsoil 20-86 cm	6.3	0.4	0.3	8.0	23.5	43.0	74	0.12	0.93	570	2 615	10 895	7.1	60	80.0

On the terraces of the offshore islands are distinctive soils coloured reddish brown or dark reddish brown (Plate 7.2). They are of varied depth and overlie coral limestone which has a highly irregular upper surface. Field textures of these soils are clayey but routine mechanical analysis, using 15 min of ultrasonic dispersion, yields very low amounts of clay. Prolonged ultrasonic treatment for 2 hr, however, increases the amount of clay considerably and it is assumed that there has been secondary aggregation of clay-size minerals, possibly during the drying out of samples prior to analysis. Most of the terrace soils have been strongly weathered and have a sufficiently low clay CEC to be classed as Oxic Tropudalfs; others do not quite qualify on this account and in the classification scheme used are typic. However, from several points of view these soils are closely similar and it is convenient to consider them together.

Clay weathering apart, the oxic subgroup has a noticeably high phosphorus status with up to 4.2% being present in Cristobal 16, and a tendency for phosphorus to accumulate in the topsoil. Magnesium values are considerably less than in the typic subgroup, which emphasises the dominance of weathered limestone products in the exchange complex: limestone occurs throughout, and the subsoils of all profiles are alkaline. Profile Cristobal 17 is a representative profile (Appendix 1).

Tropudalfs are dominant in Soil Associations LKG and LM and are common in KL, KLJ and GLO

TABLE 5 **Mean topsoil and subsoil analyses of three oxic tropudalfs and two typic tropudalfs from the Dala Land System**

	pH (H_2O)	Exchangeable meq %					Percentage			Total ppm			Available P (Bray) ppm	Clay %	Clay CEC meq %
		Na	K	Mg	Ca	CEC	BS	N	C	P	K	Mg			
Topsoil 0-11 cm	6.6	0.2	0.3	2.5	27.9	32.9	90	0.72	8.97	10 805	830	1 750	27.0	36	140.9
Subsoil 11-45 cm	6.9	0.2	0.1	0.6	21.9	16.9	92	0.40	4.54	11 190	770	1 510	15.9	63	34.1

M. Moderately weathered soils with a thick dark topsoil and high base status (Mollisols: Rendolls)

Elsewhere, these soils are closely associated with limestone parent materials and are found over coral terraces and karst landscapes: they are freely drained, strongly structured, have a relatively thick, dark-coloured, humus-rich surface horizon, and contain high levels of calcium carbonate. In this island group, however, soils over limestone largely appear to be too red in colour to qualify for Mollisols and because of this are classed as Alfisols. Even in intensively examined sample areas on Ugi and Arosi (Appendix 4), the number of descriptions with deep, dark topsoils is few and, although the organic carbon content is high, it is concluded that mostly this is masked by red-coloured free iron oxides.

M. Shallow, freely drained, stony, dark brown clay overlying limestone (Rendolls)

In those parts of the terraced landscapes of the Dala and Arosi Land Systems where soils are commonly shallow, namely their coastal margins, it is probable that Rendolls occur. Typically, they are less than 50 cm deep, dark, rich in organic matter and rest abruptly on fissured limestone. The clay content is high, moderately active and saturated with calcium. Potassium is notably deficient but phosphorus levels are high.

Rendolls are present in Soil Associations LM and YM.

PLATE 7.1 A wave-cut notch with its base now 3m above sea level, cut into the terrace margin of the Arosi Land System, western San Cristobal.

PLATE 7.2 Weathered reddish brown clay loams overlie Pleistocene to Recent coral terraces on Ugi Island. More strongly weathered soil occupies fissures in the irregular coral surface.

Related soils, the Udolls, have been identified on other islands where calcareous sediments occur. They are deeper, more leached and may have an increase in clay with depth. One such soil has been analysed on San Cristobal where, unexpectedly, it overlies ultrabasic rock (profile Cristobal 7). It consequently has unusual chemical features, namely very high total magnesium levels (almost 11% in the subsoil) and more exchangeable magnesium than calcium; the heavy metals chromium and nickel also have above-normal levels. This Hapludoll is not believed to be extensive.

K. Strongly weathered and leached soils with a low base status (Ultisols: Humults)

These are soils of hills and ridges with stable slopes not subject to erosion. They are deeply weathered soils from which soluble bases have been leached out of the profile. There is much humified organic matter at the soil surface, which distinguishes Udults from Humults. Udults have not been identified on San Cristobal and on steeper slopes subjected to surface wash, where they might be expected to occur, argillic horizons have not formed and the soils are classed as Tropepts.

K. Deep, freely drained, strong brown to red, humus-rich clay (Tropohumults)

Tropohumults are probably widespread in San Cristobal, particularly on upper and crestal slopes of the inland hills and ridges developed from basaltic rocks. On the sedimentary, commonly calcareous rocks of the Northern Foothills the continual release of bases by weathering is liable to result in Alfisols, except on the most level of sites. At high altitudes inland the breakdown of organic matter at the surface on stable slopes is delayed by cool temperatures and high rainfall, so that surface humus accumulates: in these areas Tropohumults are associated with Humitropepts.

The soils are deep, commonly stone free and have poorly developed, blocky structure with friable to firm consistence. Internal drainage is free and any deep subsoil mottling is due to fragments of weathering parent material.

The soils are deeply weathered on the whole, as shown by their low clay CEC. Partly because of the low clay activity leaching has removed soluble bases; in the deeper profiles this results in exchangeable cation peaks in the topsoil, where bases are held by humus colloids, and in the deep subsoil where minerals and are still being released by weathering.

The high levels of organic carbon in the topsoil are matched by high base levels, phosphorus and cation exchange capacity: the organic matter is less well decomposed than in the subsoil and more acid. Subsoil nutrients have low to medium values and are dominated by calcium and magnesium; levels of exchangeable and total potassium are higher in some subsoils than expected and must be attributed to the presence of a potassium-bearing mineral in the parent rock. Total magnesium in some profiles is high, particularly in the lower subsoil. Profile Cristobal 5 (Appendix 1) shows many of the features described above but the clay weathering is rather less strong than in some Tropohumults.

Tropohumults are dominant in Soil Associations KI, KL and KLJ and are common in LKG.

Y, J. Very strongly weathered and leached soils (Oxisols: Orthox)

This group of soils occurs over a wide range of parent materials but only on stable sites. They are deep, weathering is advanced and leaching of bases has thoroughly depleted the profiles of nutrients in the Haplorthox; the Eutrorthox, being formed from calcareous rocks, have retained vestiges of their limy parent material.

Y. Deep, freely drained, brown to strong brown clay (Eutrorthox)

These are soils with a base saturation exceeding 35%. They are underlain by limestone and occur largely on the terraces of the Arosi Land System where slopes are gentle, and prolonged and deep weathering has been unimpeded by surface erosion. Surface drainage in these areas is minimal and almost all rainwater is absorbed and available for leaching of bases released by weathering. The breakdown of minerals has produced clay-rich, weakly structured profiles with very little coarse subsoil material: Cristobal 23 (Appendix 1) has 92-96% subsoil clay and no coarse sand.

The brownish colours result in part from the presence of high amounts of carbon in the upper subsoil. There is insufficient, however, to class the soils as Haplohumox. A feature of the subsoil organic matter in the four profiles analysed is the narrow C:N ratio of as low as 4.8 (Table 6) which is not equalled by Eutrorthox in the New Georgia Group for example (Table 8, Volume 4).

In places, there is a tendency for pH levels to decrease below the topsoil to become acid at depths of 1.5-2 m unless the weathering calcareous parent material is encountered. The exchangeable base status is low beneath the topsoil, even calcium barely attaining medium levels. This, however, is sufficient to give a relatively high base saturation since the CEC is so low. A characteristic feature of these Eutrorthox is their high total phosphorus, a feature largely inherited from the parent material since the levels tend to increase with depth. Both total potassium and magnesium are low. Eutrorthox occur in Soil Association YM.

TABLE 6 **Mean topsoil and subsoil analyses of four Typic Eutrorthox.**

	pH (H_2O)	Exchangeable meq %					Percentage			Total ppm			Available P ppm (Bray)	Clay CEC meq %
		Na	K	Mg	Ca	CEC	BS	N	C	P	K	Mg		
Topsoil 0-30 cm	5.9	0.4	0.3	4.4	26.3	33.9	91	0.61	7.23	4 080	1 010	2 720	23.5	60.3
Subsoil 120 cm	6.2	0.1	0	0.6	5.9	7.1	79	0.08	0.50	3 930	1 180	2 490	23.8	9.5

J. Deep, freely drained, yellowish red to red clay (Haplorthox)

This soil is not common in San Cristobal and appears to be confined to scattered level ridge top sites over either sediments or volcanics. It is a strongly weathered, friable, red clay, with a weakly developed anglular blocky structure. Organic matter has not accumulated at the surface in the few profiles identified as Haplorthox in spite of the apparent lack of surface erosion and they do not, therefore, resemble the Haplohumox of New Georgia in this respect. It is possible that Haplohumox occur at high altitudes in the Central Uplands in association with Humitropepts and Tropohumults.

The Haplorthox differ from the Eutrorthox in having a base saturation of less than 35%. This is not due so much to the CEC as to the lower levels of bases, calcium in particular. All exchangeable bases are low, and total potassium, magnesium and commonly phosphorus rarely exceed low levels down the profile. Topsoils are markedly acid and pH levels rise little with increasing depth. Topsoil organic matter tends to be raw with a C:N ratio of up to 50. Profile Cristobal 4 is a typical example (Appendix 1).

It should be noted that while there is no analytical evidence for Haplorthox in the Marapa Land System, the soils on it elsewhere are so uniformly and deeply weathered that their presence, and that of the more highly weathered Acrorthox, seem certain. They can be expected to contain unusual quantities of heavy metals such as chromium and nickel (Table 12, Volume 2).

Haplorthox are only mapped in Soil Association JI in which they are believed to be common.

CURRENT LAND USE

Introduction

The inhabitants of San Cristobal, like those of the other large islands in the BSIP, have only become coastal dwellers during this century. Previously, they lived inland in small, easily defensible villages. This movement away from the interior was well under way before World War II, largely encouraged by both the missions and European administration. The depopulation of the interior was speeded up during 1945-47 with the advent of Marching Rule, a nativistic cult which spread to San Cristobal from Malaita. This movement encouraged the abandonment of the small, isolated inland villages in favour of large, well laid-out coastal settlements where the regimentation and self-help characteristics of the movement could be most effective. At the present time, inland villages remain only between the Ravo and Maghoha Rivers, along the Warihito River and along the east coast hills between Wanione and the Harigha River.

The northern coast of San Cristobal, which includes the district headquarters at Kirakira, has almost twice the population of the southern coast. Along the southern coast the population of 3 200 is unevenly distributed; less than 1500 live in the 95 km between Makira Harbour and Mwaniwowo and the remaining 1700 occupy either end of the island over a combined length of coast of 40 km. The area to the west of the Wainaraha River, the Arosi sub-district, has a population in excess of 2500 people, 28% of San Cristobal's population, yet it is the smallest administrative district, covering only 14% of the island. The population of Ugi, which totalled 817 in 1970, includes more than 400 school children attending the three mission schools on the islands. Population figures for San Cristobal and adjacent islands are shown in Table 7.

TABLE 7 **Population and population densities (1970)**

Island	Area km^2	Population	Density km^2
San Cristobal	3090	8916	2.6
Santa Ana	14	756	54
Santa Catalina	5	345	69
Ugi	42	817	19
Three Sisters	11	87	8
Total	3162	10 921	3.5

For some years, an unmetalled road suitable for four-wheel-drive vehicles has been open between the Ravo River and Waiae Bay and although this is now being upgraded on the stretch between Kirakira and the Wairaha River the problems of fording the rivers, when they are in flood, remains. Elsewhere on San Cristobal, communication between villages is by narrow footpaths and by sea.

Shifting cultivation

Subsistence farming is practised throughout San Cristobal and the adjacent islands but the degree of intensity and the crops grown vary from area to area. Land was formerly allowed to return to forest after being cultivated for 1-3 years and then was not used again for subsistence crops until it was judged, by the nature of the regrowth, that the site was again suitable for food crops. Where there was abundant customary land this period of fallow could vary between 5 and 20 years: where customary land was limited, the fallow period was shorter. To obtain maximum use of the arable land on islands such as Santa Ana surface stones were piled up to form walled enclosures which served the dual purpose of releasing more land for cultivation and protecting crops from the foraging of pigs. As in all the large islands, the hilly nature of the land does not appear to be a decisive factor influencing the choice of garden sites. Any land that is accessible from the village that is not so steep as to be unstable, is liable to be used as garden land and this results in land with slopes in excess of 30° being widely used for subsistence crops. Sweet potato (*Ipomoea batatas*) is widely grown throughout the islands and in most coastal areas it has replaced taro (*Colocasia esculenta*) as the staple crop.

On San Cristobal there is a shift in the emphasis placed on the staple food crop from west to east. Sweet potato is widely grown throughout the island but, whereas it is the dominant crop in the west and along the northern coast, it is less important over the remainder of the island where taro and bananas (*Musa* spp.) became dominant. Thus a division of the island on the basis of subsistence crops can be made with sweet potato and yams (*Dioscorea alata and Dioscorea esculenta*) to the north and west, and banana and taro-dominated crop husbandry in the south and east. These are not mutually exclusive zones and all crops occur throughout the island, but in their separate areas each group dominantes the pattern of subsisitence cropping. This division of crop types coincides with a change in the rainfall distribution over the island. The south, eastern and central high areas are exposed to the south-easterlies, which bring much of the rain to the island during June to September. This results in an average annual rainfall in excess of 6000 mm at Mwaniwowo mission on the coast, which can be expected to increase inland. By comparison, areas to the west and north are in the rain shadow of the central mountains and consequently receive less rainfall, as is shown at Pawa on Ugi Island, which has a mean annual rainfall of less than 3500 mm.

The importance of bananas in the San Cristobal diet has been noted by Tedder (1973) who mentions 22 different edible varieties. Taro was formerly widely grown on Santa Ana but has now been largely replaced by sweet potatoes.

Cash crops

Coconuts

San Cristobal and the adjacent islands supply some 8% of the Protectorate's copra, the bulk of which is produced from trees owned by Solomon Islanders on San Cristobal. Several coconut estates were established by Europeans, mainly on the northern coast of San Cristobal and Ugi islands, during the first two decades of this century; by 1931, they covered 1045 ha. Copra production from these estates totalled 661 t in 1931 (Robson. 1934), a yield of 930 kg/ha.

Although San Cristobal was not affected by the fighting or occupied by the Japanese during World War II, all estate labourers were returned to their villages at the outbreak of hostilities and all European estates were abandoned for the duration of the war. After the war Marching Rule leaders imposed a boycott forbidding their followers to work as plantation labourers and this, combined with the effects of the war, ruined many small planters. By the early 1950's, only those planters who were prepared to treat Solomon Islanders in a humane and fair way managed to obtain workers (Cochrane, 1970).

The largest expatriate-owned estates in the area are those of Levers Pacific Plantations Proprietary Limited on the two southern islands of the Three Sisters. These estates originally covered 390 ha but by 1971 the area of productive coconuts had been reduced to 330 ha with an average annual production between 1968 - 1973 of 348 t. Pre-war coconut production figures do not include Solomon Islander-owned coconuts. Consequently, no direct comparison can be made with post-war production by islanders. Since the war, copra production on San Cristobal by islanders has exceeded that of plantations but, on the Three Sisters, where there are no native-owned coconuts, and on Ugi Island, plantation production still dominates.

PLATE 7.3 In the foreground a degraded vegetation of ferns and low shrubs, that are frequently fired, covers areas of the Marapa Land System developed over ultramafic rocks. The forest behind contains *Casuarina papuana,* a tree that is characteristic of this land system.

PLATE 7.4 Alluvial soils of the Waimasi Land System are utilised for arable crops, pastures and coconuts at Alangakaula School, Ugi Island. In the distance, terraces of the Dala Land System mark the northern end of Selwyn Bay.

Two cyclones, which badly affected San Cristobal and Santa Ana in late 1971, coupled with a low market price for copra during 1972, resulted in a fall in copra production from the former and a cessation of production from Santa Ana and Santa Catalina. Copra production figures over the last 6 years for both Solomon Islanders and plantations for the main islands are shown in Table 8, and the area under coconut cultivation in Table 9 (4570 ha in 1971).

TABLE 8 Copra production from San Cristobal and adjacent islands, 1969-73

	Santa Ana/ Santa Catalina		Ugi		Three Sisters		San Cristobal		Total tons
	S.I.	Plant.	S.I.	Plant.	S.I.	Plant.	S.I.	Plant.	
1969	20	0	60	61	0	332	1478	17	1968
1970	6	0	30	58	0	327	1507	10	1938
1971	8	0	33	40	0	559	1669	13	2322
1972	0	0	1	39	0	272	1294	78	1684
1973	0	0	12	52	0	240	936	13	1253
1974	–	–	81	46	0	346	1322	106	1901

Other cash crops

Neither San Cristobal nor the adjacent islands were affected by the cocoa-planting boom of the late 1950's and only a few trees were planted, mainly on mission land. No cocoa has been produced from these islands and no trees were noted during the survey.

Cattle

The pre-war cattle population of San Cristobal and the adjacent islands was 400 head in 1931 (Robson, 1934). This had increased to 539 in 1967 (Blair Rains, 1969) and 974 in 1973 (Eele, 1974). All the cattle in the pre-war census were owned by plantations where their main task was to reduce the undergrowth beneath the coconuts. During the war, when maintenance of the estates ceased and many were abandoned, numbers of cattle were slaughtered or became feral, particularly on the Three Sisters.

A feature of the post-war increase in cattle on San Cristobal and Ugi Islands has been the development of Solomon Islanders- and mission-owned cattle herds. In 1973 islanders owned 286 head of cattle, (29% of the cattle in the Eastern District) 150 of which were in three herds on Solomon Islander-owned plantations. The remaining 136 head are divided amongst 38 herds (on average, less than four animals per herd). Cattle on expatriate plantations in the Eastern District numbered 395 in 1973 (Eele, *op cit*), 40% of the cattle population; these are confined to two herds on the southern islands in the Three Sisters group.

Land use pattern

The land use map (Separate Map 7f) of San Cristobal and adjacent islands is derived from air photograph interpretation. Complete cover was flown in 1971 at scales of between 1:36 000 and 1:43 000 for all islands except the Three Sisters which was covered by 1:16 000 scale photography. Unfortunately the photography of Santa Ana, taken at the end of a photographic run, was slightly oblique so that the air photographs could not be plotted accurately after interpretation. The 1962 photography at a scale of 1:60 000 was then used as a base land use pattern onto which modifications to the land use since that year were inserted. The land use map for the whole island group, therefore, represents existing land use between September and December 1971.

The small size of many individual clearings and the limited period that they are under cultivation leads to difficulties in interpretation. At the photo scale used there is a recognisable distinction between present subsistence gardens and formerly cultivated areas now under old garden regrowth. Present subsistence gardens are defined as land that is being currently cleared, cultivated, or has been recently abandoned and is covered in low mainly herbaceous regrowth. On the photography, this category is recognisable by its checkerboard pattern, low vegetation height and associated light grey tone. The nature of the farming practices used often results in a gradual transition between the different land use units; subsistence gardens commonly merging into older garden regrowth, and each occurring as pockets with the other.

Older garden regrowth is clearly distinguished from present-day gardens and can usually be distinguished from well established secondary and primary forest by the low (<5m), generally uniform, regrowth canopy which is dominated by quick-growing, light-demanding species and by its irregular patchwork appearance reflecting the different ages of the regrowth. The practice of not felling economically useful trees results in individual, large-crowned trees standing as emergents above a low, fine-crowned canopy. The age of the regrowth cannot be accurately estimated from the air photographs as factors affecting plant growth vary considerably at different sites.

Areas were measured on the 1:50 000-scale land use maps using a dot grid; this method incorporates a degree of error which increases as the size of the area measured diminishes. Some of the smaller areas have a measuring error of as much as 10% and all figures have been rounded to the nearest 5 hectares. To check the accuracy of the method used, an area of coconuts on Malaupaina, the largest island of the Three Sisters, was measured and compared with the original ground survey completed after planting in 1928. The dot grid method was 6% less than the 1928 ground survey which, allowing for the mortality of coconuts planted in swampy areas, probably results in a correlation to within 2-5%. Land use by land systems and islands is shown on Table 9.

A feature of the land use map of San Cristobal is the narrow strip of cultivated land along the north coast from Maro'u Bay to Star Harbour, interrupted by undeveloped land only on small areas north of Waimasi Bay and north and south of Monitawa. There is an almost unbroken line of coconut plantations and small-holdings along the coast from Maro'u Bay to the Wairaha River with areas of garden and garden regrowth fingering inland along valleys. The western extremity of San Cristobal to the vicinity of Tawaraha has an intricate mosaic of subsistence gardens and coconut groves which extends along the south coast to Oneibia. The steep, cliffed edge to the Arosi Plateau has prevented cultivation around Bwarariu Point, but gardens and small plots of young coconuts have recently been cultivated on the plateau surface. Settlements and their associated garden areas and coconuts are dispersed along the southern coast of the island in small bays that provide some shelter from the heavy seas that build up during the south-easterly season. The cultivated land between Apaora and Tetere is predominantly on steep slopes as there is little alluvial or littoral land along this part of the coast. In contrast, villages around Marunga Harbour between the Apurahe River and Wainaworasi have most of their gardens and coconuts on the wide alluvial valleys that penetrate into the mountains and until recently they have not needed to use the steeper valley sides except for small plots of taro. Now that much of the coastal alluvium has been planted with coconuts, however, areas are being cultivated for subsistence gardens and coconuts on the hill slopes. The southern coast from Wainaworasi to Mwaniwowo is sparsely settled as the mountains descend steeply into the sea and alluvial areas are limited to the heads of a few bays.

There is an intensively used area of land centred on Mwaniwowo in association with the mission and school, but eastwards there are again scattered villages as far as Gheta village. To the north and east of Gheta village, the Surville Peninsula is extensively used for both subsistence and cash crops. The peninsular is less than 4 km wide and the north-flowing rivers have low watersheds that are in places within a hundred metres of the south coast. Movement of produce and goods across

TABLE 9 San Cristobal and adjacent islands, area of land use within land systems, 1971

Land systems	Total area	Subsistence gardens and young regrowth		Old garden regrowth		Coconuts		Pastures and arable crops		Towns, villages and airstrips		Total used area	
	km²	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
SAN CRISTOBAL													
Arosi	85	480	6	725	9	680	8	—	—	55	<1	1 940	23
Bwaroo	134	225	2	260	2	100	<1	—	—	10	<1	595	4
Huro	405	275	<1	800	2	55	<1	—	—	10	—	1 140	3
Kopiu	19	240	13	290	15	410	21	—	—	35	2	975	51
Kumotu	12	20	2	20	2	50	4	—	—			90	8
Lomousa	11	65	6	75	7	640	58	—	—	45	4	825	75
Marapa	18	—	—	—	—	—	—	—	—	—	—	—	—
Pusuraghi	68	145	2	240	3	40	<1					425	6
Ravoraha	213	15	<1	80	<1	—	—	—	—	5	<1	100	<1
Tenaru	18	165	9	390	22	855	48	—	—	45	2	1 455	81
Ubuna	99	45	<1	160	2	50	<1	—	—	10	<1	265	2
Waimasi	148	860	6	2 085	14	465	3	20	<1	30	<1	3 460	23
Wainari'i	690	320	<1	170	<1	225	<1	—	—	10	<1	725	1
Wakora	1 169	65	<1	1 680	1	180	<1	—	—	30	<1	1 955	2
Total	3 089	2 920	1	6 975	2	3 750	1	20	<1	285	<1	**13 950**	4.5
UGI													
Bwaroo	16	90	7	410	26	25	1	5	<1	10	<1	540	34
Dala	12	35	3	75	6	10	1	—	—	—	—	120	10
Lomousa	4	5	1	5	1	260	66	10	2	20	5	300	75
Pusuraghi	5	30	6	10	2	15	3	—	—	—	—	55	11
Waimasi	5	45	9	40	8	75	15	30	6	<5	1	195	39
Total	42	205	5	540	13	385	9	45	1	35	1	**1 210**	29
THREE SISTERS													
Dala	3	—	—	—	—	70	23	—	—	—	—	70	23
Kumotu	3	—	—	—	—	20	7	—	—	—	—	20	7
Lomousa	5	—	—	—	—	240	48	—	—	<5	1	245	49
Total	11	—	—	—	—	330	30	—	—	<5	<1	**335**	30
SANTA ANA/SANTA CATALINA													
Dala	16	235	15	100	6	45	3	—	—	—	—	380	24
Lomousa	2	20	10	—	—	65	33	—	—	<5	2	90	45
Wakora	1	30	30	5	5	—	—	—	—	—	—	35	35
Total	19	285	15	105	6	110	6	—	—	5	<1	**505**	27
Total	**3 161**	**3 410**	**1**	**7 620**	**2.5**	**4 575**	**1.5**	**65**	**<1**	**330**	**<1**	**16 000**	**5**

the peninsular to an all-weather harbour at Star Harbour is easy; Na Mugha, in addition to having a jetty, has a clinic and an agricultural field office. The western part of Star Harbour is fringed by mangrove swamp which is in turn commonly backed by fresh-water swamps. The area is thus much less populated than the central area.

The central sector of Santa Ana south and east of Lake Wairafa has long been the agricultural nucleus of that island. The area is dominated by subsistence crops, whilst coconuts are largely grown on the sandy and rocky coastal soils. There appears to have been little increase in the area under gardens and fallow since the 1962 photograhy, although the population has increased. The land under subsistence agriculture on Santa Ana probably represents the maximum extent of the land available for agriculture, both the northern and southern parts of the island being very rocky with soil occuring only in small patches. There is evidence to suggest that, in parts of the island, fallow length has been reduced, with a resulting decrease in the size of sweet potatoes and signs of potash deficiency in young coconuts planted on these soils. Santa Catalina has less than half the population of Santa Ana and soil depth over the island is generally deeper than on Santa Ana; consequently, there are still considerable areas available for the expansion of cultivation.

Eastern San Cristobal, from Star Harbour northwards to Kahua Point, has areas of both coastal and inland cultivation. The coastal pattern of cultivation not only extends inland along the Wau and adjacent rivers but considerable areas inland from Maniate and Toroa have been cleared for hill villages and their associated gardens.

Where the large north-flowing rivers enter the sea at Wanione and Maghoha Bays, there has been a considerable build-up of alluvium. Schools, missions and private individuals are opening up this land for coconut farms, pastures and subsistence crops. A tractor road joining these bays with Kirakira is being up-graded to transport produce by road to Kirakira. Much of this coastal land is now planted with coconuts and the area under coconuts can only be matched on San Cristobal by that in the Arosi District. These alluvial areas have been chosen as sites for the resettlement of communities from Tikopia and the Reef Islands whose island homes suffer from over-population. The alluvial floodplains of the Warihito, Ravo and Maghoha Rivers have been cultivated wherever they are not subject to flooding and sinuous bands of cultivation and fallow fill the valley floor as far as 10 km inland. These valleys facilitate movement between the coast and the interior and it is around the middle sections of these rivers that inland villages occur, each surrounded by an area of subsistence gardens and fallow land.

The influence of long-established mission schools has been considerable on Ugi Island and most of the land use surrounding Selwyn Bay has directly or indirectly resulted from the schools. Coconuts and arable areas on the level land and lower slopes are run by the mission both as a source of income and to provide food for the students (Plate 7.4). Inland there are extensive areas of school gardens cultivated by the pupils to augment their rations. These school gardens merge with the subsistence gardens of the islanders to form a belt of cultivation across the central waist of the island. The western coastline is marked by coconuts on the littoral which are separated by swampy areas from the subsistence gardens which parallel them on the hills behind. The islands of Bio and Ali'ite are largely unused and have small areas of coconuts, mainly on the coast. The two southern islands of the Three Sisters group have large coconut estates, planted between 1916 and 1926. There are very few garden areas on the periphery of these estates as most of the non-swampy areas have been fully utilised for cococuts.

Forests

In order to avoid repitition the forest types, many of which recur on each island, are described in Volume 1 only. Separate Map 7h, Forest Types, is, however, specific to San Cristobal and adjacent islands and is included in the present volume. The map has been derived from air photograph interpretation using 1971 photography previously used for the land use interpretation. Consequently, the islands show forest types as they existed prior to December 1971 and do not record the effects of the cyclone which devastated much of the forest in the Star Harbour and Santa Ana areas on the 6/7th December of that year (Frontispiece).

Following the forest type identification the photo data was plotted onto 1:50 000-scale contoured map sheets which were then reduced to the final mapping scale of 1:150 000. Very small areas which were recognisable at the larger photographic scale and could be mapped at 1:50 000 were not directly transferable to the final map scale, and have therefore been deleted, amalgamated or slightly enlarged. Table 10 shows the area covered by each forest type on San Cristobal and the adjacent islands.

There is no commercial logging on San Cristobal and there are no current plans to exploit the forest areas.

TABLE 10 **Areas of forest types on San Cristobal and adjacent islands, km^2**

Forest type	San Cristobal and Santa Ana	Ugi and Bio Islands	The Three Sisters	Total
Ms	2	–	<1	2
Mt	7	–	2	9
Sh	1	–	–	1
Ss	<1	–	–	1
St	14	<1	–	14
Sg	1	<1	–	1
Sm	91	4	<1	96
Flf	3	–	–	3
Flr	20	11	5	36
Fld	155	4	<1	160
Fhm	2 298	<1	–	2 298
Fhd	178	13	–	191
Fhu	24	–	–	24
Frm	138	–	–	138
Fmo	11	–	–	11
Dg	142	12	3	157
Dr	9	–	–	9
Dt	3	<1	–	3
Total	3 097	46	11	3 154

Part 3

Landscape analysis: Land regions and land systems

INTRODUCTION

San Cristobal resembles Guadalcanal structurally and lithologically yet contains far fewer land systems (Separate Map 7e). The 15 land systems are grouped for convenience into five land regions, none of which is unique to the island. The land system (the concept has been elaborated in Volume 1) may be described briefly as a unit of land identifiable by characteristic landforms, geology, soils, vegetation and land use and like the land regions occur usually in dispersed, not discrete areas. In this study the land regions have proved a convenient unit for the determination of the agricultural potential which is described in Part 4. Each land system is described here in two ways:

1. There is an annotated block diagram to illustrate the topography of a typical area whose location can be found in an inset small-scale map. Land facets are indicated on the model, such as ridge crests and valleys, which are important subunits of the land system. These are then described in tabulated form for rapid reference by their landform, soil, vegetation and land use.

2. Facing the model is an expanded description of the landform and geology which will both assist readers interested in specific development problems caused by the terrain and help to form a general picture of the characteristics of the land system.

The land systems are arranged alphabetically within land regions. Readers are referred to Appendix 2 for definitions of geomorphological parameters referred to here, including the plan profiles of landforms. As an introduction to the full description and as an aid in comparing San Cristobal with the other major islands, the geographic distribution and main characteristics of the land systems are summarised first.

San Cristobal differs from Guadalcanal mainly in the predominance of uniform volcanic basement rocks and the consequent lack of large and varied areas of sedimentary rocks. Also, several areas, which might have been differentiated as separate land systems from their landform characteristics, have been amalgamated with similar land systems on account of their limited distribution. In this way, the Marapa Land System on ultramafic rocks contains small areas of what has been mapped as the Mbina Land System on Guadalcanal while limestone cuestas, too small to map separately, have been included in the Huro Land System

The Kaichui Land Region consists of the oldest basement rocks of San Cristobal, predominantly early to mid-Tertiary basaltic lavas which have been faulted, uplifted, tilted and dissected into low and high narrow ridges of the Wakora and Wainari'i Land Systems. The Mbetilonga Land Region comprises largely sedimentary rocks occupying the foothills along the northern coast and extending southwards in scattered areas along watersheds. The sediments are partly calcareous and cannot be thick, for incising rivers have exposed basaltic rocks in many valleys within them. The sediments grade from fine mudstones to coarse conglomerates and agglomerates and are believed to be of mid-Tertiary age. The landforms vary from cuestas showing clear sedimentary structures to deeply incised and irregular rounded ridges in which the influence of sedimentary rocks is barely perceptible. The Ghausava Land Region is limited to small scattered areas of ultramafic rocks with rounded hills and ridges largely located between sedimentary outcrops and basement basalts. Terraced landscapes form the Rokera Land Region: they consist of raised coral reef and occur in coastal areas and on the islands to the north. Alluvial land, that is the large valleys, swamps, coastal plains and beaches, form the Tetere Land Region. Many of the smaller alluvial areas are too small to show on the inset land region map (Separate Map 7e) however, and these are incorporated into neighbouring land regions.

LAND REGIONS AND LAND SYSTEMS

KAICHUI LAND REGION

1. Wainari'i Land System

Low hills and ridge systems over basaltic rocks with brownish and reddish loams and clays form this land system. Only in coastal areas is the land cultivated. Distribution is confined to western San Cristobal.

Total area: 690 km^2.

Landforms

Low ridge systems occupy the bulk of the land system, and there is a clear tendency for them to be isolated into small blocks in most areas by the presence of broad valleys and swamps of the Waimasi and Pusuraghi Land Systems respectively. The ridge crests rise from near sea level to a maximum of 560 m in the west although there seems to be a general accordance of summits at around 400 m. The amplitude of relief varies from a maximum of 400 m between major rivers and crests, and less than 40 m for the many small valleys. Ridge lengths rarely exceed 10 km and, because the crestlines are mostly uneven or broken, are commonly less than 2 km. There are some straight, long ridges, but most are irregular in plan with many offsets. The plan profile is 4L*. Crests of the ridges range from narrow to broad, but few exceed widths of 100 m: their slopes are predominantly convex and gentle to moderate.

Ridge flanks vary from long, straight moderately steep slopes to short, convex slopes adjoining deeply incised streams. Gullying is active and many major ridges are flanked by well developed spur systems: these are up to 2 km long and themselves may be eroded by secondary sets of incipient gullies producing minor spurs. Adjacent to large swamps and broad valleys, slopes tend to be concave, in marked contrast to the steep lower slope segments of incising rivers.

Valleys within the land system are chiefly narrow but in places they broaden into small floodplains with low terraces. The large swamps and valleys that penetrate the land system are mapped as separate land systems and may have resulted from large-scale regional earth movements in the recent geological past. The angular drainage pattern of the smaller streams in particular reflect a large degree of structural control, but the overall network is fine dendritic, upon which an ultra-fine gully net is apparent in most areas.

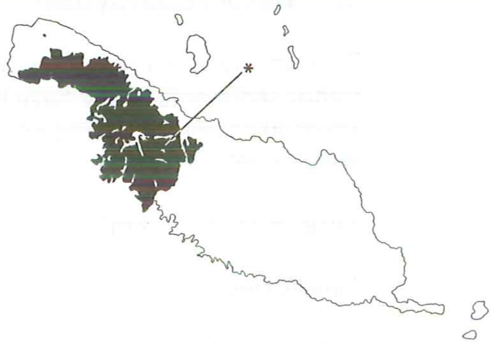
Geology

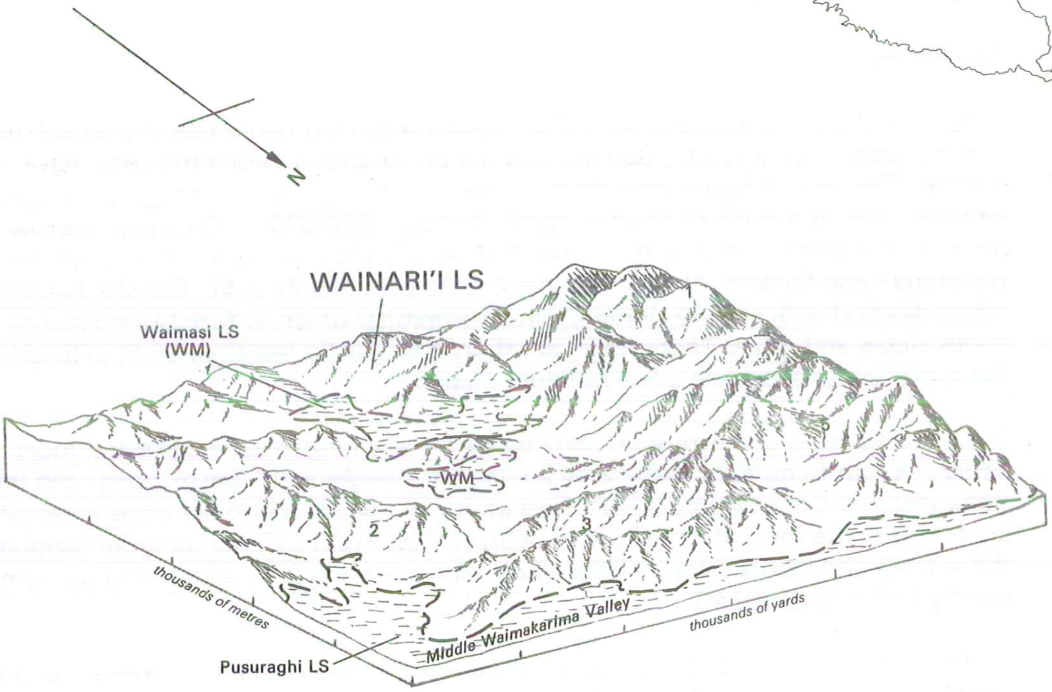
The underlying rocks comprise the basaltic-gabbroic basement of the island, the Warahito Lavas. They are of submarine origin and of pre-Miocene age, and contain common discrete lenses of calcareous rocks known as the Ravo Limestones.

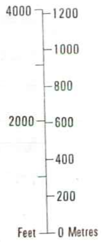
Number of observations 91. One sample site.

* See Appendix 2, Table 5 for definition of plan profiles.

Location of block diagram *
and distribution of land system







Derived from 1:50,000 DOS 456 (Series X711)
Angle of Projection 20°
Note: In areas where land systems are repeated, abbreviations only are shown.

Land facet	Area (km^2-%)	Landform	Soil	Vegetation and land use
1	20 3%	Broad ridges: less than 150 m broad; gentle convex slopes	Deep, red clay (Haplorthox, Tropohumults, Humitropepts)	Lowland forest is dominant with mid-height or tall canopy containing many *Pometia pinnata* common *Canarium salomonense* , *Vitex cofassus*, *Pterocarpus indicus* and *Calophyllum kajewskii* (58 canopy spp. identified from 76 sites). Smaller trees widely varied (168 spp. identified from 76 sites) and include common *Aglaia* sp., *Myristica* sp., *Pimeleodendron amboinicum*, *Eugenia* sp. *(Aimela)*, *Canarium indicum* and *Garcinia sessilis;* palms also are plentiful, namely *Areca macrocalyx*, *Strongylocaryum latius* and *Rehderophoenix subdisticha* with ferns, gingers and pandans.
2	352 51%	Stable slopes: predominantly upper and middle slopes; straight or convex, less than 25°	Deep, yellowish red clay, locally with deep, dark topsoil and dark, mottled weathering parent material at depth (Haplorthox, Tropohumults)	
3	76 11%	Narrow ridges: less than 15 m broad, gentle to moderate slopes	Moderately shallow to deep, dark reddish brown, reddish brown loams and clay over limestone (Tropudalfs)	
4	118 17%	Unstable slopes: mostly short lower slopes and gully heads of more than 30°	Moderately shallow to deep, yellowish or strong brown loams and clays, commonly stony (Tropudalfs)	Small coastal areas cultivated for subsistence crops and, more recently, for coconuts
5	124 18%	Valleys: narrow, bouldery courses and floodplains with terraces to 300 m width	Moderately shallow to deep, dark stony loams and clays (Tropudalfs, Eutropepts)	

Prepared by Directorate of Overseas Surveys, 1975

2. Wakora Land System

The land system comprises low and high ridges developed over basement basalts and minor sediments. They have brownish and red loams and clays beneath predominantly lowland forest, but some coastal areas are cultivated. The distribution is restricted to eastern San Cristobal.

Total area: 1170 km^2.

Landforms

Ridges are the dominant landform. The major ridges commonly rise to 600-800 m and in places reach almost 1 000 m: they are up to several kilometres long, have even profiles and, although containing many straight segments, have common curved sections. The amplitude of relief is mostly between 200-500 m. Crests are narrow to broad and in places merge with the residual weakly dissected summit areas of the Ravoraha Land System. The overall major ridge plan profile is 4L. Smaller branching ridges descend with steeply sloping, narrow summits, which in turn bifurcate into minor ridges and spurs. These ridges are short and usually less than 2 km in length, the spurs rarely exceeding a few hundred metres.

Slopes range from the ultra-short spur flanks to very long major ridge sides, most being medium to long. In shape they are largely straight with convex upper and lower slope sections. Concave upper slopes occur at gully heads and lower slope concavities are found at the foot of landslides or debris slides. From 370 non-random readings the average and median slope of the whole land system is 25°, with hill slopes lying mostly in the range 28-40°.

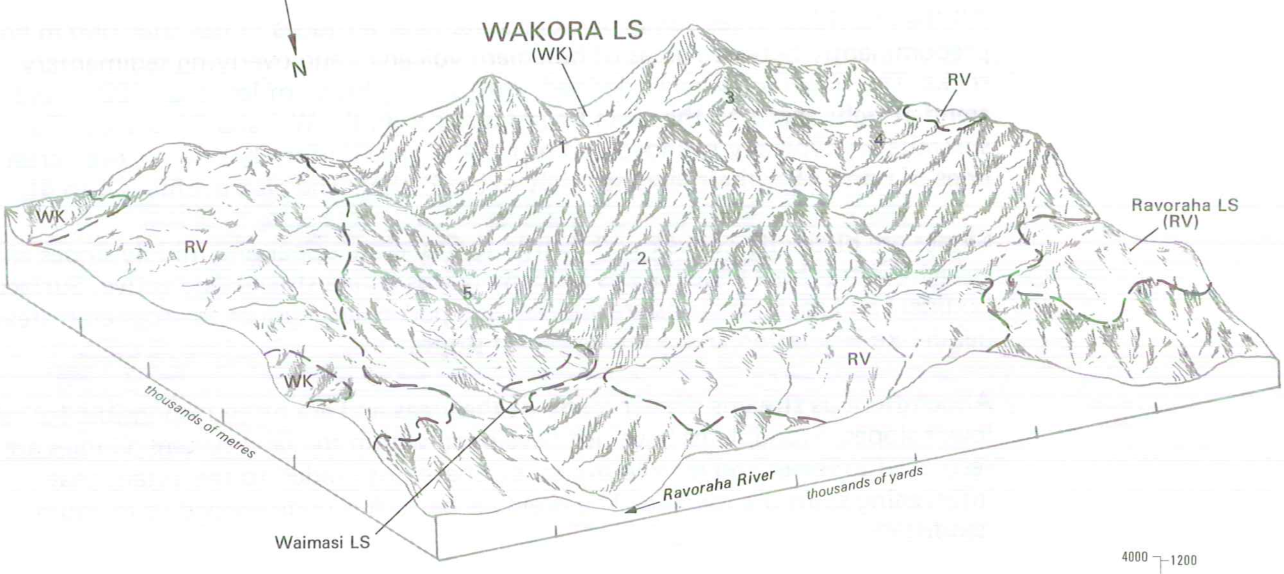
Valleys are well developed, the rivers having incised their courses by several hundred metres below major ridges. Because of the vigorous vertical erosion of main rivers, the tributary streams and gullies are equally potent in erosion and there is a dense network of minor valleys. In some inland areas, there are small perched floodplains at altitudes of up to 400 m. These are separated from downstream valley sections by waterfalls and rapids and have resulted from periodic regional uplift or warping. Many middle courses of rivers have become deeply incised with entrenched meanders following the foot of interlocking spurs. Upper courses are more linear and, with gully and stream courses, reflect some structural control by faulting or jointing. The overall pattern is fine dendritic but superimposed on this is an ultra-fine, more angular gully net.

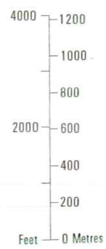
Geology.

The land system is formed from pre-Miocene gabbros and basaltic lavas, the Warahito Lavas, largely extruded beneath the sea. Associated with them are small discontinuous limestone lenses conformable with the pillow lavas, called the Ravo Limestones.

Number of observations 143. Sample sites 4.

Location of block diagram *
and distribution of land system





Derived from 1:50,000 DOS 456 (Series X711)
Angle of Projection 20°
Note: In areas where land systems are repeated, abbreviations only are shown

Land facet	Area (km²-%)	Landform	Soil	Vegetation and land use
1	35 3%	Broad ridges: more than 15m wide, gently convex	Deep, red clay (Haplorthox, Tropohumults, Humitropepts)	Predominantly lowland forest with tall to mid-height canopy dominated by *Pometia pinnata, Pterocarpus indicus, Canarium salomonense, Canarium indicum, Calophyllum kajewskii, Albizia* sp. and *Vitex cofassus* (86 canopy spp. identified from 80 sites). Smaller trees more varied (178 spp. identified from 80 sites), with common *Myristica* sp., *Pimeleodendron amboinicum, Buchanania arborescens, Horsfieldia irya* and *Aglaia* sp. Palms such as *Areca macrocalyx, Strongylocaryum latius, Rehderophoenix subdisticha* and *Caryota rumphiana* are common in the undergrowth with *Cyathea vittata* and pandans.
2	340 29%	Stable slopes: mostly upper and middle slopes of less than 25°, straight to convex	Moderately shallow to deep, reddish brown loams and clays, commonly over limestone (Tropudalfs) Deep, yellowish red clay, locally with dark lower subsoil from weathering rock (Haplorthox, Tropohumults)	
3	140 12%	Narrow ridges: less than 15m wide, long, even-profiled	Deep, yellowish brown to strong brown loams and clays, locally with deep dark topsoil (Tropudalfs)	
4	433 37%	Unstable slopes: mostly lower slopes of major ridges and gully flanks	Moderately shallow to deep, dark stony loams and clays (Tropudalfs, Eutropepts)	
5	222 19%	Valleys: narrow floodplains and bouldery terraces in places; irregular profiles, many gullies		Small areas used for subsistence crop cultivation: crops include yams, bananas, taro, cassava and sweet potato. Isolated patches of coconuts occur at the coast

Prepared by Directorate of Overseas Surveys, 1975

3. Marapa Land System

The land system is formed of rounded hills and ridges developed from ultramafic and basic rocks. The soils range from shallow dark loams and clays to red clay and are covered by *Casuarina papuana* forest. The distribution is in scattered small areas of northern San Cristobal.

Total area: 18 km^2.

Landforms

All the individual areas comprise ridge systems at altitudes of less than 600 m lying predominantly between areas of basement volcanics and overlying sedimentary rocks. The ridges are weakly defined, with an amplitude of less than 100 m and trend at right angles to the main line of outcrop in the Wairaha River area. The summits are typically rounded and broad and have uniformly sloping, even crest lines of up to 15°: their lengths rarely exceed 1 km. The plan profile is 4 to 4L.

Slopes are distinctly convex with gentle to moderate upper and middle slopes and steep, straight, ultra-short lower slopes in many places where streams are active. Surface boulders and rock outcrops are widespread, particularly under the scattered areas of heath-like vegetation and on the steepest slopes.

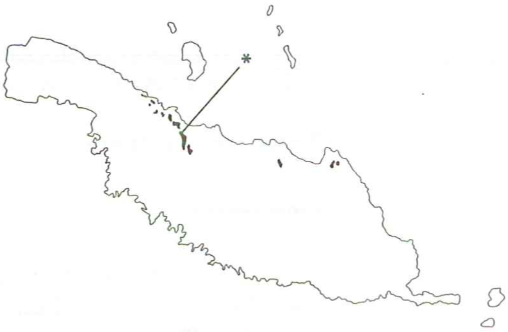
Allochthonous streams dissect many of the areas and are often responsible for steep lower slopes. Floodplains have not developed within the land system. Gullies are restricted to lower and middle slopes, but have not eroded to the extent that intervening spurs are marked. The drainage pattern is undeveloped to medium dendritic.

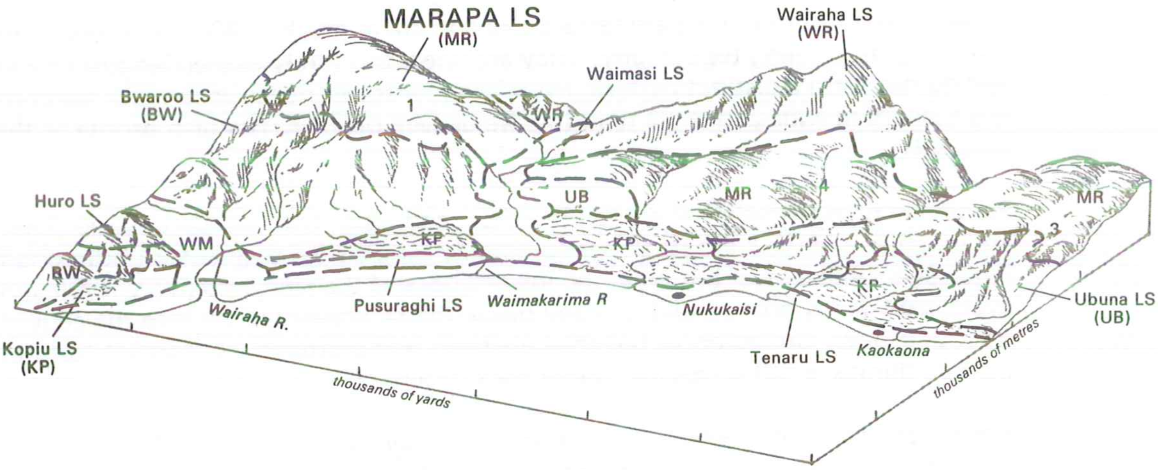
Geology.

The Wanione Ultramafics are of Upper Oligocene age and occur as upfaulted blocks. They are mainly blue-grey serpentinised peridotites, commonly soft and markedly sheared and commonly associated with gabbro.

Number of observations 17. Sample sites 2.

Location of block diagram *
and distribution of land system





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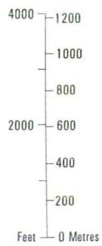
Angle of Projection 20°
Note: In areas where land systems are repeated, abbreviations only are shown.



Land facet	Area (km^2-%)	Landform	Soil	Vegetation and land use
1	16 90%	Rounded summits and merging convex upper slopes: gentle to moderate, short to long	Deep, yellowish red to red clay, commonly strongly mottled from subsoil parent material (Tropohumults, Haplorthox)	Most forest areas have species-poor tall, even canopy dominated by *Casuarina papuana* with subordinate *Streblus glaber* (23 canopy spp. identified from 17 sites). Smaller trees not widely varied but include common *Homalium tatambense, Pleomele angustifolia, Calophyllum vitiense, Canarium harveyi* and *Celtis latifolia*
2	21 2%	Steep slopes: ultra-short lower slopes, unstable	Deep, yellowish brown to strong brown clay with deep, dark topsoil (Tropudalfs)	
3	21 2%	Narrow ridges: less than 1 km long, less than 15 m wide	Moderately shallow to deep, dark stony loams and clays (Eutropepts, Tropudalfs)	Small patches of heath forest with much *Gleichenia linearis*, sedges, *Dianella ensifolia* and *Pandanus* sp. beneath scattered hardy shrubs
4	1 6%	Valleys: narrow, irregular floors; short gullies included		

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Prepared by Directorate of Overseas Surveys, 1975

4. Bwaroo Land System

The land system comprises low hills, ridges and cuestas formed of mixed sediments, with dark brown, brown and reddish clays under predominantly lowland forest.

Total area: 150 km^2.

Landforms

The hills and ridges do not exceed heights of 400 m and lie mostly between sea level and 200 m. They are lightly dissected with an amplitude of less than 40 m, locally rising to 100 m. A characteristic feature of the land system is the presence of shallow valleys merging with gentle lower slopes of adjacent hills and cuestas.

Broad ridge or hill summits are terrace-like and are as much as 40-50 m broad with level to gently rolling topography. They are linear but rarely exceed lengths of 2 km and do not form a distinct pattern. Elsewhere, narrower ridges occur with summits less than 15 m wide and these tend to have uneven profiles. The plan profile of the hills is 4L.

Slopes are predominantly short to ultra-short and range from gentle to steep. They are irregular and the steepest slopes commonly have cliffed segments of outcropping limestone. Unlike most hill areas the lower slopes of the land system are not invariably oversteepened by erosion and in many places merge imperceptibly into the alluvial tract of valleys. Gullies occur but they are short and scattered. Microrelief features include slumps, small scarps and minor rock outcrops.

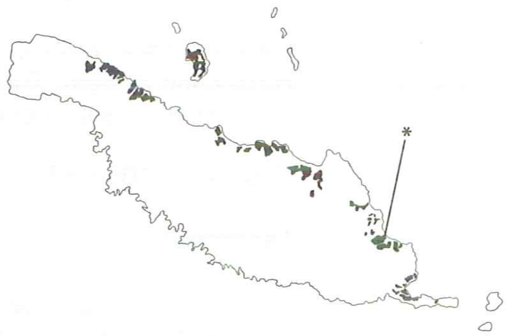
Valleys are not well developed and at an airphotograph scale of 1:60 000 approx., are commonly obscured by vegetation height differences. Large valleys do not occur, except those separating the land system and deriving from inland volcanic areas. Streams in places run underground beneath dry rocky valleys. There is no clear drainage pattern and the stream density is between medium and ultra-fine.

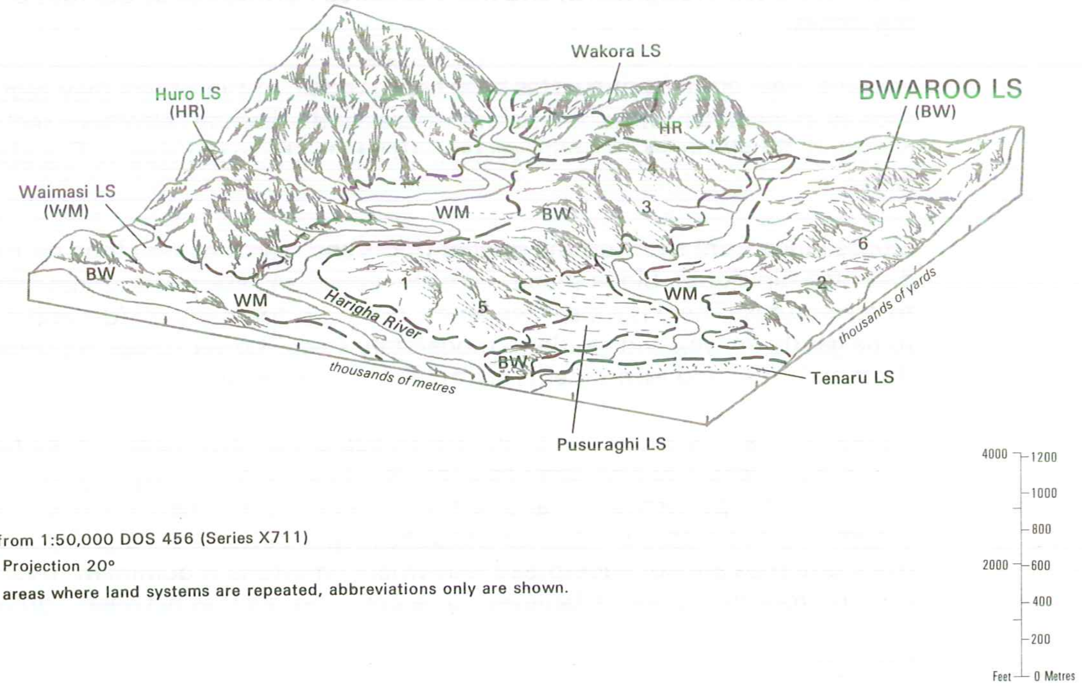
Geology

The sediments forming the land system are of Late Tertiary age and of varied lithology. They include thin beds of limestone, conglomerate, mudstone and sandstone, some of which are calcareous.

Number of observations 77. Sample sites 4.

Location of block diagram *
and distribution of land system





Derived from 1:50,000 DOS 456 (Series X711)
Angle of Projection 20°
Note: In areas where land systems are repeated, abbreviations only are shown.

Land facet	Area (km^2-%)	Landform	Soil	Vegetation and land use
1	9 6%	Broad ridges: more than 15 m wide, gentle, convex slopes	Deep, red clay (Tropohumults, Haplorthox)	Lowland forest with tall canopy dominated by *Pometia pinnata, Canarium salomonense, Pterocarpus indicus, Calophyllum kajewskii* and *Vitex cofassus* (59 canopy spp. identified over 62 sites). Smaller trees widely varied (116 spp. identified at 62 sites) with common *Myristica* sp., *Pimeleodendron amboinicum, Parinari glaberrima, Pometia pinnata* and *Canarium* spp. Undergrowth includes many palms, ferns and gingers
2	6 4%	Narrow ridges: less than 15 m wide, short, uneven	Deep, yellowish red clay (Tropohumults, Haplorthox)	
3	118 78%	Stable slopes: irregular short and gentle to moderate	Deep, strong brown to yellowish brown clay, commonly with subsoil mottling from parent material (Tropudalfs, Tropohumults)	
4	4 3%	Unstable slopes: irregular, ultra-short and steep; commonly rocky	Moderately shallow to deep, dark yellowish brown or dark brown clay (Tropudalfs)	Scattered areas of subsistence crops in places, mainly sweet potato and banana
5	9 6%	Narrow valleys: rocky irregular floors, commonly dry		
6	4 3%	Broad valleys: to 200 m wide and coalesce with footslopes of ridges; commonly dry	Deep, imperfectly drained mottled strong brown clay (Tropudalfs, Eutropepts)	

Prepared by Directorate of Overseas Surveys, 1975

5. Huro Land System

Hills and ridges eroded from mixed calcareous and volcanic rocks comprise the Huro Land System. They contain red and brownish clay and loams, are predominantly forested and occur in the northern areas of San Cristobal.

Total area: 405 km^2.

Landforms

The hills and ridges rise to a maximum height of 600 m and have a wide amplitude of relief of 50-250 m. They occupy a zone between the deeply dissected basal volcanic rocks of the island interior and the little dissected, purely sedimentary rocks of the coast. Large ridges occur with lengths of 2-3 km, with narrow to broad, even crests. These are the remnants of cuesta landforms which dipped northwards to the coast. Consequently, ridge forms tend to become more pronounced southwards towards former escarpments, and more subdued northwards at the foot of former dip slopes.

In some areas all signs of cuestas have been eroded, but in others they remain clear, such as immediately west of Kirakira where gently dipping calcareous sediments are common. Small ridges and hills occupy offsets to the major ridges. The plan profile is 4L.

Slopes range from short on the smaller ridges and scarps to very long on the least dissected dip slopes. Slope shape is equally varied and steepness ranges from gentle to precipitous. There is a clear tendency, however, for many middle and upper slopes to be gently convex and gentle to moderately steep. Lower slopes are commonly short and steep and escarpments are precipitous, even cliffed.

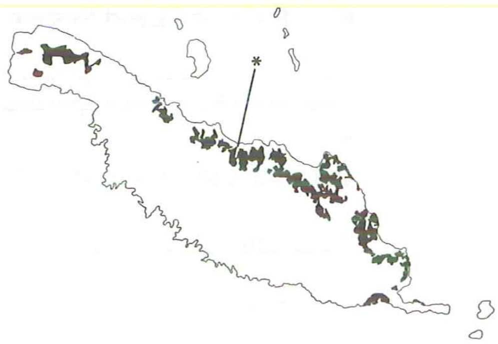
Valleys are narrow and there is minimal floodplain development. Valley floors are commonly rocky and have stepped profiles. They contain many angular segments but the overall pattern is fine and dendritic. Gullying is undeveloped and the smaller streams are not deeply incised; consequently, spur patterns are equally subdued. Rock outcrops are not widespread, but where limestone is dominant, rock cliffs and outcrops on slopes are believed to be common, such as between Toroa and Maniate.

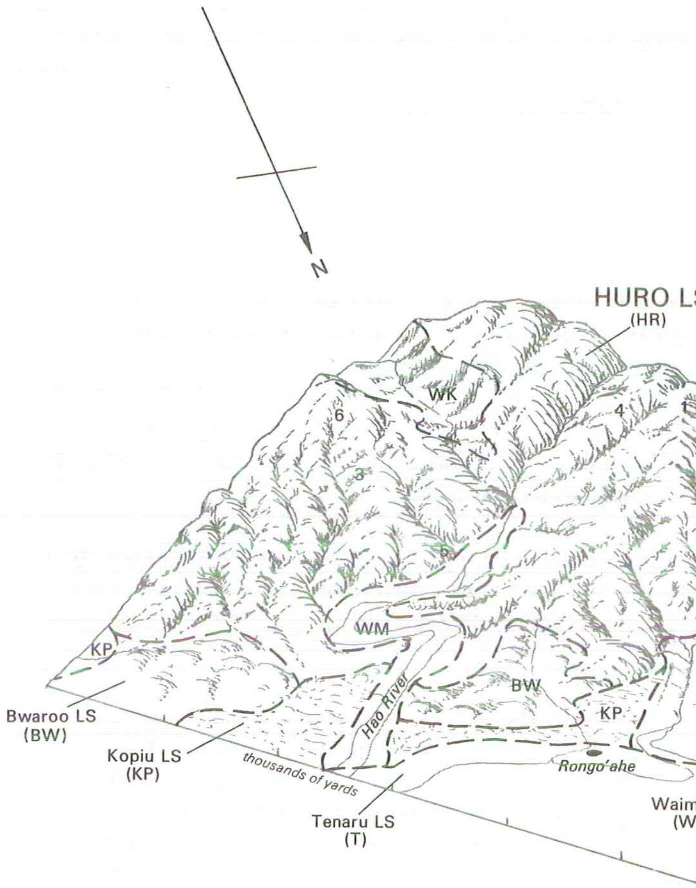
Geology

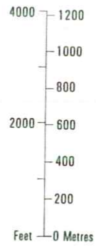
The land system has developed over basal Tertiary sedimentary successions in which limestones and other marine deposits are intermixed with coarse fluvial sediments containing a large basaltic component. Some deeply eroded areas may consist mainly of basement volcanic rocks.

Number of observations 78. Sample sites 2.

Location of block diagram *
and distribution of land system







Derived from 1:50,000 DOS 456 (Series X711)
Angle of Projection 30°
Note: In areas where land systems are repeated, abbreviations only are shown.

Land facet	Area (km^2 -%)	Landform	Soil	Vegetation and land use
1	24 6%	Broad ridges: more than 15 m wide, gently convex	Deep, red clay (Haplorthox, Tropohumults) Deep, yellowish red clay (Haplorthox, Tropohumults)	Large areas of lowland forest with canopy dominated by *Pometia pinnata, Vitex cofassus, Canarium salomonense, Amoora* sp. and *Neoscortechinia forbesii* (63 canopy spp. identified over 59 sites). Smaller trees include in addition *Aglaia* sp., *Pimeleodendron amboinicum* and *Myristica* sp. (118 spp. identified from 59 sites)
2	36 9%	Stable slopes: mostly upper and middle slopes, short to long and from 10-25°		
3	227 56%	Narrow ridges: less than 15 m wide, even crests	Moderately shallow to deep, strong brown or yellowish brown clay and loams (Tropudalfs, Eutropepts)	
4	61 15%	Unstable slopes: mostly scarps and lower slopes of more than 30°; short, straight and commonly rocky	Moderately shallow to deep, dark yellowish brown or dark brown stony loams and clays (Tropudalfs, Eutropepts)	Subsistence crops near coast include sweet potato, yam and banana. Cultivated areas are predominantly coastal
5	53 13%	Valleys: narrow, rocky with no floodplains		
6	4 1% (est)	Cuestas: gentle to steeply dipping limestone slopes of 10-30°; rocky	Shallow to moderately deep, dark stony loams and clays (Rendolls, Tropudalfs)	Areas of pure limestone containing heath-like associations and *Casuarina papuana* in the east

Prepared by Directorate of Overseas Surveys, 1975

6. Ravoraha Land System

The land system is confined to eastern San Cristobal and consists of low-amplitude, high-altitude, rolling summit areas underlain by sedimentary and volcanic rocks. The soils are predominantly reddish clays and the lowland forest, which covers most of the land system, shows signs of disturbance in the past.

Total area: 213 km^2.

Landforms

The ridges and hills which form the land system extend from about 100 m to slightly over 1 000 m. Although lying predominantly at high altitudes, the amplitude of relief does not usually exceed 200 m and is commonly less than 100 m. Summit levels are broadly accordant. Randomly oriented ridges are moderately well defined in that crests are mostly narrow and 1-3 km long; their crests are even, straight to curved and produce a 4L plan profile. In the largest areas, some summits are broad to very broad and gently rounded.

Slopes are varied. Lengths range from ultra-short to long and are mostly straight to convex and moderate to steep. Many lower slopes have been steepened by stream incision to the point where they are unstable and are composed of rock outcrops and scree material.

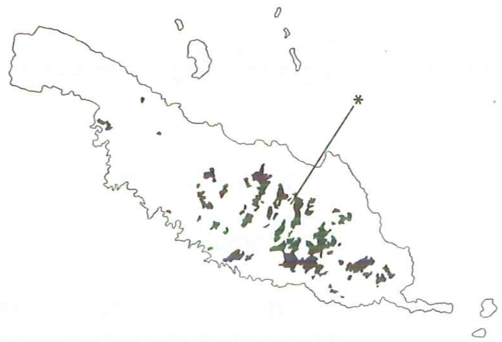
Valleys are formed by small streams and there is no floodplain formation, all fluvial erosion being vertical. Valley floors are commonly stepped or irregular: they contain many short straight segments but the overall pattern is medium and fine dendritic. Gullying is active in some places, particularly on lower slopes, but most are less than 200 m long and 10-40 m deep. Where they are common, gullies have caused the formation of an ultra-fine, parallel spur pattern on main ridge footslopes.

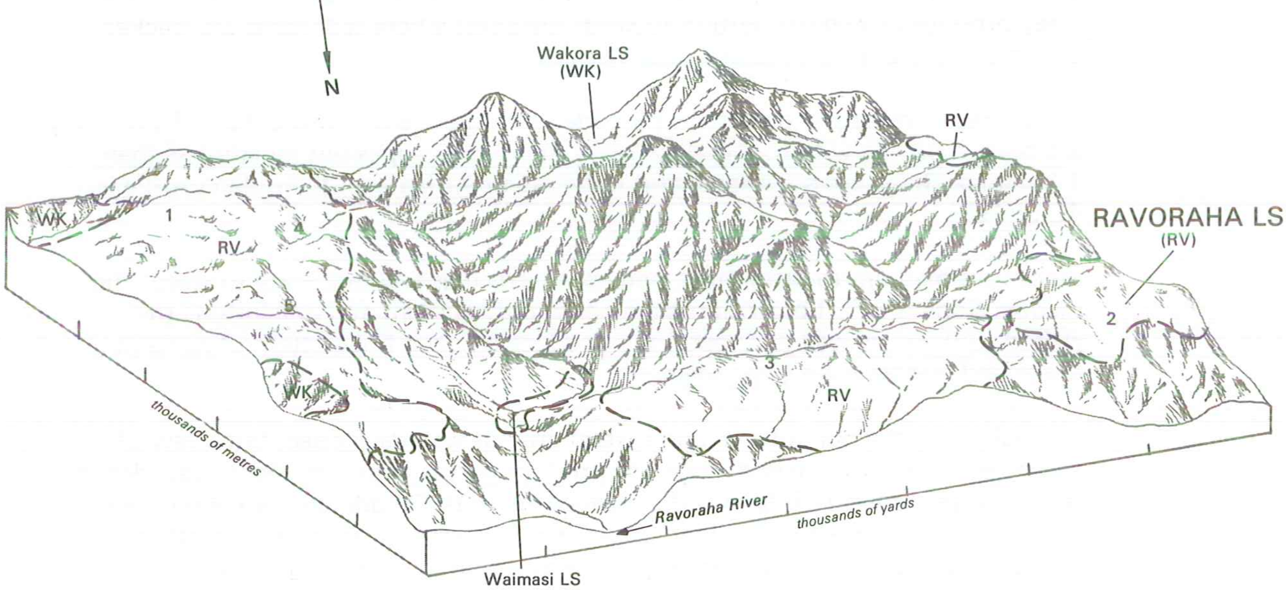
Geology

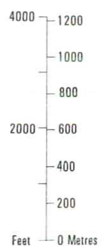
Most areas covered by this land system have not been mapped geologically. It is deduced from air photograph interpretation and field evidence collected during this survey that many of these summit areas are formed of sedimentary rocks ranging from cherty limestones to sandstones. Other areas, however, contain basaltic volcanic rocks and it is concluded that the land system basically represents relics of a former erosion surface developed in Early Tertiary basal sediments overlying basement volcanics.

Number of observations 41. Sample sites 2.

Location of block diagram *
and distribution of land system







Derived from 1:50,000 DOS 456 (Series X711)
Angle of Projection 20°
Note: In areas where land systems are repeated, abbreviations only are shown.

Land facet	Area (km^2-%)	Landform	Soil	Vegetation and land use
1	11 5%	Broad ridges: gently convex summit areas up to 300 m broad	Deep, red clay (Haplorthox, Tropohumults). Moderately shallow to deep, reddish brown loams and clays over limestone (Tropudalfs) Deep, yellowish red clay with dark lower subsoil in places (Haplorthox, Tropohumults)	Large areas covered by mid-height lowland forest. Canopy is regular, species-poor but contains many *Albizia* sp. *Eugenia effusa, Neoscortechinia forbesii* and *Eugenia* sp. or *Memecylon* sp. (41 canopy spp. identified over 32 sites). Smaller trees more varied and include in addition many *Aglaia* sp., *Myristica* sp., *Prunus schlechteri* and *Calophyllum vitiense* (140 spp. identified over 32 sites)
2	128 60%	Stable slopes: mostly less than 30° and confined to upper and middle slope segments		
3	25 12%	Narrow ridges: less than 15 m wide, 1-3 km long and with even profile	Deep, strong brown to yellowish brown clay, locally with deep dark topsoil or lower subsoil (Humitropepts, Tropohumults) Moderately shallow to deep, dark stony loams and clays (Eutropepts, Tropudalfs)	Highest ridges contain low, species-poor forest with much moss on ground and on tree boles. Main species are *Belliolum haplopus, Ascarina maheshwarii, Calophyllum vitiense, Podocarpus* sp. and *Schefflera* sp. (38 species identified from 6 sites). In contrast with above forest there are no palms, and *Pandanus* spp. at ground level are more common
4	6 3%	Unstable slopes: mostly more than 30° and occupying mainly lower slopes; straight, ultra-short		
5	43 20%	Valleys: floors of rivers, streams and gullies; irregular or stepped, narrow		

Prepared by Directorate of Overseas Surveys, 1975

7. Ubuna Land System

This land system is formed of moderately high ridges with low amplitude of relief developed over mixed basalts and sedimentary rocks. The soils are mixed red and brownish clays and loams; most areas lie under old forest, except near the coast.

Total area: 99 km^2.

Landforms

The ridges occur between sea level and 560 m with an amplitude of relief predominantly less than 50 m, but rising to 100 m where main river dissection is vigorous. They produce an angular pattern towards the coast where sediments are thicker, but inland there is no coherent ridge pattern.

Ridge crests are largely narrow but broaden in some areas to more than 150 m: they are even in profile with rounded, gentle to moderate slopes but mostly less than 1 km long. Ridge cross sections tend to be asymmetrical and their plan profile is 4L or 4L//.

Slopes are medium to ultra-short, convex to irregular and moderate to steep: the median slope is 21°. Lower slopes are commonly straight and precipitous to cliffed. Gullies are well developed and produce an ultra-fine pattern of spurs in lower and middle main slope segments.

The valleys in the bulk of the land system are not well developed, but a few of the larger rivers have incised deeply to produce gorges in places. Most rivers derive from volcanic country inland and are allochthonous. Floodplains are absent and valley bottoms consist of boulder-strewn, stepped stream floors with gentle to moderate slopes. The major drainage pattern is fine to medium grain and dendritic mostly, but in some coastal areas it is parallel. Smaller streams and gullies give an ultra-fine network.

Geology

Lower Miocene sediments, mainly mudstone, limestone and basaltic conglomerate, interfinger with and overlie pre-Miocene basaltic lavas. The whole has been block faulted but not folded, and there has been considerable structural instability.

Number of observations 145. Sample sites 3. Sample area SC.

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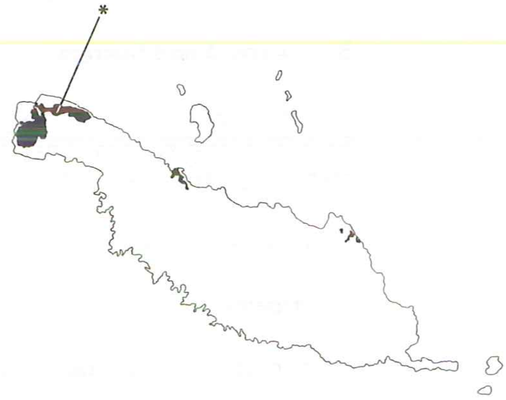
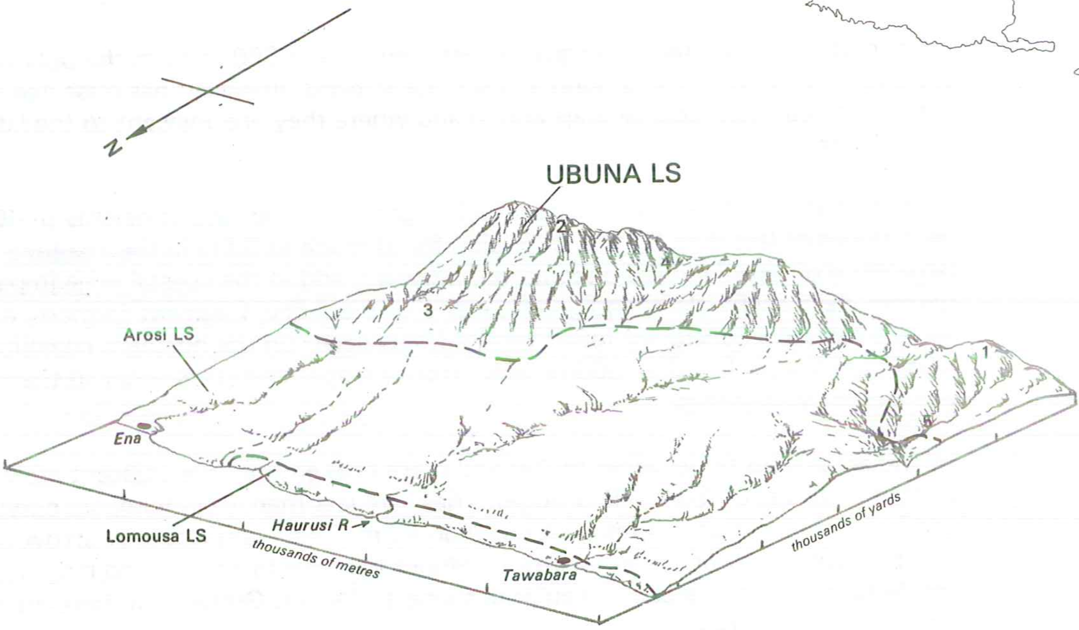
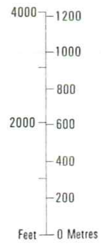
Number of observations 145. Sample sites 3. Sample area SC.

Location of block diagram *
and distribution of land system







Derived from 1:50,000 DOS 456 (Series X711)
Angle of Projection 20°

Land facet	Area (km² -%)	Landform	Soil	Vegetation and land use
1	26 26%	Broad ridge crests: rounded and gently convex slopes	Deep, red clay, commonly with darker deep subsoil (Tropohumults)	Tall, irregular-crowned lowland forest with canopy containing many *Pometia pinnata* and *Calophyllum kajewskii* (46 canopy spp. identified from 46 sites). Smaller trees more varied (105 spp. identified at 46 sites) but with *Pimeleodendron amboinicum, Fagraea racemosa, Horsfieldia irya, Myristica* sp. and *Aglaia* sp. most common
2	11 11%	Narrow ridges: less than 15 m wide, even profile	Deep, yellowish red clay (Orthox, Tropudalfs)	
3	45 41%	Stable slopes: mainly gentle to moderately steep convex upper and middle slopes	Deep, yellowish brown clay loam to clay (Tropudalfs)	
4	10 10%	Unstable slopes: mainly straight, short and steep lower slopes above incising rivers	Deep, strong brown clay (Tropudalfs, Eutropepts)	Shifting cultivation for subsistence crops in some coastal areas, mainly sweet potato, banana and taro
5	12 12%	Valleys: narrow, with no floodplain, boulder-choked, , irregular profile	Shallow to deep, dark loams and clays	

Prepared by Directorate of Overseas Surveys, 1975

8. Arosi Land System

Lightly dissected marine terraces underlain by pure and impure calcareous sediments form the land system. They have red, brown and dark brown clays and in coastal areas are extensively cultivated for subsistence and cash crops.

Total area: 85 km^2.

Landforms

Coral platforms elevated to heights of between 20 and 360 m form the bulk of the land system. Incision by underground and surface streams, however, has dissected the platforms near their coastal edge and inland where they are adjacent to the Ubuna Land System.

Undissected smooth areas comprise level or gently rolling land at heights of 40-160 m with slopes of less than 8° and extending for as much as 3 km in the Hareni'a area. Such large areas of level land are uncommon, however, and at the coastal edge in particular narrow, deep rocky clefts and gorges, many of them dry, fragment formerly extensive terrace surfaces. Subsidiary lower terrace levels occur on the northern coastline but these benches are less than 200 m wide. Rocky slopes and cliffs occur at the coast but are not widespread.

Inland areas tend to be rather higher and more broken than the adjacent main terrace level and consist of low, rolling ridges. These are less than 1 km long, are curvilinear and have an amplitude of relief of less than 40 m. Their summits are narrow to broad and the cross-sections are symmetrical. Slopes flanking these hills and ridges are gentle to moderately steep, irregular in shape and short. Gullying in these areas is only weakly developed.

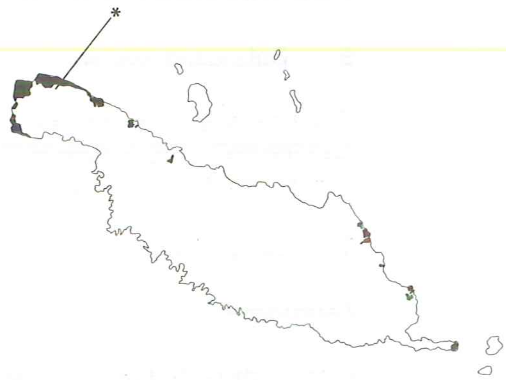
Valleys in the land system range from deep, commonly dry, gorges near the coast with rectangular patterns to shallow, weakly defined dendritic systems inland. There is no surface drainage pattern on the terrace surfaces, most rainwater escaping to underground karstic drainage systems. Sink holes, dry valleys and disappearing streams have all been noted. Valley floors are narrow with no floodplain development. The drainage density ranges from very coarse to fine.

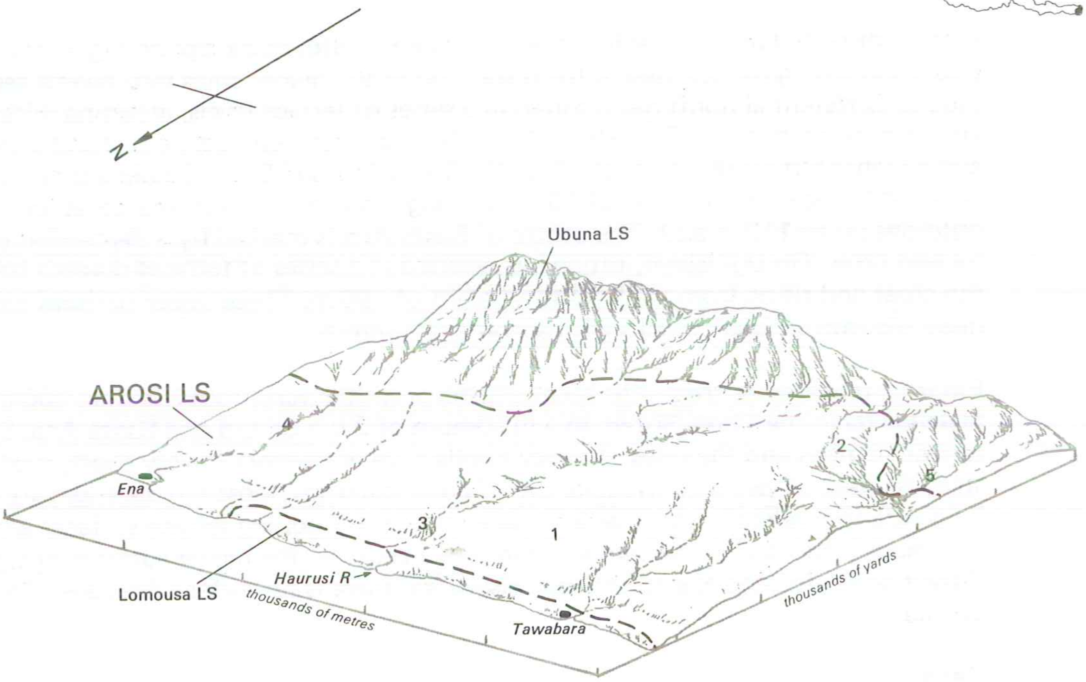
Geology

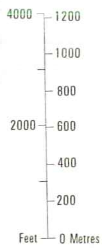
The land system is underlain by Plio-Pleistocene sediments. These range from pure reef limestones to lagoonal sediments containing fluvial impurities. Volcanic detritus occurs in sandstones and conglomerates, particularly in basal successions.

Number of observations 347. Sample sites 5. Sample area SA.

Location of block diagram *
and distribution of land system







Derived from 1:50,000 DOS 456 (Series X711)
Angle of Projection 20°

Land facet	Area (km^2-%)	Landform	Soil	Vegetation and land use
1	32 37%	Terrace surfaces: up to 3 km but mainly less than 200 m wide; less than 5^{o} slopes	Deep, red clay (Tropohumults, Orthox)	Predominantly lowland forest with tall canopy dominated by *Pometia pinnata, Canarium salomonense, Calophyllum kajewskii and Vitex cofassus* (41 canopy spp. identified from 27 sites) Smaller trees widely varied (95 spp. identified from 27 sites) and include many *Neoscortechinia forbesii, Pimeleodendron amboinicum, Myristica* sp. and *Aglaia* sp. Palm, ferns and gingers common. Scattered areas of disturbed forest. Coastal areas used for subsistence crops such as taro, banana and coconuts
2	40 47%	Hills and ridges: low, short and with gentle to moderately steep slopes	Deep, strong brown clay, in places merging to yellowish red (Eutrorthox)	
3	9 11%	Steep slopes: predominantly coastal but found also flanking main rivers; rocky	Deep, yellowish red clay (Eutrorthox, Tropudalfs) Moderately shallow to deep, dark brown clay (Tropudalfs)	
4	4 5%	Valleys: mostly clefts and gorges; few large rivers	Imperfectly to poorly drained dark loams and clays	

Prepared by Directorate of Overseas Surveys, 1975

9. Dala Land System

The land system comprises elevated reef platforms of Quaternary coral containing pumice and other volcanic impurities, with reddish and brownish clays. It occurs on Ugi, Santa Ana, Santa Catalina and the Three Sisters.

Total area 31 km^2.

Landforms

Lightly dissected marine platforms are the main landforms except on Ugi island where uplift and tilting has resulted in the dissection of the higher areas into several separate blocks. Differential uplift has resulted in a series of terrace levels, attaining different altitudes on each island. The Three Sisters have a major level between 2 and 3 m a.s.l. and a higher but smaller level at 40 m. On Santa Ana and Santa Catalina there is a series of terraces up to a level of 40 m, although, north of Nataghera, coral limestone outcrops up to 110 m a.s.l. The centre of Santa Ana is marked by a depression occupied by two lakes. On Ugi Island, tilting has resulted in a series of terraces dipping towards the coast and rising from sea level to a height of 180 m. These upper surfaces have been dissected into separate blocks with accordant summits.

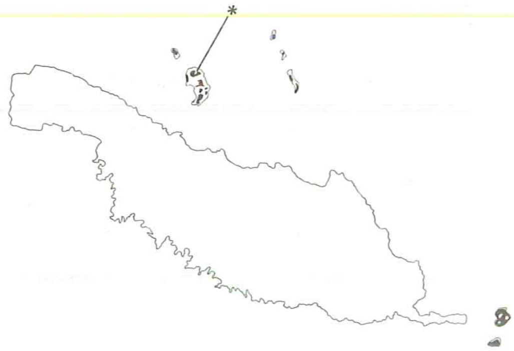
External relief varies from 3 to 50 m. Platform widths vary from less than 200 m on Malaupaina in the Three Sisters to a maximum of 2 km on Ugi and Santa Ana. Some terrace margins and the sides of rocky knolls have ultra-short to very short, moderately steep to steep slopes with irregular pitted coral outcrops. Most terrace edges are marked by gentle to moderate slopes which grade into gently sloping terrace surfaces with a hummocky microrelief. Stream incision only occurs on the higher surfaces of Ugi where dissection is ultra-shallow to shallow; elsewhere there is no surface drainage. Plan profile: 7.

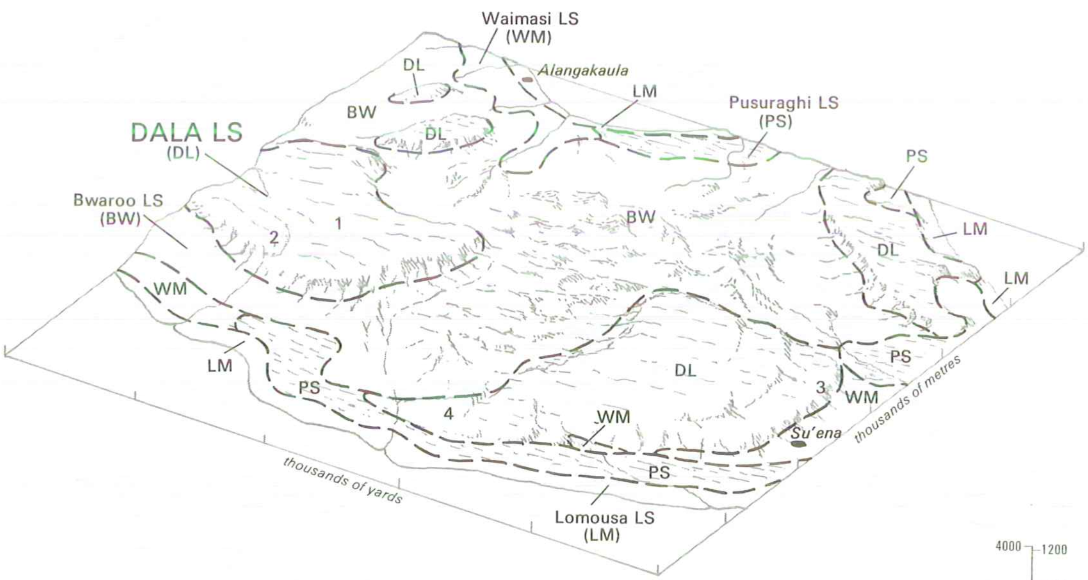
Geology

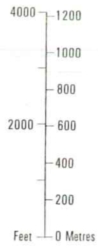
Pleistocene to Recent coral reef elevated by warping. Riverine deposits and outwash from older sediments have added later superficial deposits, whilst pumice and other volcanic impurities have provided additional terrigenous material.

Number of observations 205. Sample sites 5. Part of Sample Area SB.

Location of block diagram *
and distribution of land system







Derived from 1:50,000 DOS 456 (Series X711)
Angle of Projection 30°
Note: In areas where land systems are repeated, abbreviations only are shown.

Land facet	Area (km^2-%)	Landform	Soil	Vegetation and land use
1	16 51%	Platform surfaces: commonly stepped, lightly dissected; gentle slopes less than 6°, width mainly more than 400 m	Shallow to moderately shallow, dark reddish brown or reddish brown clay loam with coral outcrops common (Lithic Tropudalfs). Moderately shallow to deep, yellowish red clay	Widely used for subsistence cultivation on Ugi and Santa Ana, resulting on the latter island in large areas of low regrowth dominated by *Timonius timon* and *Premna corymbosa* Sweet potato widely grown; yams and pana in localised areas only Coconuts cover considerable areas on the Three Sisters Disturbed lowland fores with *Pometia pinnata, Neonauclea* sp., *Elaeocarpus sphaericus* and *Amoora* sp. locally common
2	5 16%	Valley sides: moderate slopes, very short to medium length, straight or undulating	Moderately shallow to deep, brown to dark brown clay with many coral rock fragments	
3	10 32%	Rocky knolls and cliffs: edges of uplifted terraces; moderately steep to steep, height 3m to 40m maximum; many outcrops of coral rock	As above but deeper and becoming strong brown or yellowish brown with depth	
4	1 1%	Drainage depressions: flat to slightly concave poorly drained	Deep, gleyed dark grey clay with much organic matter	

Prepared by Directorate of Overseas Surveys, 1975

TETERE LAND REGION

10 KOPIU LAND SYSTEM

The land system is formed over mixed alluvial and colluvial boulder fans and terraces on the northern coast of San Cristobal. The area was formerly forested but is now being extensively cultivated.

Landforms

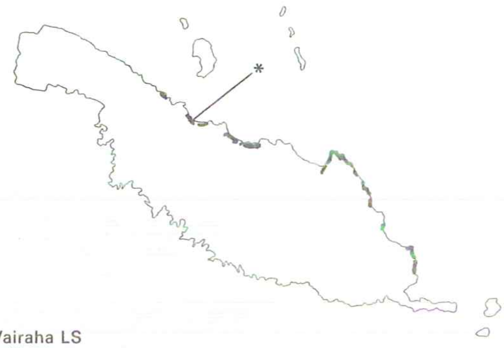
Lightly dissected fluvial/colluvial fans 500-1500 m wide at a height of 0-30 m a.s.l. Slopes are gently convex to straight, flat to gently sloping at 0-9^{o} increasing to 4-19^{o} inland where colluvial fans have developed. East of Wanione cliffed coastal margins 2-5 m high occur. Narrow stream channels result in ultra-short moderate to steep valley slopes. River dissection results in a medium to coarse grain with a plan profile of 7 or 1L//.

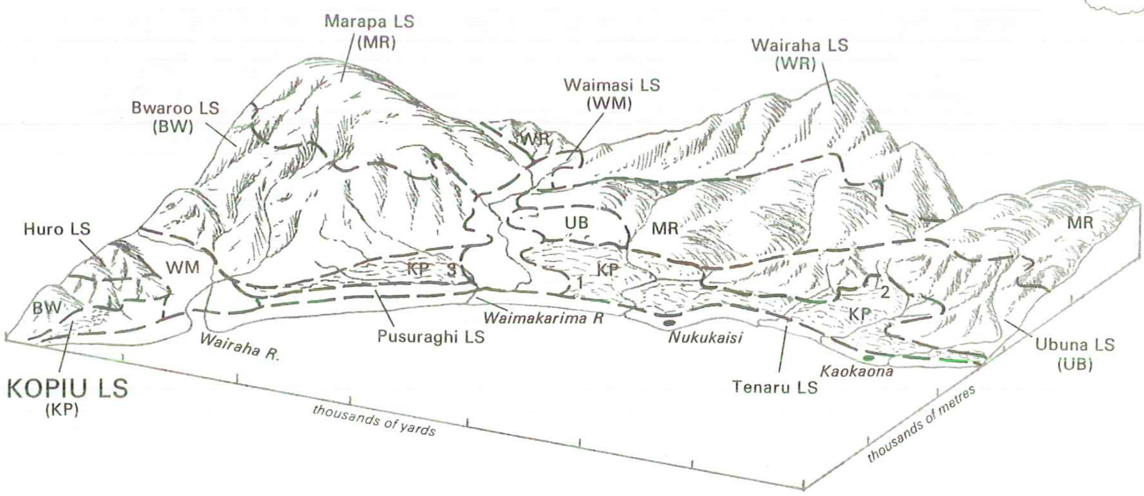
Geology

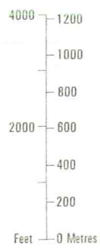
Recent deposits of poorly sorted, unconsolidated colluvium and alluvium derived by deposition and outwash from the adjacent Basement volcanics. Pleistocene to Recent fringing reef occurs at the coast.

Total area 19 km^2. Number of observations 22. One sample site.

Location of block diagram * and distribution of land system







Derived from 1:50,000 DOS 456 (Series X711)

Angle of Projection 20°

Note: In areas where land systems are repeated, abbreviations only are shown.

Land facet	Area km^2-%	Landform	Soil	Vegetation and land use
1	16 85%	Fan or terrace surface: locally stepped to form a series of levels, slopes varied 2-9^{o}, maximum width 1500 m	Deep, imperfectly to poorly drained, brown to dark greyish brown clay with occasional mottles (Aquic Tropofluvents) Moderately deep to deep, well drained, brown to dark brown or dark yellowish brown sandy clay loam or sandy clay with rounded basaltic stones common (Eutropepts, Tropofluvents)	Lowland forest dominated by *Pometia pinnata, Canarium indicum, Ficus* sp. and *Celtis latifolia* but signs of disturbance shown by the large numbers of trees with edible fruit. Widely cleared for subsistence gardens and areas under regrowth forest Areas of mature and young coconuts widespread and rate of new plantings rapidly increasing
2	2 10%	Colluvial fans: along margins of foothills, gradient varied 4-19^{o}, width varied	Similar to above but with an increased content of coarse material (Troporthents)	
3	1 5%	Terrace scarp: moderately steep slopes between terrace levels and along river margins, rarely cliffed with coral outcrops	Moderately deep, well drained, brown to dark brown sandy clay with basaltic or coral fragments (Tropofluvents) Moderately shallow to deep, well drained, yellowish brown clay overlying coral or coral fragments	

Prepared by Directorate of Overseas Surveys, 1975

11. KUMOTU LAND SYSTEM

The land system comprises of small saline coastal swamps on coral platforms and at river mouths, dominated by mangrove vegetation and occurring particularly in Star Harbour and on the Three Sisters.

Landforms

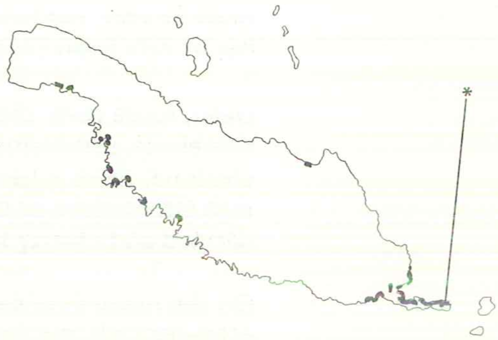
Altitude less than 1 m, almost level with a slight microrelief. Microrelief varied in height and intensity and is generally caused by crab mounds or irregularly buried organic detritus. Plan profile 7.

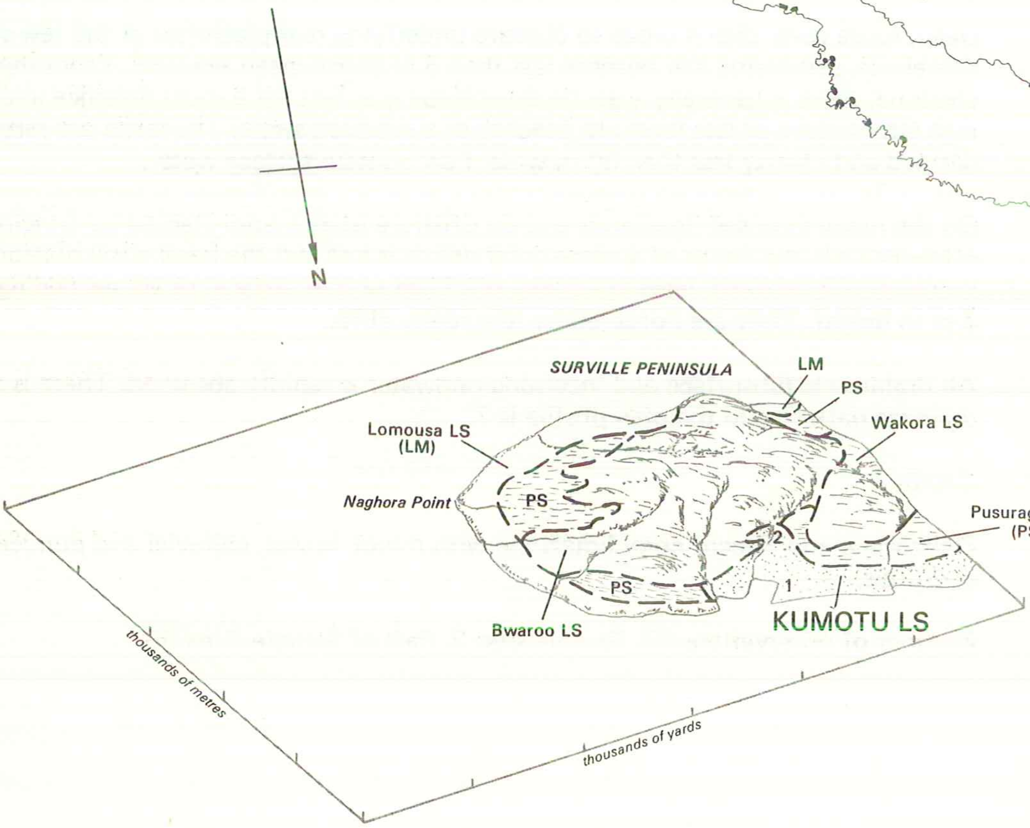
Geology

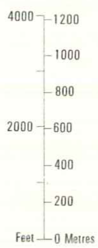
Recent marine sediments of mainly unconsolidated alluvium or coral platforms locally overlain by accumulations of organic matter.

Total area 15 km^2.

Location of block diagram * and distribution of land system







Derived from 1:50,000 DOS 456 (Series X711)
Angle of Projection 30°
Note: In areas where land systems are repeated, abbreviations only are shown.

Land Facet	Area km^2-%	Landform	Soil	Vegetation and land use
1	10 70%	Coral platforms: intertidal, flat, except for low microrelief; frequently flooded by up to 1.5 m of sea water; width varied 10-400 m	Shallow, very poorly drained, greyish or brownish coral debris (Tropaquents) Moderately shallow, very poorly drained, dark peat overlying coral (Sulfihemists) Moderately shallow, very poorly drained, thin dark peat over pale sandy loam to sandy clay (Tropaquents)	Mangrove with a low to medium-height canopy, dominated by *Rhizophora* spp. with local concentrations of *Bruguiera* spp., *Lumnitzera littorea* and *Dolichandrone spathacea*
2	5 30%	Lower reaches of river and inner lagoon flats: intertidal, flat, with many small creeks and streams		

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12. Lomousa Land System

This land system consists of beaches and low terraces formed from coral debris. The soils are predominantly pale stony sands utilised extensively for coconut plantations, settlements and communications. The distribution is restricted to western and eastern coastal San Cristobal and offshore islands.

Total area: 22 km^2.

Landforms

In most areas, the land system occupies a coastal fringe between foothills and the sea no more than 300 m wide. Young reef limestone, which was formerly offshore or onshore reef, has been covered with coral debris to varying depths and in some places has in turn been covered by an alluvial or colluvial veneer.

Deep, loose coral debris tends to obscure underlying reef platforms at the few sheltered shorelines, producing low beaches less than 3 m above mean sea level. From their crestline, there is generally a gentle downslope gradient for a short distance inland into either more or less level old beaches or a subdued swale. The latter are rarely well defined and mostly less than 60 m wide. Few contain surface water.

On the many exposed headlands and on offshore islands unprotected by fringing or offshore reefs the depth of surface coral debris is less and the basal coral platform is commonly exposed, leaving a rocky platform or low terrace, rarely exceeding 3 m in height. They are bordered by low rocky cliffs.

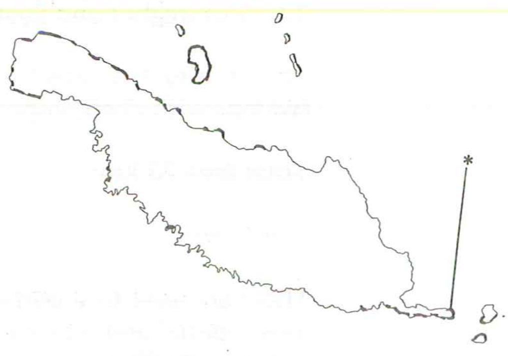
All drainage is subsurface and incoming rainwater is rapidly absorbed. There is no drainage pattern and the plan profile is 7.

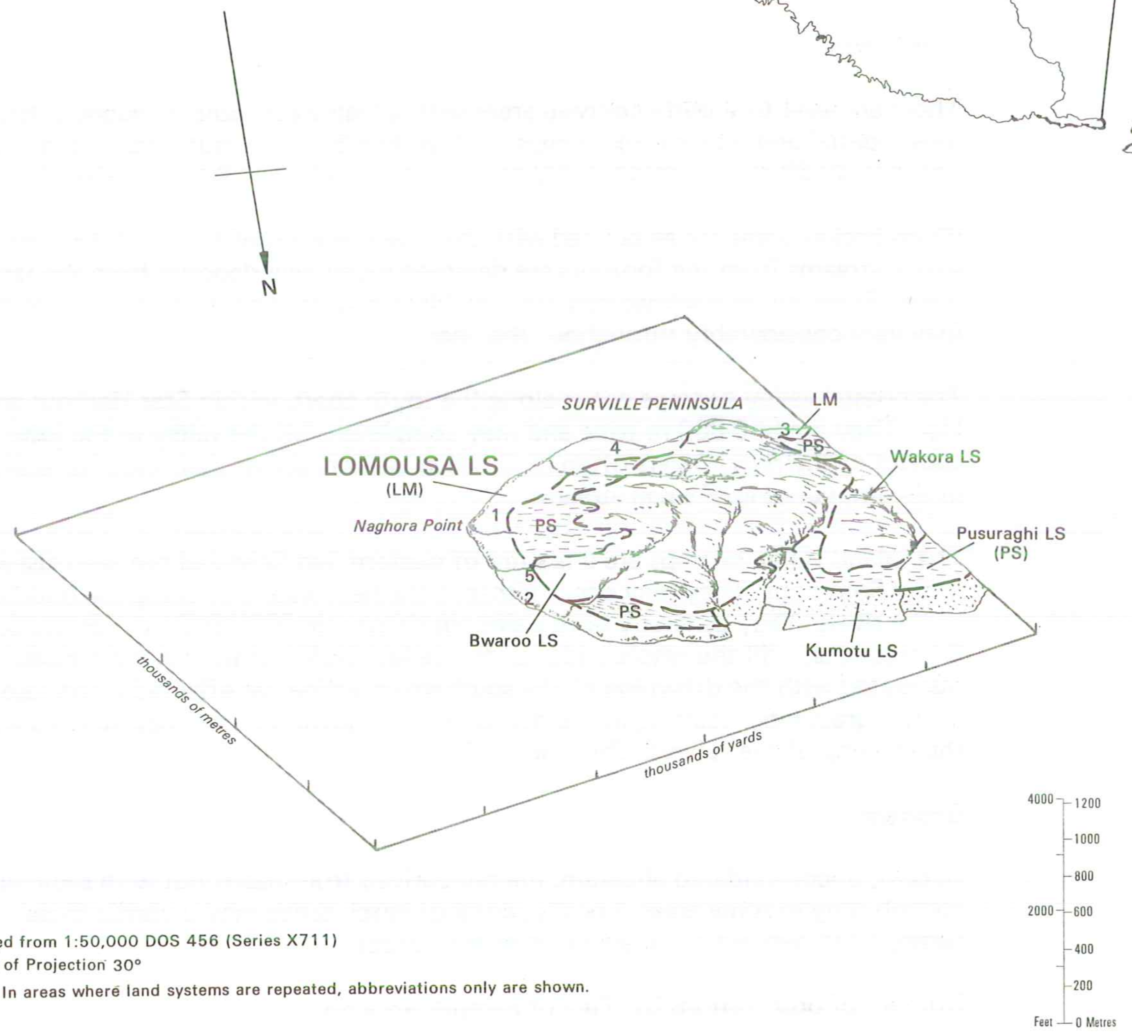
Geology

Pleistocene and Recent coral limestone with minor fluvial, colluvial and pumice additions.

Number of observations 53. Sample sites 2. Part of Sample Area SB.

Location of block diagram *
and distribution of land system





Derived from 1:50,000 DOS 456 (Series X711)
Angle of Projection 30°
Note: In areas where land systems are repeated, abbreviations only are shown.

Land facet	Est. area (km^2 -%)	Landform	Soil	Vegetation and land use
1	14 60%	Platform surfaces: almost flat to gently undulating with common coral outcrops locally	Shallow, stony pale to dark sand and sandy loam (Troporthents)	Most areas have been cleared for planting of coconuts. Cattle are grazed on the Three Sisters on poor pasture beneath coconuts Regrowth contains several *Ficus* spp. and hardy shrubs such as *Acalypha grandis, Morinda citrifolia, Evodia* sp. and *Glochidion* sp. The ground cover in many areas is *Nephrolepsis hirsutula* and gingers
2	2 10%	Platform margins: mainly comprising outcropping, strongly etched and pitted coral		
3	3 15%	Beaches: narrow, low and confined to shoreline	Moderately shallow to deep, pale sands with dark humic topsoil (Tropopsamments)	
4	1 5%	Swales: close to sea level, narrow and poorly developed	As above but imperfectly to poorly drained	
5	2 10%	Footslopes: gently sloping land adjacent to foothills	Deep, dark loams and clays over pale coral sand	

D.O.S. 3215 AE

Prepared by Directorate of Overseas Surveys, 1975

TETERE LAND REGION

13. Pusuraghi Land System

This land system largely comprises forest covering small and extensive freshwater swamps with deep, imperfectly to poorly drained soils.

Total area 73 km^2.

Landforms

These are level to slightly concave areas with a high watertable throughout the year. Most coastal and plains backswamps are less than 5 m a.s.l. but inland valley swamps occur at 30-80 m (one reaches 200 m in the headwaters of the Hada River).

Plains backswamps are associated with the lower reaches of the north-flowing rivers where streams from the foothills are dammed by alluvial deposits from the larger rivers. These plains backswamps are 700-1400 m wide. The level of the watertable may vary considerably throughout the year.

The coastal valley swamps occur along the south coast, within Star Harbour and on Ugi . They are 300-800 m wide and may completely fill the valley in the lower courses of the river. Rivers often have beach barriers across their mouths resulting in the impounding of small streams.

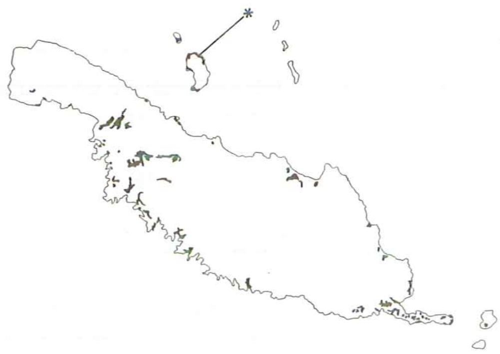
The inland valley swamps are a feature of western San Cristobal not seen elsewhere in the Solomons. They may occur either in the headwaters or along the middle courses of the rivers. They generally have a sinuous shape, are 500-1000 m wide, up to 5 km long and fill the whole width of the valley. Uplift of the northern coast associated with the drowning of the southern coastline has effected a decrease in river gradients, resulting in the deposition of alluvium by braided streams and the infilling of the valleys. The plan profile is 7.

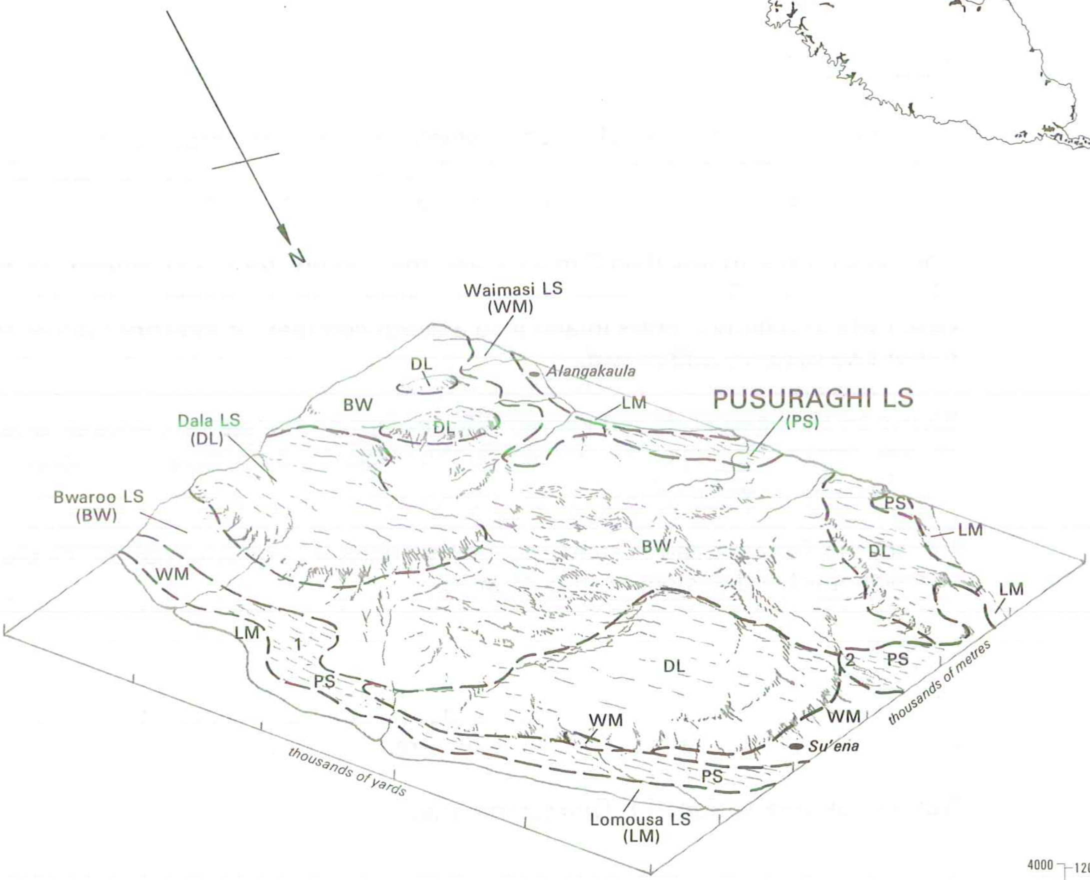
Geology

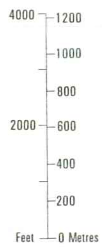
Recent, unconsolidated alluvium, mainly derived from basalt but with sediments contributing in some areas. Locally, coral or beach sands may underlie these swamps and patches of organic matter may occur.

Number of observations 82. Part of Sample Area SB.

Location of block diagram *
and distribution of land system







Derived from 1:50,000 DOS 456 (Series X711)
Angle of Projection 30°
Note: In areas where land systems are repeated, abbreviations only are shown.

Land facet 3 is not present in area shown

Land facet	Area km^2-%	Landform	Soil	Vegetation and land use
1	11 15%	Plains backswamp: low-lying areas between 700-1400 m wide; subject to occasional flooding	Moderately deep to deep, imperfectly drained, brown to yellowish brown clay to sandy loam with occasional gravels (Tropofluvents)	Gardens and low regrowth characterised by *Hibiscus tiliaceus, Macaranga* spp. and *Litsea solomonensis*
2	33 45%	Coastal valley swamps: completely or partly filling southern valleys, between 300-800 m wide at or close to sea level	Deep, imperfectly to poorly drained, brown to dark greyish brown mottled, mixed sandy loam and clay loam (Aquic Tropofluvents) Shallow, very poorly drained grey sandy clay or sandy loam (Tropaquents)	Tall mixed swamp forest with a canopy 30-35 m high dominated by *Terminalia brassii* and with *Pometia pinnata, Eugenia tierneyana* and *Inocarpus fagiferus* common in the canopy and sub-canopy
3	29 40%	Inland valley swamps: sinuous, up to 5 km long, width 500-1000 m, altitude between 30 and 80 m a.s.l.	Deep, very poorly drained, grey or greenish grey clay loam or clay (Fluvaquents) Deep, waterlogged peat and peaty clay (Tropohemists)	A low dense cover of bamboo, pandans and *Hibiscus tiliaceus* covered by scrambling *Stenochlaena* sp. to 12-15 m, with emergents of *Terminalia brassii* and *Barringtonia racemosa*

D.O.S. 3215 AF

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TETERE LAND REGION

14. Tenaru Land System

This land system comprises narrow beaches occurring in the larger bays, formed predominantly of coarse volcanic debris and is widely used for settlements and coconut estates.

Total area 18 km^2.

Landforms

The land system is formed of beaches which develop at the mouths of the larger rivers draining the volcanic interiors. The beaches contain little coral material, compared with the similar but coral-rich Lomousa Land System.

The beaches rise to less than 3 m a.s.l. and they do not form a prominent feature of the landscape. There is generally a steep shelving seaward edge to the storm beach which rapidly merges inland into a beach complex of indistinct ridges and minor swales up to 300 m wide.

Slopes on the beaches do not exceed 3-5°, except on the seaward edge or where narrow creeks and swales run parallel to the ridges, where slopes may exceed 10°. The plan profile is 7.

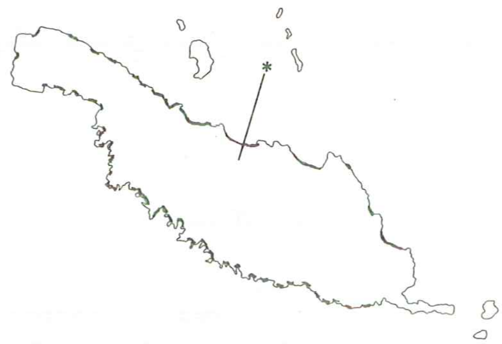
Inland, the Tenaru Land System commonly grades into alluvium of the Kopiu and Waimasi Land System or into swamps.

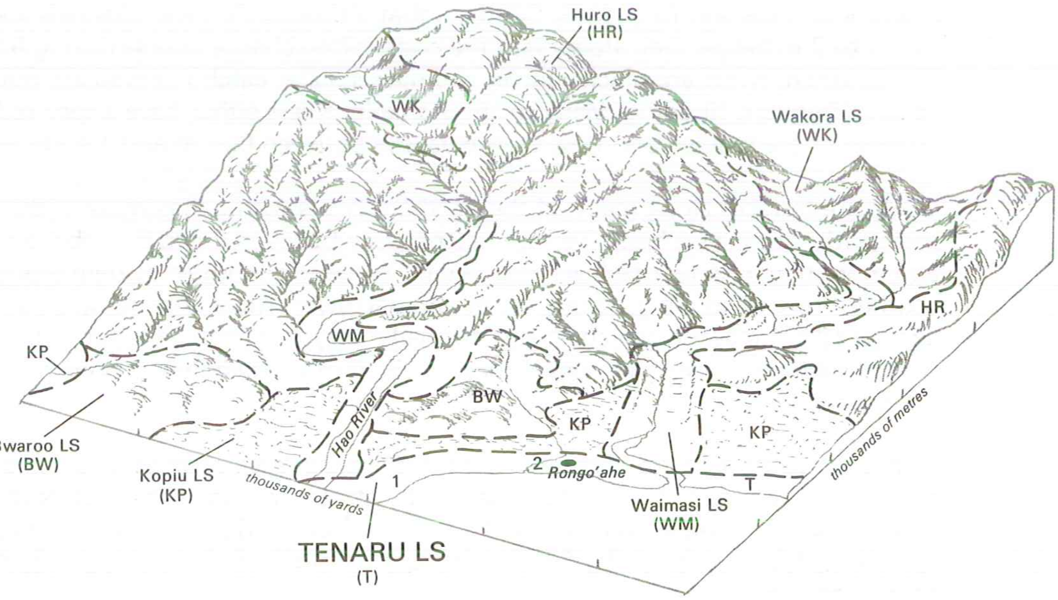
Geology

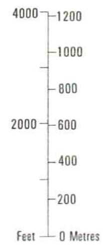
Recent coarse sediments derived from andesitic and basaltic parent materials with occasional small amounts of limestone or coral fragments.

Number of observations 11. One sample site.

Location of block diagram *
and distribution of land system







Derived from 1:50,000 DOS 456 (Series X711)
Angle of Projection 30°
Note: In areas where land systems are repeated, abbreviations only are shown.

Land facet	Area km2-%	Landform	Soil	Vegetation and land use
1	15 85% (est)	Beach ridges: varied width generally less than 300 m; up to 3 m high, gently undulating micro-relief, slopes gentle	Deep, well drained, dark brown to yellowish brown loose sand (Tropopsamments) Moderately deep to deep, well drained, dark brown rounded gravels (Troporthents)	Almost entirely used for village sites, garden areas and coconut estates; the latter often neglected, with regrowth trees such as *Securinega flexuosa, Kleinhovia hospita, Artocarpus incisus* and *Barringtonia asiatica*
2	3 15% (est)	Swales: low between beach ridges, less than 20 m wide, almost flat, high watertable	Deep, poorly drained, greyish brown mottled sandy clay (Aquents)	

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15. Waimasi Land System

This land system includes alluvial plains and low terraces associated with many of the larger rivers. Soils are well to poorly drained, of mixed composition and are widely used for gardens.

Total area 153 km^2.

Landforms

Alluvial valleys with one or more terrace levels, incised by active streams and former river channels, comprise most of the land system. The altitude varies between sea level and 600 m and the plan profile is 7.

Valley widths are varied, with the larger valleys being up to 1.6 km wide. The long, north-flowing rivers commonly have a well-defined meander belt. They have large catchment areas and frequently flood, so that although the river channels are incised by up to 3 m below their floodplain the rivers often change course during flooding. The southern rivers are much shorter and have smaller catchments so are not subject to such frequent flooding. Many of these smaller rivers either have a very reduced channel or are braided and flow within valleys between 600 m and 1.4 km wide.

There are terraces along many of the northern rivers with a maximum width of 600 m and gently sloping surfaces. Terrace heights vary between 2 and 6 m above river level and more than one terrace level may occur. Terraces are not so evident along the southern rivers and are generally lower and narrower. River channel widths may exceed 120 m close to the coast and normally only one channel is active but in the Nughu valley, the river has numerous small 5-10 m wide channels, none of which are clearly marked.

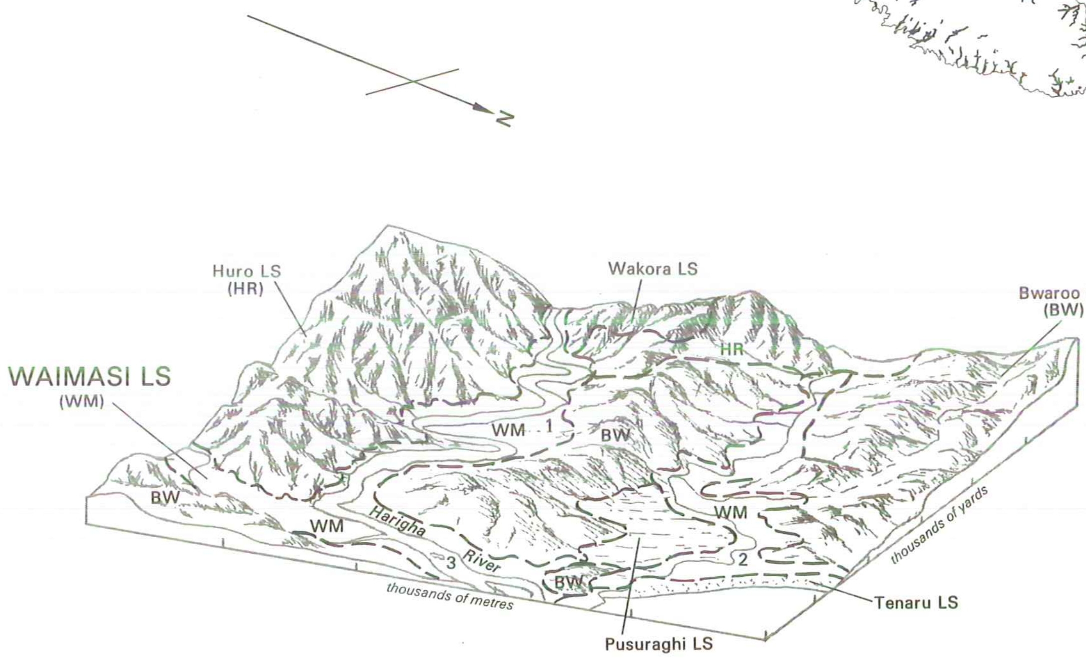
In the headwaters of the northern rivers, there occur several areas of old alluvium or lacustrine deposits now being dissected by stream incision. The best developed of these is in the headwaters of the Waimarae River at 160 m. Slopes on these old alluvial surfaces are generally 2-5° but stream incision results in valley slopes of between 18-25°.

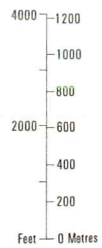
Geology

Recent river alluvium derived chiefly from basic volcanic rocks with the addition of some calcareous and non calcareous sediments locally.

Number of observations 107. Sample sites 7. Part of Sample Area SB.

Location of block diagram *
and distribution of land system





Derived from 1:50,000 DOS 456 (Series X711)
Angle of Projection 20°
Note: In areas where land systems are repeated, abbreviations only are shown.

Land facet 4 is not present in area shown

Land facet	Area km²-%	Landform	Soil	Vegetation and land use
1	69 45% (est)	Terraces: several different levels, up to 600 m wide, slopes 0-2°, height 2-6 m above river level	Moderately deep to deep, well drained, dark brown to dark yellowish brown clay or sandy clay loam, occasionally loamy sand (Fluvents/Eutropepts)	Lowland forest with *Pometia pinnata, Pterocarpus indicus, Amoora* sp., *Vitex cofassus* and *Ficus* spp. all common canopy-forming trees. In wetter areas *Terminalia brassii* occurs as an emergent whilst *Inocarpus fagiferus, Hibiscus tiliaceus* and *Dysoxylum* sp. form a medium to low canopy. Widely used for subsistence gardens or under garden regrowth
2	54 35% (est)	Alluvial plains: almost flat, slopes 1°, width varied up to 1000 m, network of small creeks and channels, slight hummocky microrelief	Deep, imperfectly drained, brown clay loam or clay, becoming water-logged below 50 cm (Aquic Tropofluvents) Deep, poorly drained, dark grey or greenish grey clay loam or clay (Fluvaquents)	
3	15 10% (est)	Channels and depressions: incised up to 3m, varied width, sinuous	Boulders and gravel beds	Unvegetated river channels
4	15 10% (est)	High level alluvium: inland valleys dissected by present rivers, resulting in moderate to moderately steep slopes	Deep, well drained, yellowish red to red silty clay or clay (Haplorthox)	Lowland forest similar to above but with a large number of trees with edible fruits especially *Canarium* spp.

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Part 4

Agricultural potential of the land regions

INTRODUCTION

The land regions, and in some instances their component land systems, are discussed below. Their main agricultural limitations are assessed and some remedial measures for these are suggested. Alternative means for increasing the productivity of the land are proposed which are consistent with the rational use of the land, but which necessarily have taken only nominal account of socio-economic factors; these should properly be the topic of supporting specialist surveys. A number of cash crops which are known to grow well in BSIP, either as cultivated currently by farmers or on research stations, are suggested. It would be possible to add many more grown as cash crops elsewhere in the humid tropics, but the selection of these lies in the field of specialist agronomists/economists.

There has been no agricultural research in this island group in the past and there are no known plans for future research work. However, the results of such work on other islands is relevant if applied judiciously, and in the general context it is useful to relate the main island of San Cristobal to the comments made on the agricultural potential of Guadalcanal (Volume 2), and the offshore islands to suggestions made for the development of parts of Malaita (Volume 3).

San Cristobal is notably lacking in large blocks of land suitable for intensive development (Part 5), and, where land with moderate or good potential exists, it is largely fragmented and surrounded by steep, dissected country. Even if several large areas were favourable for development, the low population of 11 000, with an overall density of less than 4/km^2, is not likely to yield sufficient permanent labour for more than one or two such areas.

As on the other island groups topography is the major physical constraint to agricultural development. The implications of this are introduced briefly here because the problems posed are common to several of the land regions. The presence of many steep-sided ridges and valleys hinders access, planting, maintenance, cropping, supervision and transport of produce. In addition, erosion on the widespread moderately steep and steep slopes is constantly present, whether by slow surface wash or by periodic abrupt slope failure in the form of debris slides or landslips.

Observations during fieldwork revealed that surface wash of topsoil occurs under natural forest cover on hillsides as well as under crops. It is possible to attempt to control this but debatable whether to do so, for even in the developed parts of the world there is no complete agreement on the means or even the need for it. It would be neither possible nor practicable to attempt to prevent the recurrent, large-scale earth movements, for they result from a combination of uncontrollable factors such as heavy rains and earthquakes. There is a plausible argument for a *laissez-faire* attitude to surface erosion control; this sees the continual removal of weathered soil as enabling plant roots to reach richer, less-weathered and therefore nutrient-rich subsoil. The converse argument is that most soils, even those on steep slopes, retain most nutrients and roots in their humic topsoil and, therefore, the loss of any of this is detrimental to plants.

A high proportion of farmers on San Cristobal currently use steep hill land for subsistence crops in a shifting cultivation system. Since it is possible that some of these hill lands will be used for cash crops in the future, in the absence of Agricultural Opportunity Areas, it is important that the dangers of erosion be made known, especially under increasingly intensive use. In this, as in the other volumes of this report, we support a policy of conserving topsoil wherever and however possible.

Ideally, slopes in excess of 25° should be left under natural forest - but where such land is predominant and there is no alternative it is suggested that, for subsistence crops, bands of forest be left across hill-sides and cultivation be confined to narrow horizontal intervening strips. These forest strips would not only arrest the movement of topsoil downslope but would help to stabilise the soil. Where long-continued cultivation has removed all old forest, bands of economic trees or food forests requiring little maintenance should be planted.

Furthermore, moderate to steep slopes liable to surface wash under cultivation should be protected by simple terraces, as soils on this kind of land are generally insufficiently deep to permit prolonged topsoil removal before bedrock is exposed. The presence of terraces facilitates movement on steep slopes and permits easier extraction of produce. Bench terraces may be desirable for semi-permanent and permanent crop production on slopes exceeding 20°.

KAICHUI LAND REGION

This land region consists of low and high, mostly narrow and steep-sided ridges with shallow and deep, commonly stony soils overlying basaltic rocks. It occupies a high proportion of San Cristobal and covers approximately 1 860 km^2. The land region is unsuitable for intensive development, mainly because of its unfavourable topography. The soils are well drained, have a moderate nutrient status and have no flooding or salinity hazards. This land region occurs on Guadalcanal, and comments on it in Volume 2 are largely relevant to San Cristobal and are repeated below.

Wakora Land System

The Wakora and Wainari'i Land Systems comprise the land region. The former is the least suitable for agricultural use, its ridges being higher, narrower and generally more steep-sided than the latter; yet it is the Wakora Land System that is still cultivated inland, in eastern parts of the island. Its major ridges commonly rise to 600-800 m, with medium to very long, mostly straight and steep flanks. The minor ridges and spurs are separated by narrow, deep gullies with steep lower slopes. As much as 50% of the land system comprises steep slopes liable to erosion and a further 20% consists of narrow stream and valley floors of no agricultural use.

The traditional methods of shifting cultivation do not include even the simplest elements of erosion control, and sweet potato and banana gardens may be left relatively unprotected in the early stages of growth when heavy rainfall can remove much topsoil. The soils on these slopes are believed to be largely Eutropepts, that is with good available and reserve nutrient supplies. Nevertheless, the topsoil is the richest part of the profile which it is in the farmer's long-term interests to conserve. Topsoil structure is not strong and even under old forest cover there is a certain amount of separation of the fine earth fraction and its removal downslope during heavy rains.

With shifting cultivation it is uneconomic and unnecessary to construct permanent terraces. Simple erosion barriers on slopes exceeding about 25° would be beneficial, however, and not difficult to build. They can consist simply of the cut branches, litter, stones and debris from clearing operations placed in swathes across slope and lodged where convenient behind tree stumps. There probably would be little extra work involved in this suggestion and the traditional subdivision of gardens could be co-ordinated readily with barrier spacing. When the garden is abandoned after 1-3 years, the barriers will fall into disrepair but by this time regrowth vegetation will have secured a foothold and be able to protect the surface.

The number of crops that could be grown in these hilly areas is potentially wide but the range is reduced severely by excluding those that require mechanical cultivation and those that are labour-intensive. Unless very small areas are considered there is insufficient manpower at present to cope with crops such as capsicums that require attention at frequent intervals. In addition, it will not be possible to grow high weight/low value produce in areas distant from the coast until roads are available, and there can be little justification for serving these areas until the network over the better populated coastal lands is improved. Crops such as gingers and turmeric, however, should grow well if good husbandry is practised; they are best planted on gentle or moderate upper slope segments.

There is a large variety of local fruit trees which would provide a variation in the diet, such as *Areca catechu* (betel nut), *Canarium* spp. (nuts) *Barringtonia edulis* (cut nut), *Artocarpus incisus* (bread fruit), *Eugenia malaccensis* (Solomon Island apple), *Mangifera* sp. (mango) and *Barringtonia dulcis* (hogplum). At present, however, there is little financial inducement and no formal marketing setup available to promote the growth of these potential cash crops. Where settlements are becoming more permanent, it would be beneficial to encourage the planting of these species on land that requires permanent protection, namely steep slopes, gullies or stony sites.

To summarise, the Wakora Land System is sparsely populated at present and until there is greater pressure to make use of the land few suggestions are immediately practicable. The present system of shifting cultivation is not greatly detrimental the the land but could be improved upon by simple erosion control and the use of a greater variety of crops.

Wainari'i Land System

This land system is separated from the Wakora Land System by a major fault line. The rock types are similarly basaltic but the ridges are lower, rather less steep and are separated by wide swampy valleys of the Tetere Land Region. The soils that have been analysed appear to be less nutrient-rich and the watershed plateaux, so common in the east, are rare.

The land system is uninhabited, except in scattered coastal areas, but, for a number of reasons, has more potential than the Wakora Land System. Because the ridges are lower, the slopes are shorter and the proportion of narrow ridges, together with unstable, mainly lower slopes, is only about 28%: as much as 54% of the land consists of stable slopes and broad ridges, although individual areas are small and fragmented. Steep slopes limiting to cultivation, therefore, are fewer and there is more scope for the planting of permanent crops on the widespread moderate and moderately steep slopes.

Few soils have been analysed from this land system but the indications are that on the slopes there are brownish, shallow to deep, commonly stony Dystropepts with low available nutrients. On the ridge summits, especially where they broaden, more strongly leached reddish Tropohumults can be expected. Although infertile in the subsoil these soils are well drained and their fertility status can be improved readily by relevant fertiliser application.

The presence of several broad valleys penetrating the land system from north and south coasts is a potential asset. They are also discussed in the Tetere Land Region, but since they are intimately connected in this area with the potential of the Wainari'i Land System, it is important to outline four important features. Firstly, the valleys provide obvious access routes to the island's interior from both north and south coasts. Secondly, several of the valleys contain swamps, but this need not hinder road development around their fringes. Thirdly, broad valley sections are separated from each other by steeper, narrower valley sections in which road building would be more difficult, and fourthly, adjacent to many of the broad valleys, there are ridge footslopes that range from gentle to moderate in steepness and which would lend themselves to cultivation.

The land system on the whole, therefore, is virtually unused and there appears to be little actual pressure or potential population movement into it. The overall potential for crop production is low because of its hilly nature, but there are many small pockets of land that could support permanent crops. A redeeming feature is the presence of broad valleys, which facilitate access.

Within the Kaichui Land Region there may be scope for small-scale timber operations. The forest comprises mixed-species lowland forest, with no areas identified from air photograph interpretation or fieldwork as containing predominantly one species. Large areas of cyclone-damaged forest were not noted during fieldwork, but in 1971 cyclone Ursula devastated forest on the Surville Peninsula and the Star Harbour area of San Cristobal. The main canopy species is *Pometia pinnata* with *Pterocarpus indicus, Canarium* spp, *Calophyllum kajewskii* and *Vitex cofassus* all commonly occurring. The presence of an *Albizia* sp. in several areas is indicative of cultivation in the past. These features are confirmed by Walker (1948) who examined several coastal areas.

GHAUSAVA LAND REGION

This land region of 18 km^2 is small and scattered, but distincitive. It consists of rounded hills and ridges with brownish and reddish soils formed from ultramafic rocks and is further characterised by species-poor *Casuarina papuana* forest. It occurs only close to the northern coast as isolated areas of the Marapa Land System near Waimasi and Wanione Bays.

Although the soils of these areas appear to be largely deep and well drained and the topography of middle and upper slopes is favourable for cultivation, the land region is considered unsuitable for agricultural development because of the adverse soil fertility. This is the result more of an excess of certain minerals than a deficiency, although potassium and phosphorus are low. Levels of nickel and chromium are higher than in any other land system and may exceed 0.3% in the subsoil. In some areas there may be as much as 10.8% Mg in the lower subsoil and an unusually high magnesium/calcium ratio in the cation exchange complex. Probably for these, and possibly for other reasons, the natural vegetation is dominated by *Casuarina papuana,* other species being less tolerant or able to compete in these conditions.

Some areas in the west have a fern-pandan thicket or open woodland appearance that is thought to have resulted from periodic firing in the past (Plate 7.3). These places have shallow, stony soils with common rock outcrops.

MBETILONGA LAND REGION

The land region comprises low to moderately high hills and ridges overlying sedimentary rocks. The soils are predominantly brownish or reddish loams and clays and the region includes areas of subsistence farming. The region extends along or near the northern coast, and in the east, fingers southwards and forms scattered outliers: its total area is approximately 867 km^2. Many small areas are suitable for agricultural development. The chief limitations are localized deeply dissected topography and infertile soils: there are no drainage, flooding or salinity hazards. The Mbetilonga Land Region is also described in Volumes 2 and 4 where suggestions for use are basically relevant to San Cristobal.

Some land systems have greater potential than others and for ease of discussion the lower hills and ridges are separated from the more dissected hills and the plateaux.

The Bwaroo and Ubuna Land Systems

These land systems comprise low-amplitude, rolling hills and ridges where steep slopes are relatively uncommon and confined to lower slopes adjacent to incising streams. Soil stability, moreover, is generally high and signs of erosion under old forest are confined to small terracettes formed by surface wash. Steep to moderate hill slopes mainly contain nutrient-rich Eutropepts; less steep slopes have more strongly leached brown Tropudalfs, while broad summits commonly show strongly leached yellowish red Tropohumults or even the very strongly weathered red Haplorthox. Heavy manuring of crops should not be necessary except on the most deficient red clays of summits although potassium deficiency is liable to be a recurrent feature on almost all soils.

Based on the air photograph analysis for facet identification (Part 3), approximately 70-80% of these two land systems has stable, gentle to moderate slopes suitable for cultivation. Unfortunately, these areas are commonly fragmented and separated by many smaller areas of steep slopes, narrow and deep valleys. This effectively hampers planning of large-scale development and hinders cross-country access.

Shifting cultivation for subsistence crops in the Bwaroo and Ubuna Land Systems is not detrimental provided the fallow period is sufficiently long and provided that the short, steep lower slope facets are avoided, or at least protected from erosion. Prolonged cultivation in parts of Ugi Island has led to soil exhaustion (see Dala Land System below). Where bananas form part of the staple diet it would be particularly suitable to concentrate their planting on the steeper slopes, where their growth on the rich soils could be expected to be rapid, and the discarded stems after fruiting can act both as a mulch and as erosion barriers.

As in the Kaichui Land Region it is possible to suggest many cash crops that could be grown. The choice is less restricted by labour limitations, because in several localities there are groupings of villages in which sufficient labour would be available for small blocks of development. Similarly, transport is not the same problem as for inland areas, most places being within a short distance of the northern coast. A road is being constructed from Kirakira to Arosi which will considerably aid movement of people and produce along this harbourless coast. Thus gingers, turmeric, chilli and possibly other spices would be suitable crops for smallholders or preferably for small block development by co-operatives. Cocoa should grow on these commonly calcareous soils as satisfactorily here as in Malaita (Volume 3), also coconuts and possibly coffee. It should be remembered, however, that the chief nutrient deficiency of most of the soils is potassium, and crops such as coconut may be particularly sensitive to this deficiency. Crops such as oil palm, which requires large single blocks of land and on-site factories for preliminary processing are unsuitable.

Cattle could be kept in conjunction with some pastures under crops such as coconut. There is no shortage of streams but it may be necessary to restrict pastures to the least sloping land to prevent erosion.

These land systems inevitably will play an important part in cash crop production from San Cristobal. At present their production is nil except for possibly a little copra, and it will take considerable advice, aid and encouragement to initiate production, in addition to which a marketing infrastructure has to be established for the collection and transport of produce.

Huro Land System

The potential of this land system approximates that of the steep land in the Kaichui Land Region and is low. It is limited chiefly by the presence of many steep-sided ridges which are separated by narrow rocky valleys. Only on some broad ridge summits is the scope for intensive agriculture at all high. The soils range from erodible, unleached, nutrient-rich Inceptisols on the steeper slopes, to strongly leached, less fertile but stable ridge summit soils: there are no flooding, drainage or salinity hazards, however.

At present, small inland areas are used for shifting cultivation in the eastern half of San Cristobal. As with the Kaichui Land Region, there is no tradition of slope protection by terracing but the construction of simple erosion barriers during felling and clearing would again be effective. The results of excessive clearing and burning during cultivation are apparent in the Wanione area where gullying is spreading.

Because of the dissected nature of the terrain, there is no possibility of large-scale cash crop introduction and those wishing to utilize the land system for cash crop have little choice but to use more intensively the small area of level summits and gentler upper slopes with low-fertility soils.

Ravoraha Land System

The distribution of this land system is confined to widely scattered ridge summit areas of the eastern part of inland San Cristobal. It comprises low hills and ridges forming hilly plateaux between 1 and 40 km^2 in area at about 600-800 m. The hills have a low amplitude of relief with moderate to steep short slopes which constitute an erosion hazard in scattered small areas: gullying seems common locally, which may partly be a reflection of high rainfall in these medium-altitude situations. The soils are varied but most have accumulated organic-rich surface horizons (Humitropepts, Tropohumults). Leaching has been effective in the profiles analysed and it is probable that subsoil nutrient deficiencies are a limitation. There are no flooding, drainage or salinity hazards but shallow, rocky soils are known to occur in places, particularly in areas underlain by limestone.

The land system is not currently used but the vegetation contains species associated with regrowth from which it is inferred that these hilly areas were used extensively when the population of the inland area was higher, as they would be the obvious places for settlements and gardens in otherwise deeply dissected country.

Although the land system could be used for either shifting cultivation or cash crops, there being no serious limitations apart from steep slope facets, the practical development of it would be difficult due to the scattered fragmented areas, commonly isolated by deep, narrow valleys. Some areas near the north coast are accessible by ridges rising gently from the coastal plains but in most cases any produce would be difficult to transport. Several areas occur at altitudes of 800-1 000 m, where rainfall can be expected to be high and mean temperatures at least 5-6°C lower than at the coast. The advantages of this for possible warm temperate crop growth may be offset by a decrease in sunshine hours due to cloud.

It is concluded that even though the potential of the land is moderate, it should remain low on the list of priorities for development until better land elsewhere is fully occupied.

ROKERA LAND REGION

This land region consists of low and high, coral-based terraces with shallow and deep soils, which occur in western, northern and eastern San Cristobal. They are the dominant landform of the offshore islands covering a total of 116 km^2. Topography is not a major factor limiting development and there are no drainage, flooding or salinity problems. However, some soils are infertile and others are shallow with common rocky outcrops. The land region occurs also on Malaita (Volume 3) and some of the discussion on the Alokan and Kohinggo Land Systems of New Georgia (Volume 4) is relevant to San Cristobal. Slopes on the main terrace surfaces are level to gently rolling and are not a limitation. At terrace margins, however, particularly on the seaward edge, are steep to cliffed, rocky slopes with coral limestone outcrops. In addition, there are scattered, joint-controlled clefts and gorges, particularly along the northern mainland coast which both reduce the cultivable area and restrict access parallel to the coast. The building of a road onto the main terrace in the Arosi area (Hada AOA, Part 5) may be difficult because of the gradient, but roadstone abounds.

Arosi Land System soils (which only occur on the mainland) are typified by their varied depths and low fertility. Those on the main terrace surface are deep but strongly weathered and leached (Eutrorthox), while those on the margins are less strongly weathered and leached but shallow (Rendolls/Tropudalfs). Common to both, however, is a calcium-saturated, lower subsoil with free carbonates and a deficiency of potassium beneath the topsoil. The Eutrorthox of the terraces have the greatest potential but require a balanced fertilizer: the terrace margins cannot be used extensively because of the many rock outcrops.

Dala Land System soils are shallow to deep, and differ in being less strongly weathered and showing an increase in clay content with depth (Oxic Tropudalfs). They require potash fertilisers, in particular, and experience at Dala Experiment Station (Dala Land System, volume 3) shows that, with potassium alone, coconut, sweet potato and cocoa growth can be improved considerably (Gollifer, 1972; Friend, 1970). In the calcareous soils that prevail on these terraces, trace element deficiencies, particularly iron, are also possible.

Ugi Island has a localized high population density, it is apparent that there is a trend in these areas to cultivate land for too long and with too short a fallow period. This results in exhausted soils and degraded regrowth vegetation containing *Acalypha grandis,* and *Nephrolepis hirsutula* . These features are especially noticeable around long-established schools, where there is limited surrounding land in which school produce gardens can be established. Sweet potato is a high potassium feeder and if the potato vines are thrown away after repeated cropping, instead of mulching, the soil will rapidly become deficient. In these situations the use of fertiliser is essential for sustained yields.

The potential of these land systems is high and, where sufficiently extensive, they form AOA's (Part 5). The range of crops that can be grown is wide and from the physical point of view is limited only by those requiring acid soils. Spices, cocoa and coconut are all suitable and known to grow well on these soils under good management. Cattle may also be reared but there is a potential difficulty of lack of surface water in places. Surface runoff of water is minimal and the drainage system is principally subterranean.

TETERE LAND REGION

This land region comprises forested and cultivated floodplains, low riverine and marine terraces, swamps and beaches with a wide variety of young soils on Recent sediments. It occurs as a discontinuous coastal belt in the north of San Cristobal, as isolated alluvial valleys in the centre of the island and as separated small valleys and narrow beaches on the south coast. The approximate area is 300 km². There is a varied potential and the chief limitations are fertility, drainage, flooding and salinity. Because of their widely different properties, the component land systems are discussed separately.

Pusuraghi Land System

The main limitations of this land system are poor soil drainage and a liability to flooding. The soils are not saline, are moderately fertile and the topography is only a limitation in those coastal situations where the land lies very close to sea level, so making drainage improvements difficult. The extent of the individual swamps forming the land system is not great, the largest being in the order of 1 000 ha. Their potential is high if the drainage can be improved. Some marginal areas are already suitable for tree crops not susceptible to periodic brief flooding.

The coastal swamps in the southern valleys are thought to be shallow. They develop where the main rivers become choked and split into many smaller streams over a wide area. Shallow peat develops in places, but most soils are poorly or very poorly drained and the underlying alluvium consists of poorly sorted silts, sands and gravels. It is anticipated that drainage improvement would not be difficult in places, mainly by the clearing and enlargement of one major channel and the closing of small distributaries. This would be most easy at the heads of floodplains where braiding is minimal and become progressively more difficult downstream where there is no apparent main channel. There is also the distinct possibility of periodic intense cyclonic rainfall causing such a great rise in river level that all such improvements are completely demolished.

North-coast swamps are located in backswamp basins where braiding difficulties do not occur: the watertable is permanently high, however, and flooding to 1-2m may occur once or more each year. To improve the drainage of these areas where they lie at least a few metres above sea level it is necessary to open main drains from the swamp through the nearest main river levee, and to develop a network of feeder drains into the main drains. This will not prevent periodic short-term flooding but will lower the ground watertable sufficiently to aerate the upper part of the soil profile. Flood prevention by artificially raising main river levees would be possible but expensive.

The inland swamps of the Western Lowlands have different properties. They have developed in old floodplains which have become stranded through structural movements of the land; in most it is thought that swampy conditions have developed as a result of the land tilting and sinking to the south and so decreasing the gradient of north-flowing rivers to the point where some are almost reversed. Peat depths probably vary widely, and in some valleys, water ponding has created virtual lakes. The gradient of some swampy valleys, however, is probably sufficiently great to improve the drainage by main stream clearance and the digging of a pattern of feeder drains. The periodic floods that probably fill the floodplains at intervals will be lessened but not entirely eliminated by drainage improvements.

Swampy lands are not used at present except in small areas for swamp taro *(Cyrtosperma chamissonis)* and sago for thatch. They are potentially suitable for a wide variety of crops after drainage, but since flooding is liable to be a recurrent threat, tree crops may be a better choice. Flooding has the small advantage of adding fresh silt deposits, which renews the soil fertility. Crops requiring a great rooting depth, or with deep tap roots, may be unsuitable for areas with only slightly improved drainage.

Irrigation for rice is a practicable possibility in some areas, to judge by qualitative observations of river water quality and quantity. Cattle pastures would also be appropriate in many places, particularly in conjunction with light-shading tree crops such as coconut.

Waimasi and Kopiu Land Systems

These land systems consists of river floodplains, low riverine terraces, and outwash fans, found in small areas throughout the islands except the Eastern Highlands of San Cristobal. The soils vary from red to brownish clays and loams and are predominantly fertile. The main limitations for agriculture are flooding, and, with this exception, they have a high potential for development.

Mapped areas of the Waimasi Land System (Separate Map 7e) do not differentiate between floodplain and terrace because of mapping scale limitations. Narrow inland valleys consist almost entirely of rocky floodplains and low terraces highly susceptible to flooding, while closer to the sea there are likely to be areas of terrace and levees that are only flooded infrequently if at all. Some remote inland areas of stranded alluvium which consist of high dissected terraces (est. 5-10 m high) contain deeply weathered red clays, but these are thought to be exceptional.

The brownish loams and clays of lowland riverine tracts and the outwash fans are fertile with the possible exception of their subsoil potassium status. Being freely or imperfectly drained they have high agricultural potential for a variety of purposes. Some coastal areas are being used for sweet potato or coconut production, but these can be extended considerably, especially in the large bays of the northern coast. Arable cultivation should be possible in places as the soils are mostly deep, and in the Waimasi Land System are stone free in their upper parts. Cattle pastures could be easily established and good water supplies are plentiful.

Transport should not be too difficult at the coast and in lower river courses, as tractor trails can easily be built along river levees. Inland areas, however, are more difficult to reach, and floodplains with rocky courses or narrow deep valleys may prevent their development. Many villages are sited on or near the land system and labour supplies for small development schemes should be adequate.

Kumotu Land System

This land system occurs only in small areas and is unimportant. It has a severe limitation of daily inundation by seawater. In addition, the soils are poorly drained and saline and would be costly to reclaim. Their present use is limited to the cutting of mangrove timber for housing structures and the collection of shellfish. Mangrove is used elsewhere to make excellent charcoal and cutch (tanin extract), while the habitat provides an important breeding ground and refuge for a wide variety of molluscs and fish.

Lomousa and Tenaru Land Systems

While not widespread, and of unusually low fertility, the soils of these land systems play a greater part in the economy of these islands than any other. They are freely or excessively drained, have low fertility, are highly calcareous and are commonly stony. They are not flooded and their topography does not hinder development. Many areas are planted with coconuts, fruit gardens or used for villages or roads.

The main reasons for their intensive use is the proximity to the villages and the convenience of being close to the means of transport and commumication. In addition, the one traditional cash crop in the Protectorate, the coconut, is able to thrive in the soils.

Since the soils are largely unsuitable for other crops because of their low fertility and unfavourable drainage, depth and stoniness, it is reasonable that the continuing planting of coconuts on them should be encouraged. Potash is notably deficient, however, and applications of appropriate fertiliser would undoubtedly be beneficial. In addition, coconuts growing on the most lime-rich soils might require trace elements such as manganese and iron, as foliar analysis of palms has indicated low levels of these elements (Joint Coconut Research Scheme, 1968). Since the soils are extremely sandy and porous and, beneath the topsoil, have low cation exchange capacity, they have a low ability to retain nutrients. In this respect alone, it is important to preserve the topsoil and, if possible, to improve it by mulching vegetation around the base of the palms.

Road construction on these land systems is simplified by the abundance of road-building materials but hindered by the presence of common streams and rivers.

Part 5

Agricultural Opportunity Areas

INTRODUCTION

The concept of the Agricultural Opportunity Area (A O A) is discussed fully in Volume 1. Briefly, it can be defined as a largely unused or under-utilised area exceeding 2 500 ha in which the prospects for cash crop farming are good. It does not signify that they are suitable only for agriculture and, for example, forestry could be an equally feasible occupation in all the Opportunity Areas. In San Cristobal, 20 015 ha (77 mi^2) are mapped as A O A 's (Separate Map 7g) whose size and characteristics are tabulated in the following pages. It is stressed, firstly, that these A O A 's represent only the largest blocks of land with outstanding potential; the coloured areas within the boundaries indicate the individual land systems. Secondly, there remain many other smaller parcels of land with equally good inherent potential outside the A O A 's, many of which coincide with specific land systems and are also coloured on Separate Map 7g. Thirdly, there are additional small (20 ha) uncoloured pockets of land with good to moderate potential in the remaining land systems which individual farmers can utilize for cash crops. Conversely, there is a small area of land facets and land systems in the A O A 's which is of moderate or poor potential.

The A O A 's are selected primarily on the basis of their undissected topography, since it is presumed that steep lands cannot be developed easily and economically over large areas. Soils are also important, and clearly it is preferable to have fertile soils to those requiring large inputs of expensive fertilizer. Saline, shallow and swampy soils are excluded as far as possible. The A O A 's, therefore, consist of rolling, level or low hilly areas with moderately deep, well drained soils of varied fertility. In addition, areas already used extensively for shifting cultivation or cash crops, such as the Dala Land System on Ugi Island, are excluded: the degree to which the A O A 's are cultivated is summarised in Table 10 below.

TABLE 10 **Agricultural opportunity areas: a summary of land use data derived from 1971 photography**

Agricultural Opportunity Area		Total area	Subsistence gardens and young regrowth	Old garden regrowth	Coconuts	Towns, villages and airstrips	Total used area
Hada	%	100	2	4	4	<1	10
	ha	9 685	225	385	415	30	1 055
	ac	23 930	560	955	1 025	80	2 620
Heuru	%	100	3	6	7	<1	17
	ha	7 340	220	465	525	25	1 235
	ac	18 140	545	1 155	1 300	60	3 060
Harigha	%	100	1	7	<2	<1	10
	ha	3 010	40	220	50	5	315
	ac	7 440	100	545	125	10	780

Only three areas in San Cristobal have been designated as Agricultural Opportunity Areas and there are none on the adjacent islands, although numerous small areas with moderate to good agricultural potential exist. Along the northern coast a number of discrete blocks of good land are separated by steep-sided valleys which prevents east-west communications except at the coast. The Warihito and Ravo Rivers flowing into Wanione Bay have considerable areas of utilisable alluvium, and associated with them are low hills of the Bwaroo Land System. Unfortunately, there are areas of swamp within the valleys which considerably reduce the potential of the area.

Several other areas exist which do not fulfill the minimum size criterion of an A O A but nevertheless still cover a considerable area where two or more land systems with moderate to good potential are in juxtaposition.

In the following descriptions the tabulated area data for each AOA shows a grouping of land facets within each land system rated according to their suitability for agricultural development.

High suitability: land with few physical limitations to development and having either slopes that do not require complex soil conservation measures or soils with few drainage and no salinity problems.

Medium suitability: land having some limitations to development, particularly drainage, salinity and flooding problems or steep slopes requiring some measure of erosion control.

Low suitability: land that, because of the major limitations of slope steepness, drainage, salinity, flooding or soil toxicity problems, is unsuitable for development.

For the sake of brevity minor inclusions of swamp, valley and dissected hilly land systems are not discussed; their characteristics can be found in the land system descriptions of Part 4.

HADA (97 km², 37 mi²)

TABLE 11 Area of component land systems of the Hada AOA

Land system: % of AOA and area	Land facet: % of AOA, and area		
	High suitability	Medium suitability	Low suitability
7. Ubuna 56% 5 420 ha, 13 390 ac	Facets 1 and 3 37% 3 630 ha, 8 970 ac	Facet 2 6% 595 ha, 1 470 ac	Facets 4 and 5 13% 1 195 ha, 2 950 ac
8. Arosi 34% 3 300 ha, 8 155 ac	Facet 1 13% 1 220 ha, 3 015 ac	Facet 2 16% 1 550 ha, 3 830 ac	Facets 3 and 4 5% 530 ha, 1 310 ac
15. Waimasi 5% 485 ha, 1 200 ac	Facets 1 and 4 3% 290 ha, 715 ac	Facet 2 1.5% 145 ha, 360 ac	Facet 3 0.5% 50 ha, 125 ac
5. Huro 4% 360 ha, 890 ac	Facets 1 and 2 0.5% 55 ha, 135 ac	Facets 3 and 6 2.5% 205 ha, 505 ac	Facets 4 and 5 1.0% 100 ha, 250 ac
12. Lomousa 1% 120 ha, 300 ac	–	All facets 1% 120 ha, 300 ac	–
Suitability totals	53.5% 5195 ha, 12835 ac	27.0% 2 615 ha, 6 465 ac	19.5% 1 875 ha, 4 635 ac

The Ubuna Land System consists of moderately high ridges with a low amplitude of relief, whilst the other major land system within the Hada AOA, the Arosi Land System, comprises a lightly dissected coral platform.

The major limitation of the Ubuna Land System is the scattered presence of unstable, short, steep slopes which become most common inland where the Hada and Eteria Rivers have dissected the landscape. Rocky slopes and cliffs associated with the elevated margins of the Arosi Plateau occur around the seaward margin of the Arosi Land System and close to the two largest rivers, so that shallow soils and rock outcrops are the major limitations. On the plateau surfaces, rock outcrops and shallow soils are limited to incised drainage lines and moderately deep to deep soils predominate over the greater part of the land system.

Flooding may affect the lower parts of the alluvium associated with the Hada and Eteria Rivers, but elsewhere in the AOA neither flooding nor drainage should present any problems.

Stony and commonly shallow soils of the Lomousa Land System and the deep sands of the Tenaru Land System are found at the coast. Both are suitable only for coconut cultivation.

A high potential for different kinds of agriculture ranging from mechanised cultivation of arable crops to tree crops, annuals, spices and the establishment of pasture for cattle exists on the plateau surface. Application of fertiliser, particularly potash, will be necessary and levels of magnesium will be low in some soils. Phosphorus levels of the soils however are already high.

On the low inland hills of the Ubuna Land System there will be little scope for mechanised arable crops, although small areas suitable for hand-cultivated spices will be numerous. This land would be suitable for a wide variety of tree crops including coconuts and cocoa, provided that precautions were taken to control erosion on the steeper slopes. Levels of potassium will initially be limiting in some areas, but, after a short period of cropping, other nutrients, particularly phosphorus and nitrogen, will be required; levels of magnesium should remain adequate.

The margins of the AOA are in use for both subsistence crops and coconuts but as yet there has been little utilisation of the central area. 860 persons lived in the area in 1970, a density of $9/km^2$.

Access into the AOA will be difficult, because of the steep terrace edge which surrounds the area and which would have to be surmounted before the interior could be opened up. The continuation of the northern San Cristobal road into the area would provide an outlet for produce through Kirakira but it would mean transporting it a considerable distance by road. The possibility of providing a wharf at Maro'u Bay should be considered, for although this bay is exposed to the north-westerlies, it is sheltered from the south-easterlies for the greater part of the year. The coral limestone which underlies a large part of the AOA will provide very suitable hardcore for road making.

A detailed study of the soils of part of this AOA can be seen in Appendix 4, the Arosi Sample Area (SA). This has shown that the soils of the terrace surfaces are predominantly deep and it is not considered necessary to have follow-up surveys. A similar detailed study has been carried out on the soils of the Ubuna Land System in the Heuru Sample Area (SC) in Appendix 4. However, it would be advisable to have a wider understanding of steep slope distribution in the Ubuna Land System before the area is developed on a large scale; this can be achieved by the production of detailed contoured maps.

HEURU (73 km², 28 mi²)

TABLE 12 Area of component land systems of the Heuru AOA

Land system: % of AOA, and area	Land facet: % of AOA and area		
	High suitability	Medium suitability	Low suitability
8. Arosi 46% 3 380 ha, 8 350 ac	Facet 1 17% 1 250 ha, 3 090 ac	Facet 2 22% 1 615 ha, 3 990 ac	Facets 3 and 4 7% 515 ha, 1 270 ac
7. Ubuna 43% 3 155 ha, 7 800 ac	Facets 1 and 3 29% 2 130 ha, 5 270 ac	Facet 2 5% 365 ha, 900 ac	Facets 4 and 5 9% 660 ha, 1 630 ac
4. Bwaroo 6% 440 ha, 1 085 ac	Facets 1 and 3 5% 365 ha, 900 ac	Facets 2, 4 and 5 0.5% 50 ha, 125 ac	Facet 6 0.5% 25 ha, 60 ac
12. Lomousa 3% 200 ha, 545 ac	–	All facets 3% 220 ha, 545 ac	–
15. Waimasi 2% 145 ha, 360 ac	–	All facets 2% 145 ha, 360 ac	–
Suitability totals	51% 3 745 ha, 9 260 ac	32.5% 2 395 ha, 5 920 ac	16.5% 1 200 ha, 2 960 ac

In this AOA the Arosi Land System does not form the broad, level platform or terrace which is characteristic of the Hada AOA. Instead, the seaward margin of the terrace forms a low, less steep edge and the sloping terrace surface rises in steps inland to reach a height of 120 - 200 m. This surface has been dissected by the north-flowing rivers into a number of discrete blocks with steep to precipitous sides. Further inland, the Ubuna Land System is also affected by this north-flowing drainage pattern but it has gentler slopes, and formerly wide terrace surfaces have been reduced, by stream dissection, to broad ridge crests. As in the Hada AOA, the presence of scattered unstable, steep slopes is the limiting factor in the Ubuna L.S. whilst in the Arosi L.S., rocky slopes and cliffs close to the incised rivers and along the seaward margins will limit its agricultural use.

The Bwaroo Land System covers only 6% of the AOA and its main limitations are steep slopes and a low soil fertility. The Waimasi Land System is of limited occurrence and problems in its utilisation are likely to be due to poor drainage and occasional flooding close to the main channel. The Lomousa Land System forms a very narrow strip along the coast and this is already fully utilised by villages and coconuts. The potential of this AOA is similar to that of the Hada AOA with the same restrictions on development. The Bwaroo L.S. will have little scope for mechanised arable cultivation and it's development should be largely confined to tree crops, similar to the Ubuna Land System. Like Ubuna, potassium, phosphorus and probably nitrogen fertilisers will be required; levels of magnesium are high.

It can be seen from Separate Map 7f that land use on the AOA is largely coastal and that areas of subsistence crops are gradually moving inland as coastal areas become planted with coconuts. The population of the AOA during the 1970 census was 937 at a density of 13/km².

The projected north San Cristobal road would flank the northern boundary of the area and would enable the produce from the area to be moved either to Kirakira or to Maro'u Bay. To develop the area fully, however, would require feeder roads into the hills. These spur roads, because of the dissected nature of the terrain, would be short and could only serve a limited area. Consequently, several would be needed to fully open up the area, but need be little more than motorable tracks, requiring minimal maintenance. The coral which underlies the Arosi Land System would provide adequate suitable road metal.

A detailed study of the area near Heuru village was mapped (Sample Area SC, Appendix 4). This shows that rock outcrops are common, especially on the valley sides, but that elsewhere soils are moderately deep to deep. As with the Hada AOA, more detailed contoured maps of the topography of the Ubuna Land System should be produced before large-scale development commences.

HARIGHA (30 km^2, 12 mi^2)

TABLE 13 Area of component land systems of the Harigha AOA

Land system: % of AOA, and area	Land facet: % of AOA and area		
	High suitability	Medium suitability	Low suitability
4. Bwaroo 54% 1 625 ha, 4 015 ac	Facets 1 and 3 45% 1 355 ha, 3 350 ac	Facets 2, 4 and 5 7% 210 ha, 520 ac	Facet 6 2% 60 ha, 145 ac
15. Waimasi 25% 750 ha, 1 850 ac	Facet 1 12% 360 ha, 890 ac	Facet 2 10% 300 ha, 740 ac	Facet 3* 3% 90 ha, 220 ac
8. Arosi 7% 215 ha, 530 ac	Facet 1 3% 90 ha, 220 ac	Facet 2 3% 90 ha, 220 ac	Facets 3 and 4 1% 35 ha, 85 ac
14. Tenaru 5% 150 ha, 370 ac	Facet 1 4% 120 ha, 295 ac	Facet 2 1% 30 ha, 75 ac	–
13. Pusuraghi 4% 120 ha, 295 ac	–	–	All facets 4% 120 ha, 295 ac
5. Hura 3% 90 ha, 220 ac	–	All facets 3% 90 ha, 220 ac	–
14. Kopiu 2% 60 ha, 145 ac	All facets 2% 60 ha, 145 ac	–	–
Suitability totals	66% 1 985 ha, 4 900 ac	24% 720 ha, 1 775 ac	10% 305 ha, 745 ac
*Facet 4 does not occur in this AOA			

This is the smallest AOA in San Cristobal. The dominant land systems are those that are of restricted occurrence in the two AOAs of western San Cristobal.

The Bwaroo Land System covers 54% of the AOA. It comprises low hills and ridges up to 320 m but generally not exceeding 120 m. They are lightly dissected and a characteristic feature of the land system is the presence of shallow valleys merging with gentle lower slopes. Short, steep slopes and small cliffs with outcropping rocks do occur and these are the major limitations on the use of this land system.

The alluvium of the Waimasi Land System occurs along the Nakereapena, Nanuta and Harigha rivers. These rivers have well-developed terraces but lower alluvial plains predominate in this area. Consequently, many soils are imperfectly drained and become waterlogged after periods of heavy rain. From evidence of similar rivers elsewhere, it is expected that flooding may be a major hazard, especially along the Harigha River but it is not likely to be so prolonged or frequent along the smaller rivers.

A small area of the Arosi Land System occurs at the eastern end of the AOA, and here the major limitations will be soil depth and rock outcrops. Limitations on the development of the other land systems will be steep slopes on the Hura and Wakora Land Systems and poor drainage on the Pusuraghi Land System and parts of the Tenaru Land System.

The potential of this AOA is somewhat reduced by the high proportion of poorly drained soils and areas susceptible to flooding, which together may amount to 15%

of the area. It is not known how difficult drainage or flood control methods would be in this area, but any development of the low-lying alluvial soils would require an improvement in soil drainage.

The higher terraces of the Waimasi Land System together with the Kopiu Land System should provide level areas large enough for mechanised cultivation of a wide range of rain-fed arable crops, including rice. Tree crops and pasture or a combination of the two would also be a suitable means of utilising these soils. Because of the limited area of the AOA, crops such as oil palm should not be grown, as they require processing on the site and a large crop area to supply the factory.

The nutrient status of the alluvial soils is moderate to low with potassium particularly being in short supply. The soils are well supplied with calcium and magnesium and reserves of the latter are as high as 6%.

Development of the hill land will be largely confined to tree crops, as only small areas are suitable for small-scale arable farming. The establishment of pastures on the gentle to moderately sloping hillsides of the Bwaroo, Arosi and Hura Land Systems would be feasible and cattle could be raised on pastures with or without coconuts. The potassium status of Bwaroo soils appears to be unusually good, with medium to high levels occurring in the subsoil, in three out of four soils analysed. Levels of magnesium are also high but sodium is moderate to low and phosphorus is low. The 1970 population of the AOA was estimated at 150, five persons/km^2.

With such a low population it is probably impossible to develop the area unless people from elsewhere, possibly from the adjacent island of Santa Ana, can be encouraged to settle.

The coastline is largely exposed to the south-easterlies and there is no safe anchorage. An excellent, sheltered natural harbour is close by at Star Harbour and any roads should link it with the AOA. This road would also link up areas of Kopiu and Bwaroo Land Systems around the northern side of Star Harbour and any wharf facilities would be of immense value to the villages on the northern side of the Surville Peninsula. Road metal would be available from coastal coral deposits and river gravels.

Follow-up survey work will be required in the Waimasi Land System to determine the extent of the poorly drained soils, the feasibility of drainage and the possibility of flood control.

Part 6

References and relevant works

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Appendixes 1-4

Appendix 1

Selected soil profile descriptions representative of San Cristobal and adjacent islands

The locations indicated are on Directorate of Overseas Survey Maps, Series 456, and the profiles are arranged in numerical sequence.

SAN CRISTOBAL 4	PROFILE	LAND SYSTEM SOIL GROUP	WAIMASI TYPIC HAPLORTHOX

Location San Cristobal, headwaters of Waimarae River in a large, level-floored basin. DOS 10/161/6 643609

Site Wide alluvial basin with streams lightly dissecting the surface; dominant slope 5° with adjacent slopes of 12° and 9°; slope into incised river 13°; normal drainage. Alt. 116 m

Parent material Alluvial deposits of soft sandstones and conglomerates

Microrelief Smooth

Stoniness Few round basaltic surface stones

Erosion Not evident

Vegetation Medium-height, 24-27 m forest with few large trees. These include: *Pometia pinnata* (1) and *Canarium salomonense* (1); other smaller trees include *Teysmanniodendron ahernianum, Myristica kajewskii, Eugenia cincta* and *Neoscortechinia forbesii; Flagellaria gigantea* is very common in the shrub and lower tree storey

Land use Unused

Soil surface Complete leaf litter cover with many fine and medium surface roots

Horizon	Depth cm	Description
1 A1	0-5	Yellowish red (5YR4/6, wet); clay; moderate fine angular blocky structure; plastic, slightly sticky, wet; free drainage; many small and medium woody and fibrous roots:
2 B21	5-25	Red (2.5YR 4/6, moist); clay; friable, moist; free drainage:
3 B22	25-97	Red (2.5YR 4/6, moist); silty clay loam; friable, moist; free drainage:
4 B3	97-142	Red (10 R 4/8, moist); silty clay; friable, moist; common patches of weak red (10 R 4/4) and brown streaks of weathered rock fragments; free drainage.

Characteristic	Horizon (depth in cm) 1	2	3	4
	0-5	5-25	25-96	96-142
Moisture 100-105°C %	2.2	2.5	2.3	2.6
Bulk density g/ml	0.80	0.93	0.94	0.86
Loss on ignition %				
pH (1:2.5) soil:water	5.0	5.0	5.1	5.2
Conductivity mmho s	0.14	0.04	0.03	0.03
Carbonate meq %				
Exch. Na meq %	0.1	0.1	tr	0.2
Exch. K meq %	1.3	tr	tr	tr
Exch. Mg meq %	0.8	0.3	0.7	0.5
Exch. Ca meq %	2.0	0.6	0.2	0.3
TEB meq %	3.2	1.0	0.9	1.0
CEC meq %	19.1	7.5	6.6	10.6
Base saturation %	16	14	15	10
Total N %	0.52	0.17	0.07	0.03
Organic C %	5.84	1.69	0.83	0.29
Total P ppm	1 110	670	550	370
Total K ppm	1 050	1 250	1 150	1 050
Total Mg ppm	1 250	1 550	1 950	3 050
Available P				
(Olsen) ppm				
(Bray) ppm	6.2	3.0	3.9	4.2
Mechanical analysis				
2 mm – 200 μ %	2	0	0	0
200 μ % – 50 μ %	2	1	3	4
50 μ % – 20 μ %	7	8	16	13
20 μ % – 2 μ %	17	20	31	49
< 2 μ % –	72	71	50	34

SAN CRISTOBAL 5	PROFILE	LAND SYSTEM SOIL GROUP	UBUNA TYPIC TROPOHUMULT

Location — San Cristobal, near old village of Tahuruna south of the Hada River; DOS 10/161/6 547648

Site — At junction of crest and upper slope where the two merge resulting in a wide ridge 21-24 m wide; dominant convex slope 5°, adjacent upper slope 9°, associated middle slopes 16° and 20°, crestal slope 10°; shedding drainage. Alt. 213m

Parent material — Probably Hariga conglomerates and sandstones

Microrelief — Smooth

Stoniness — No surface stones

Erosion — Not evident

Vegetation — Probably very old secondary, 24-30 m, with some nut trees. *Pometia pinnata* (3) only large tree; smaller trees include *Ficus nodosa, Zizyphus angustifolius, Aporosa papuana* and *Barringtonia edulis;* shrub layer dominated chiefly by *Calamus* and saplings

Land use — Widely used in the past for subsistence farming

Soil surface — Complete litter cover

Horizon	Depth cm	Description
1 A1	0-5	Reddish brown (5YR 4/4, moist); some dark reddish brown (5YR 3/2) organic stains on the surface; clay; moderate medium sub-angular blocky structure; friable moist; free drainage; many fine interstitial pores; many fine fibrous, few medium and coarse woody roots:
2 B21	5-25	Yellowish red (5YR 4/6, moist); clay; strong coarse sub angular blocky structure; friable , moist; free drainage; common medium tubular, common fine interstitial pores:
3 B22	25-76	Red (2.5YR 4/6, moist); clay; friable to firm, moist; free drainage:
4 B23	76-127	Red (2.5YR 4/6, moist); clay; friable, moist; few dark reddish purple, weak red (10YR 4/4) and black soft weathered rock particles; free drainage.

Characteristic	Horizon (depth in cm) 1 0-2	2 2-10	3 10-30	4 30-50
Moisture 100-105°C %	5.0	3.1	2.2	3.0
Bulk density g/ml	0.68	0.91	0.92	0.94
Loss on ignition %				
pH (1:2.5)soil:water	5.1	5.0	5.3	5.1
Conductivity mmhos	0.29	0.09	0.03	0.03
Carbonate meq/meq %				
Exch. Na meq %	0.4	0.2	0.2	0.2
Exch. K meq %	0.6	0.2	0.1	0.2
Exch. Mg meq %	5.4	2.3	1.0	1.5
Exch. Ca meq %	15.0	4.3	2.7	1.8
TEB meq %	21.4	7.0	4.0	3.7
CEC meq %	48.8	20.7	13.7	14.6
Base saturation %	44	34	29	26
N Total %	1.25	0.41	0.12	0.04
C Organic %	15.18	4.16	1.08	0.32
Total P ppm	830	560	350	260
Total K ppm	2 650	3 550	4 500	5 950
Total Mg ppm	3 600	4 200	4 150	5 050
Available P				
(Olsen) ppm				
(Bray) ppm	7.0	3.1	4.5	5.0
Mechanical analysis				
2 mm – 200 μ %	1	1	0	9
200 μ % – 50 μ %	2	1	1	0
50 μ % – 20 μ %	1	2	2	0
20 μ % – 2 μ %	26	15	20	32
<2 μ %	70	81	77	59

SAN CRISTOBAL 9	PROFILE	LAND SYSTEM SOIL GROUP	BWAROO TYPIC TROPUDALF

Location	Ugi Island, east of Apaone village, inland from mouth of 'Ete'ete River; DOS 10/161/7 994647
Site	On 27-30 m-wide ridge top; small stream dissecting one side; dominant slope 6°, flanking slopes 17° and 7°; shedding drainage. Alt. 37 m
Parent material	Middle to Upper Miocene mudstones with minor sandstone bands
Microrelief	Smooth
Stoniness	No surface stones
Erosion	Not evident at site but seen in pathway on spur flanks
Vegetation	Secondary regrowth, gardened 1970 after former regrowth; bush regrowth patchy, height 3-5 m; species include *Prosopis insularis, Hibiscus tiliaceus, Phyllanthus reticulatus, Pipturus argenteus, Morinda citrifolia* and *Canarium indicum;* herb layer dominated by ferns – 100% cover, sedges very common
Land use	Crops remaining in 1970 are pineapple, betel nut, cabbage and sweet potatoes
Soil surface	Covered by thin litter layer and complete herb layer

Horizon	Depth cm	Description
1 A1	0-10	Brown to dark brown (10YR 4/3, moist); clay; moderate coarse angular blocky structure; friable, moist; few subangular gravels of manganese-coated weathered fragments; free drainage; few fine tubular and common fine interstitial pores; many small fibrous and few medium roots; clear irregular boundary:
2 B1	10-18	Yellowish brown (10YR 5/4, moist); clay; moderate medium to coarse subangular blocky structure; firm, moist; few subangular and rounded weathered rock gravel; free drainage; common fine tubular and common fine interstitial pores; common small fibrous roots; clear irregular boundary:
3 B21	18-28	Strong brown (7.5YR 5/6, moist); clay; moderate medium angular blocky structure; friable to firm, moist; few soft and hard weathering rock fragments; free drainage; many fine tubular and common fine interstitial pores; few small fibrous roots; clear smooth boundary:
4 B22	28-58	Strong brown (7.5YR 5/6, moist); common fine faint dark grey (10YR 3/1) mottles; silty clay; weak medium angular blocky structure; friable, moist; mottling due to relic-weathered rock; rare rounded medium sized hard sandstone pebbles; free drainage; common fine tubular pores; few small fibrous roots; diffuse smooth boundary:

Horizon	Depth cm	Description
5 B3	58-81	Strong brown (7.5YR 5/6, moist); common fine very dark greyish brown (10YR 3/2) relic-weathering rock fragment mottles; clay; weak medium angular blocky structure; friable, moist; few soft weathered sandstone fragments; free drainage; many fine tubular, few fine interstitial pores; diffuse wavy boundary:
6 C	81-165	Strong brown (7.5YR 5/6, moist); common coarse faint yellowish red (5YR 5/6) and common medium very dark grey (10YR 3/1) mottles represent weathered surface of parent material; clay; weak coarse angular blocky structure; friable, moist; many weathered weak mottles and relic coarse round to linear bedrock outlines and few hard round sandstone fragments; free drainage; common fine tubular pores.

Remarks On lower slopes many outcrops of pitted coral limestone but also sediments on pathway. Pit here almost entirely derived from sediments as no coral fragments seen.

SAN CRISTOBAL 9 **ANALYSIS** **LAB. NO. 9196-9201**

Characteristic	Horizon (depth in cm) 1	2	3	4	5	6
	0-10	10-18	18-28	28-58	58-81	81-165
Moisture 100-105°C %	4.9	4.7	5.5	5.7	6.4	5.8
Bulk density g/ml	0.97	0.96	0.93	0.91	0.89	0.82
Loss on ignition %						
pH (1:2.5) soil:water	6.6	6.2	6.0	6.0	6.4	6.6
Conductivity mmhos	0.14	0.08	0.04	0.03	0.03	0.03
Carbonate meq %						
Exch. Na meq %	0.1	0.2	0.3	0.2	0.4	0.4
Exch. K meq %	0.3	0.2	0.3	0.4	0.4	0.4
Exch. Mg meq %	9.1	11.9	10.2	17.3	17.6	20.7
Exch. Ca meq %	28.0	22.3	16.2	21.5	22.0	24.1
TEB meq %	37.5	34.6	27.0	39.4	40.4	45.6
CEC meq %	45.1	45.0	42.8	52.9	47.2	44.8
Base saturation %	83	77	63	75	86	100
Total N %	0.41	0.30	0.11	0.05	0.05	0.04
Organic C %	4.35	2.83	0.86	0.39	0.36	0.32
Total P ppm	1 190	790	500	390	380	380
Total K ppm	1 750	1 750	2 550	2 600	2 600	2 550
Total Mg ppm	6 700	7 050	10 150	13 550	14 700	19 000
Available P						
(Olsen) ppm						
(Bray) ppm	9.0	5.0	7.3	7.6	7.8	7.8
Mechanical analysis						
2 mm – 200 μ %	6	6	0	0	0	0
200 μ % – 50 μ %	9	7	2	3	4	4
50 μ % – 20 μ %	12	9	8	9	11	17
20 μ % – 2 μ %	21	23	25	24	29	30
<2 μ %	52	55	65	64	56	49

SAN CRISTOBAL 10	PROFILE	LAND SYSTEM SOIL GROUP	WAIMASI EUTROPEPT

Location Pawa school, north of playing fields in paddock behind copra drier, about 183 m inland from coastal track; DOS 10/161/7 991635

Site Below foot of small hill of slope 27° on small wash apron over alluvial land; slope 3°, slightly convex

Parent material Mixed wash and alluvium from mudstone and siltstone sediments

Microrelief Level

Stoniness No surface stones

Erosion Not evident

Vegetation Cultivated, grass, clover and rare *Sida acuta*

Land use Coconut estate more than 50 years old with well maintained pasture beneath. Coconuts green and healthy but only moderately bearing. Coconuts on sedimentary hills very yellow and commonly devoid of fruit

Soil surface Covered by thick grass and root mat

Horizon	Depth cm	Description
1 A11	0-4	Very dark greyish brown (10YR 3/2, moist); silty clay; weak coarse crumb structure; friable, moist; free drainage; common fine interstitial pores; many small fibrous and fleshy roots; abrupt smooth boundary:
2 A12	4-10	Greyish brown (10YR 5/2, moist); few medium distinct strong brown (7.5YR 5/6) and few coarse faint dark grey (10YR 4/1) mottles; silty clay; moderate, medium angular blocky structure; friable, moist; imperfect drainage; few fine tubular roots; many small fibrous and fleshy and few medium rhizomatose roots; clear smooth boundary:
3 B21	10-38	Yellowish brown (10YR 5/4, moist); silty clay; weak medium angular blocky to subangular blocky; friable, moist; many rounded and broken soft weathering mudstone fragments, 4 -3 cm; when broken give light yellowish brown (2.5YR6/4) colour; imperfect drainage; few fine tubular pores; many small fibrous roots; clear smooth boundary:
4 B22	38-53	Yellowish brown (10YR 5/4, moist); few fine faint dark yellowish brown (10YR 4/4) mottles; silty clay; weak medium angular blocky structure; friable, moist; common small soft weathering rock pebbles; free drainage; common fine tubular pores; rare medium roots; gradual smooth boundary:
5 B3	53-127	Brown to dark brown (10YR 4/3, moist); pale brown (10YR 6/3) soft weathered rock fragments and very dark brown (10YR 2/2) weakness lines in fragments; silty clay; weak coarse angular blocky structure; friable, moist; many rounded and shaley small and medium mud pebbles; free drainage; common fine tubular pores; rare medium roots.

Remarks From 86 cm+ auger sample and number and size of stones increases.

Characteristic	Horizon (depth in cm) 1 0-4	2 4-10	3 10-38	4 38-53	5 53-127
Moisture 100-105°C %	4.6	5.7	6.5	5.9	6.6
Bulk density g/ml	0.69	0.85	0.70	0.81	0.68
Loss on ignition %					
pH (1:2.5) soil:water	5.7	6.3	6.8	6.7	6.8
Conductivity mmhos	0.15	0.08	0.05	0.04	0.03
Carbonate meq %					
Exch. Na meq %	0.3	0.6	0.6	0.5	0.9
Exch. K meq %	1.2	0.9	0.7	0.7	0.7
Exch. Mg meq %	12.9	16.1	22.1	20.7	21.2
Exch. Ca meq %	16.7	19.5	30.9	26.8	26.5
TEB meq %	31.1	37.1	54.3	48.7	49.3
CEC meq %	45.2	45.1	61.9	57.3	56.9
Base saturation %	69	83	88	85	87
Total N %	0.64	0.32	0.10	0.08	0.06
Organic C %	7.98	3.03	0.70	0.64	0.64
Total P ppm	1 070	570	200	250	190
Total K ppm	2 150	2 350	2 350	2 400	2 500
Total Mg ppm	8 600	13 150	18 750	19 100	19 700
Available P					
(Olsen) ppm					
(Bray) ppm	16.2	10.0	9.5	10.6	10.5
Mechanical analysis					
2 mm – 200 μ %	1	1	0	0	0
200 μ % – 50 μ %	6	6	1	2	3
50 μ % – 20 μ %	18	12	12	13	13
20 μ % – 2 μ %	30	30	37	31	37
<2 μ %	45	51	50	54	47

SAN CRISTOBAL 11	PROFILE	LAND SYSTEM SOIL GROUP	WAKORA OXIC HUMITROPEPT

Location	On watershed between Paregho and Hao Rivers, 30-40 m below summit point; DOS 10/161/12 038207
Site	Narrow ridge 9-12 m wide, 2° slope; associated upper slopes 38° and 31°; shedding drainage. Alt. 917 m
Parent material	Basalts and pillow lavas
Microrelief	Hummocky due to accumulation of organic matter around roots and dead trees
Stoniness	No surface stones
Erosion	Not evident
Vegetation	Low primary forest, canopy height 9-12 m due to unfavourable site and aspect; moss on all trees but very little over ground surface, no festooning; high proportion of epiphytes, mainly orchids or ferns, over all trees; dominant tree species *Memecylon sp.* Herb layer dominated by pandans and ferns with *Freycinetia spp.* creeper very common; some large gingers seen in lower tree storey; *Casuarina papuana* noticed from a distance on lower part of adjacent hill
Land use	Unused
Soil surface	Covered by thick humus layer, but exposed on steep slopes where humus layer denuded

Horizon	Depth cm	Description
1 0	10-0	Dark reddish brown (5YR 3/2, wet); organic loam; structureless; non-sticky, slightly plastic, wet; impeded drainage; many fine interstitial pores; many fine and medium woody or fibrous roots; abrupt wavy boundary:
2 A1	0-13	External ped yellowish red (5YR 4/8, moist); internal ped yellowish red (5YR 4/6, moist); silty clay; weak, coarse subangular blocky structure; friable, moist; free drainage; few coarse tubular and common fine interstitial pores; few medium woody roots:
3 B21	13-58	Red (2.5YR 4/6, moist); silty clay; firm, moist; free drainage:
4 B22	58-125	Red (2.5YR 4/6, moist); red to strong brown (10YR 4/6 to 7.5YR 5/6) mottles; silty clay; friable, moist; mottles of weathered rock slightly hard and easily crushed between the fingers; free drainage:
5 B3	125-142	Red (2.5YR 4/6, moist); many black red and yellow weathered rock mottles; gritty silty clay; very friable, moist; soft and small angular hard rock fragments; free drainage.

Characteristic	Horizon (depth in cm) 1	2	3	4	5
	10-0	0-13	13-58	58-125	125-142
Moisture 100-105° C%	5.8	4.1	2.6	3.0	2.6
Bulk density g/ml	0.20	0.81	0.78	0.75	0.74
Loss on ignition %	94.2				
pH (1:2.5) soil:water	4.1	4.3	5.0	5.0	5.1
Conductivity mmhos	0.18	0.12	0.03	0.02	0.02
Carbonate meq %					
Exch. Na meq %	1.5	0.2	tr.	0.1	nil
Exch. K meq %	1.5	0.2	tr.	0.1	tr.
Exch. Mg meq %	9.0	0.6	0.1	tr.	tr.
Exch. Ca meq %	3.0	0.7	0.1	0.3	0.3
TEB meq %	15.0	1.7	0.2	0.5	0.3
CEC meq %	103.0	37.4	8.1	9.6	11.2
Base saturation %	15	5	3	5	2
Total N %	1.82	0.50	0.07	0.04	0.05
Organic C %	LOI	8.80	0.86	0.38	0.60
Total P ppm	430	710	720	790	750
Total K ppm	550	1 000	1 450	2 400	2 400
Total Mg ppm	900	1 900	1 800	2 400	2 450
Available P					
(Olsen) ppm					
(Bray) ppm	13.8	3.8	3.3	3.5	3.3
Mechanical analysis					
2 mm – 200 μ %		2	4	2	6
200 μ % – 50 μ %		4	10	10	10
50 μ % – 20 μ %		7	11	15	11
20 μ % – 2 μ %		35	29	30	29
<2 μ %		52	46	43	44

SAN CRISTOBAL 17 | PROFILE | LAND SYSTEM DALA | SOIL GROUP OXIC TROPUDALF

Location	Ugi Island, almost south of Su'ena village. Sample area SB, line 2, auger position 24; DOS 10/161/4 993095
Site	Undulating terrace surface; normal drainage. Alt. 15-21 m
Parent material	Coral debris, commonly waterworn
Microrelief	Slight depressions (minor sink holes) and areas of coral stones around uprooted trees
Stoniness	Rare volcanic stones less than 3 cm (not in pit); 5-10% ground cover with coral boulders except where uprooted trees expose underlying coral
Erosion	Not evident
Vegetation	Primary forest, 24-30 m canopy, 60-70% closed; main species *Pometia pinnata* (4), *Amoora* sp. (1), *Neonauclea* sp. (2). Herb and shrub layer dominated by seedlings; few *Flagellaria* sp. and palms in shrub layer
Land use	Unused
Soil surface	Leaf litter and tree debris covers 20-30% of ground surface; small surface roots common

Horizon	Depth cm	Description
1 A1	0-6	Brown to dark brown (7.5YR4/4, moist); loam; weak medium subangular blocky structure breaking down to fine or very fine moderate crumb; very friable, moist; non-sticky, plastic, wet; few subangular small coral fragments; free drainage; many fine interstitial and common medium tubular pores; few large, common medium woody, many small, few medium fibrous roots; clear smooth boundary:
2 B1	6-20	Dark brown to dark reddish brown (7.5YR 3/2-5YR 3/4, moist); clay loam; weak medium subangular blocky structure breaking to weak very fine crumb; very friable, moist; non-sticky, plastic, wet; few (1-2%) irregular coral fragments; free drainage; common fine interstitial, few fine tubular pores; few large woody and common fine fibrous roots; clear to abrupt wavy boundary:
3 B12	20-36	Dark reddish brown (5YR 3/4, moist); silty clay loam; weak fine crumb structure; very friable, moist; non-sticky, plastic, wet; free drainage; common fine interstitial and common fine tubular pores; common small fibrous roots; abrupt wavy boundary:
4 B2	36-89	Dark reddish brown (5YR 3/4, moist); clay loam; very weak fine crumb structure; very friable, moist; slightly sticky, plastic, wet; many subangular medium coral fragments; free drainage; few fine interstitial pores; few small fibrous roots; abrupt irregular boundary:
5 C	89-102	Pale yellow (2.5YR 8/4, moist); coral sand; horizon of weathering coral rock; free drainage.

Remarks Horizon 4 occurs as vertical pipes in limestone. Coral weathered and soft in most areas but occasionally hard crystalline limestone.

Characteristic	Horizon (depth in cm) 1 0-6	2 6-20	3 20-36	4 36-89	5 89-102
Moisture 100-105° C%	3.9	3.7	3.1	2.2	0.1
Bulk density g/ml	0.75	0.84	0.77	0.93	1.13
Loss on ignition %					
pH (1:2.5) soil:water	6.2	6.5	7.1	8.0	8.7
Conductivity mmhos	0.22	0.11	0.08	0.16	0.08
Carbonate meq %	100		110	470	1 880
Exch. Na meq %	0.4	0.1	0.1	tr.	0.1
Exch. K meq %	0.4	0.1	tr.	tr.	tr.
Exch. Mg meq %	1.6	0.5	0.4	0.6	0.4
Exch. Ca meq %	22.1	18.3	14.8	> 50.0	>50.0
TEB meq %	24.5	19.0	15.3	> 50.0	>50.0
CEC meq %	35.1	22.5	10.1	3.0	0.3
Base saturation %	70	85	100		
Total N %	0.76	0.50	0.24	0.09	0.02
Organic %	11.09	6.21	2.54	0.99	0.15
Total P ppm	9 320	10 900	10 310	7 990	950
Total K ppm	700	700	650	550	850
Total Mg ppm	1 000	1 050	1 200	1 500	1 750
Available P					
(Olsen) ppm	16	11	11	23	11
(Bray) ppm		19.6			
Mechanical analysis					
2 mm – 200 μ %	4	11	5	16	62
200 μ % – 50 μ %	12	38	18	20	12
50 μ % – 20 μ %	25	20	24	18	7
20 μ % – 2 μ %	25	16	26	15	13
< 2 μ %	34	15	27	31	6
Trace metals ppm					
Cobalt Co	110	130	140	120	60
Copper Cu	120	170	180	150	20
Chromium Cr	160	180	190	190	20
Manganese Mn	6 450	7 780	7 950	4 790	340
Nickel Ni	430	500	530	430	140
Zinc Zn	30	40	40	40	20

Location	Ugi Island. Sample area SB, extension line 1, 640 m from base line; near small coastal track about 46 m from sea; DOS 10/161/4 997702
Site	Inner margin of beach ridge, about 12 m inland from crest and about 60 m seawards of brackish water swamp; 4° slope, slightly convex; normal drainage. Alt. 1.5 m
Parent material	Slightly indurated coral debris, coral fragments and comminuted coral sand
Microrelief	Few tree-fall hollows
Stoniness	Common surface coral fragments 5-15 cm
Erosion	Not evident
Vegetation	Coconut plantation. Dense surface cover of creepers. Cutnut common amongst palms
Land use	Seawards, coconuts estimated 25-30 years old; inland palms estimated 12-15 years old. Healthy palms, good fruits
Soil surface	Covered by creepers and herbs

Horizon	Depth cm	Description
1 A11	0-25	Grey (10YR 4/1, moist); loamy coarse sand; structureless, fine granular; loose, moist; non-sticky, non-plastic, wet; common subangular small 3 cm coral fragments; excessive drainage; small interstitial pores; common small fibrous roots; clear smooth boundary:
2 A12	25-56	Grey (10YR 5/1, moist); loamy coarse sand; structureless, granular; loose, moist; non-sticky, non-plastic, wet; common subangular small and few subangular medium coral fragments; excessive drainage; many small interstitial pores; few small fibrous and few medium fibrous coconut roots; abrupt smooth boundary:
3 R	56-114	White (5YR 8/2, moist); coarse patches very pale brown (10YR 8/3) mottling; loamy sand; loose, moist; non-sticky non-plastic, wet; very many small and large coral stones; free drainage; common medium vesicular pores; few small fibrous roots.

Remarks Horizon 2 slightly more compact than 1. Levelled beach debris deposit of water-worn coral fragments overlain by later coral sand as storm deposits (?) Coral rock limits root development at 51-61 cm.

Characteristic	Horizon (depth in cm) 1 0-25	2 25-56	3 56-114
Moisture 100-105° C%	0.7	0.6	
Bulk density g/ml	1.07	1.07	0.99
Loss on ignition %			
pH (1:2.5) soil:water	8.1	8.1	8.6
Conductivity mmhos	0.17	0.19	0.12
Carbonate meq %	1 800	1 830	1 920
Exch. Na meq %	0.6	0.4	0.3
Exch. K meq %	0.1	tr.	tr.
Exch. Mg meq %	0.9	0.7	2.0
Exch. Ca meq %	>50.0	>50.0	>50.0
TEB meq %	>50.0	>50.0	>50.0
CEC meq %	8.2	5.3	0.5
Base saturation %			
Total N %	0.28	0.18	0.04
Organic C %	2.08	1.49	0.32
Total P ppm	800	660	170
Total K ppm	700	800	700
Total Mg ppm	700	700	4 900
Available P			
(Olsen) ppm	11	9	5
(Bray) ppm			
Mechanical analysis			
2 mm – 200 μ %	71	73	71
200 μ % – 50 μ %	10	9	10
50 μ % – 20 μ %	5	4	5
20 μ % – 2 μ %	6	6	6
< 2 μ %	8	8	8

GUADALCANAL 22	PROFILE	LAND SYSTEM	ESPERANCE
		SOIL GROUP	TYPIC DYSTROPEPT

Location		Along steep ridge from Agriculture Department cocoa plot up very steep slope to the summit; AMS 7729/1 829668
Site		Convex slope, 28°; free drainage. Alt. 560 m
Parent material		Andesitic volcanics
Microrelief		Smooth
Stoniness		Some areas vertical with cliffs of large lava blocks
Erosion		Slight sheet erosion and wash
Vegetation		All less than 3-8 m high; species include *Hibiscus tiliaceus, Prunus schlechteri,* the fern *Angiopteris evecta* and bamboo
Land use		Unused
Soil surface		Thin litter layer
Horizon	**Depth cm**	**Description**
1 A11	0-8	Dark yellowish brown (10YR 3/4, moist); silty clay; crumb structure; friable, moist; free drainage; abundant fine roots; abundant mineral fragments, not quartz:
2 A12	8-33	Dark brown (7.5YR 3/2, moist); clay; crumb (?) structure; firm, moist; free drainage; abundant fine roots; abundant mineral fragments, not quartz:
3 B21	33-64	Dark brown (7.5YR 3/2, moist); clay; firm, moist; free drainage; abundant mineral fragments, not quartz:
4 B22	64-86	Dark yellowish brown (10YR 4/4, moist); common coarse light yellowish brown (10YR 6/4) and reddish brown (5YR 4/4) mottles; clay; firm, slightly plastic, moist; free drainage:
5 B23	86-99	Dark yellowish brown (10YR 4/4, moist); clay; firm, moist; free drainage:
6 B3	99-109	Brown to dark brown (10YR 4/3, moist); with patches of greyish brown (10YR 5/2); clay; sticky (no longer polishing on auger); firm, moist; few rock fragments; free drainage; rare heavy minerals present and felspar and rock fragments.

Characteristic	Horizon (depth in cm)					
	1	2	3	4	5	6
	0-8	8-33	33-64	64-86	86-99	99-109
Moisture 100-105° C%						
Bulk density g/ml						
Loss on ignition %						
pH (1:2.5) soil:water	6.5	6.0	5.7	5.9	5.9	5.8
Conductivity mmhos						
Carbonate meq %						
Exch. Na meq %	0.08	0.21	0.52	0.62	0.59	0.61
Exch. K meq %	0.42	0.09	0.04	0.03	0.03	0.03
Exch. Mg meq %	4.31	1.47	1.05	1.37	1.37	1.26
Exch. Ca meq %	15.00	5.00	3.75	3.75	3.13	3.75
TEB meq %	19.81	6.77	5.36	5.77	5.12	5.65
CEC meq %	22.27	11.21	11.79	11.69	10.15	9.84
Base saturation %	89	60	45	49	50	57
Total N %	0.49	0.15				
Organic C %	6.5	2.1				
Total P ppm	390	210	100	104	80	100
Total K ppm	400	460	100	140	100	100
Total Mg ppm	2 700	2 300	2 300	2 700	2 700	3 400
Available P						
(Olsen) ppm						
(Bray) ppm	14.4	6.8	6.3	6.6	7.4	7.0
Mechanical analysis						
2 mm – 200 μ %		4	3	3	5	7
200 μ % – 50 μ %		15	13	13	13	14
50 μ % – 20 μ %		12	6	14	13	14
20 μ % – 2 μ %		25	30	26	25	21
<2 μ %		44	49	44	44	44

SAN CRISTOBAL 23	PROFILE	LAND SYSTEM SOIL GROUP	AROSI EUTRORTHOX

Location	Sample Area SA, Arosi; line 1, 244 m; DOS 10/161/6 516697
Site	About 2.5 km inland on Arosi Plateau on terrace surface. Alt. 152 m
Parent material	Not seen but some scattered surface limestone. Basalts underneath?
Microrelief	Smooth
Stoniness	Rare small limestone
Erosion	Not evident
Vegetation	Primary forest with irregular canopy at 9-34 m; canopy species include *Pometia pinnata* (3), *Vitex cofassus* (1), *Neoscortechinia forbesii* (1); small trees, *Celtis latifolia, Myristica* sp., *Prunus schlechteri* and *Neoscortechinia forbesii.* Undergrowth to 4.6 m, 80% closed; 50% ground cover
Land use	Unused
Soil surface	4-0 cm coarse litter

Horizon	**Depth cm**	**Description**
1 A11	0-3	Very dark grey (10YR 3/1, wet); common fine distinct (10YR 3/3) mottles; clay; weak fine crumb structure; plastic, non-sticky, moist to wet; free drainage; common fine interstitial pores; common fine to coarse fibrous and woody roots; abrupt smooth boundary:
2 A12	3-20	Dark greyish brown (10YR 4/3, wet); clay; massive to weak very fine subangular blocky structure; slightly plastic, non-sticky, wet; free drainage; few fine interstitial pores; common fine to coarse fibrous and woody roots; abrupt smooth boundary:
3 B1	20-43	Strong brown (7.5YR 5/6, moist); clay; massive to weak moderate to fine subangular blocky structure; friable, moist; free drainage; few fine interstitial pores; few fine fibrous roots; few faint clayskins; gradual smooth boundary:
4 B21	43-99	Strong brown (7.5YR 5/6, moist); clay; massive to moderate fine and medium angular blocky structure; friable, moist; free drainage; few fine interstitial pores; clear and faint clayskins on vertical faces; gradual smooth boundary:
5 B22	99-132	Strong brown (7.5YR 5/6, moist); clay; massive to moderate fine and medium angular and subangular blocky structure; firm, moist; free drainage; few fine interstitial pores; few faint clayskins:
6 B23	132-168 (Auger sample)	Strong brown (7.5YR 5/6, moist); clay; firm, moist; free drainage:
7 B24	168-211 (Auger sample)	Strong brown (7.5YR 5/6, moist); clay; very firm, moist; free drainage:
8 B25	211-236+ (Auger sample)	Strong brown (7.5YR 5/6, moist), but darker in patches and streaks; clay; firm, moist; free drainage.

Characteristic	Horizon (depth in cm) 1 0-2.5	2 2.5-20	3 20-43	4 43-99	5 99-132	6 132-168	7 168-211	8 211-235
Moisture 100-105° C%	6.0	3.3	3.0	3.1	2.7	2.5	3.0	2.4
Bulk density g/ml	0.60	0.87	0.84	0.83	0.83	0.81	0.83	0.85
Loss on ignition %								
pH (1:2.5) soil:water	6.2	5.8	6.6	5.8	6.1	5.5	5.3	5.6
Conductivity mmhos	0.22	0.07	0.23	0.03	0.03	0.02	0.02	0.02
Carbonate meq %								
Exch. Na meq %	0.3	0.1	0.1	0.1	0.2	0.1	0.1	0.1
Exch. K meq %	0.5	0.1	tr.	tr.	tr.	tr.	tr.	tr.
Exch. Mg meq %	6.5	1.0	0.6	0.7	0.6	0.4	0.4	0.6
Exch. Ca meq %	46.3	8.2	9.2	4.3	11.6	4.9	4.5	6.1
TEB meq %	53.6	9.4	9.9	5.1	12.4	5.4	5.0	6.8
CEC meq %	63.5	18.9	7.3	8.0	7.8	8.1	9.6	9.2
Base saturation %	85	50	100	65	100	67	51	74
Total N %	0.88	0.39	0.12	0.09	0.07	0.06	0.07	0.05
Organic C %	15.74	3.33	0.72	0.48	0.37	0.28	0.31	0.24
Total P ppm	2 160	2 120	2 160	2 350	2 350	2 280	2 020	2 060
Total K ppm	850	1 000	1 050	1 100	1 100	1 100	1 150	1 150
Total Mg ppm	2 150	2 100	2 350	2 250	2 250	2 300	2 500	2 650
Available P								
(Olsen) ppm								
(Bray) ppm	14.6	4.0	10.1	16.6	13.2	13.0	10.6	12.1
Mechanical analysis								
2 mm – 200 μ %	3	4	0	0	0	0	0	0
200 μ % – 50 μ %	4	3	2	1	0	1	1	1
50 μ % – 20 μ %	11	5	3	2	3	0	0	2
20 μ % – 2 μ %	10	21	3	2	2	3	5	3
<2 μ %	72	67	92	95	95	96	94	94
Trace metals ppm								
Cobalt Co	130	210	130	110	80	80	90	100
Copper Cu	100	130	160	160	170	180	180	180
Chromium Cr	120	160	130	120	120	110	110	100
Manganese Mn	3 540	5 130	900	520	410	460	650	1 260
Nickel Ni	170	250	250	260	270	260	270	300
Zinc Zn	130	140	140	140	140	140	150	150

SAN CRISTOBAL 27 PROFILE LAND SYSTEM KOPIU
SOIL GROUP FLUVENTIC EUTROPEPT

Location	Wanione area, San Cristobal; DOS 10/162/9 770412
Site	Estimated 183 m from sea and 12 m from fence line on northern mission boundary. Colluvial footslope, or part of, above terrace; receiving drainage. Alt. 6 m
Parent material	Basalt
Microrelief	Irregular from rocks in places and old stream channels
Stoniness	Common surface stones up to 1.5 m; pale brown, coarse-grained sandstone (?), slightly calcareous but mostly angular black basalt
Erosion	Very little
Vegetation	Coconut plantation
Land use	Coconut plantation estimated 50 years old, mostly healthy but vary in number of fruit bunches; moderately well brushed; cattle for last few years, grass well established. Leaf count; 30, 29, 28, 25, 23, 27
Soil surface	Thin grass litter

Horizon	Depth cm	Description
1 A1	0-13	Very dark brown (10YR 2/2, wet); stony clay loam; weak fine crumb to massive structure; plastic, sticky, wet; common up to 2.5 cm subangular and angular stones; free drainage; common fine interstitial pores; many coarse coconut and many grass roots; common ant activity; clear smooth boundary:
2 B2	13-30	Very dark greyish brown (10YR 3/2, moist); clay loam; weak fine crumb to subangular blocky structure; very friable, moist; free drainage; common fine interstitial pores; common roots as above; clear smooth boundary:
3 C11	30-76	Brown to dark brown (10YR 4/3, moist); stony loam; massive structure; very friable, moist; many angular stones to 2.5 cm; few coconut roots; arbitrary boundary:
4 C11	76-122	As above:
5 C11	122-152+	As above.

Remarks Shiny clay faces around stones in horizons 3, 4 and 5 may denote clay movement. Stones may limit root penetration from 30 cm.

Characteristic	Horizon (depth in cm) 1	2	3	4	5
	0-13	13-30	30-76	76-122	122-152
Moisture 100-105° C%	4.5	3.3	5.0	3.8	3.7
Bulk density g/ml	0.72	0.94	0.87	0.95	0.89
Loss on ignition %					
pH (1:2.5) soil:water	5.5	6.1	6.4	6.4	6.7
Conductivity mmhos	0.15	0.04	0.05	0.03	0.03
Carbonate meq %					
Exch. Na meq %	0.8	0.2	0.3	0.3	0.3
Exch. K meq %	0.4	0.1	0.1	0.1	0.1
Exch. Mg meq %	11.3	8.1	10.5	8.3	10.2
Exch. Ca meq %	12.5	12.8	17.0	14.1	14.6
TEB meq %	25.0	21.2	27.9	22.8	25.2
CEC meq %	40.8	27.9	34.1	27.3	27.5
Base saturation %	62	76	82	84	92
Total N %	0.53	0.15	0.05	0.05	0.05
Organic C %	8.58	1.58	0.75	0.78	0.64
Total P ppm	1 270	610	320	340	200
Total K ppm	950	900	1 050	850	1 250
Total Mg ppm	10 700	14 850	18 150	21 250	22 600
Available P					
(Olsen) ppm					
(Bray) ppm	11.0	7.2	7.7	6.9	6.2
Mechanical analysis					
2 mm – 200 μ %	20	37	34	45	33
200 μ % – 50 μ %	14	12	17	12	13
50 μ % – 20 μ %	11	10	12	10	13
20 μ % – 2 μ %	25	18	15	13	17
<2 μ %	30	23	22	20	24
Trace metals ppm					
Cobalt Co	60	70	60	80	110
Copper Cu	50	50	70	60	70
Chromium Cr	160	150	50	110	210
Manganese Mn	1 190	1 270	980	980	1 220
Nickel Ni	140	200	200	310	460
Zinc Zn	110	90	90	80	90

SAN CRISTOBAL 34	PROFILE	LAND SYSTEM SOIL GROUP	WAIMASI TYPIC TROPOFLUVENT

Location	East coast San Cristobal near Pehuru clinic, about 183 m south of Pehuru village; DOS 10/162/9 896268
Site	Alluvial plain, probably riverine wash over old beach material; flat; ponded? drainage. Alt. less than 9 m
Parent material	Mixed alluvial-origin basalt, calcareous mudstone and probably limestone
Microrelief	Smooth
Stoniness	No surface stones
Erosion	Not evident
Vegetation	Young coconut garden competing with bush including *Kleinhovia hospita, Macaranga aleuritoides, Artocarpus incisus, Leea suaveolens, Pometia pinnata, Ficus* sp., and *Ficus copiosa*
Land use	Coconut garden 2-3 years old and healthy in spite of bush competition. Leaf count 12, 15, 14, 19. Leaves of newly (heavily) fruiting palms (about ten years old) 25, 22, 24, 17, 25
Soil surface	Scattered fresh litter

Horizon	Depth cm	Description
1 A1	0-1	Very dark brown (10YR 2/2, wet); clay; weak fine to medium crumb structure; plastic, sticky, wet; free drainage; many fine to coarse intergranular pores; abrupt smooth boundary:
2 B21	1-13	Dark brown (10YR 3/3, moist); sandy clay loam; massive in profile breaking to moderate subangular blocky structure; friable, moist; many rounded very small gravel; free drainage; few small fibrous roots; gradual smooth boundary:
3 C21	13-41	Dark yellowish brown (10YR 3/4, moist); loamy sand; massive in profile breaking to weak fine or medium angular blocky structure; friable, moist; many rounded very small gravel; free drainage; few fine tubular pores; few small fibrous and woody roots; gradual smooth boundary:
4 C22	41-74	Brown to dark brown (7.5YR 4/4, moist); sand; massive in profile breaking to weak fine to medium subangular blocky structure; very friable, moist; many rounded very small gravel; free drainage; few fine tubular pores; few small fibrous roots; clear wavy boundary:
5 IIC	74-112	Very dark greyish brown (10YR 3/2, moist); sand; massive in profile breaking to weak fine subangular blocky and single grain structure; very friable to loose, moist; free drainage; few small fibrous roots; abrupt smooth boundary:
5 IIIC	112-145	Brown to dark brown (7.5YR 4/4, moist); sandy loam; massive in profile breaking to moderate medium and coarse angular blocky structure; friable, moist; many subangular and rounded very small gravels; free drainage; common fine tubular pores; a few signs of clayskins on some structural faces; clear irregular boundary:
7 IVC	145-155+	Dark yellowish brown (10YR 3/4, moist); few fine faint reddish brown mottles; sand; massive breaking to weak fine to medium subangular blocky structure; very friable, moist; slightly impeded drainage.

Characteristic	Horizon (depth in cm) 1	2	3	4	5	6	7
	0-1	1-13	13-41	41-74	74-112	112-145	145-155+
Moisture 100-105° C%	6.9	3.4	2.6	3.0	1.6	3.5	1.7
Bulk density g/ml	0.60	1.09	1.10	1.22	1.49	1.03	1.56
Loss on ignition %							
pH (1:2.5) soil:water	5.9	5.9	6.1	6.3	6.3	6.6	6.4
Conductivity mmhos	0.29	0.07	0.05	0.05	0.04	0.05	0.03
Carbonate meq %							
Exch. Na meq %	0.5	0.2	0.3	0.2	0.1	0.4	0.3
Exch. K meq %	1.0	0.1	tr.	tr.	0.1	tr.	0.1
Exch. Mg meq %	14.8	5.0	3.2	1.2	0.5	4.6	0.4
Exch. Ca meq %	34.7	10.8	6.4	2.6	1.2	8.3	2.1
TEB meq %	51.0	16.1	9.9	4.0	1.9	13.3	3.7
CEC meq %	71.8	25.7	15.9	9.2	5.7	17.6	5.9
Base saturation %	71	63	62	44	33	76	49
Total N %	1.32	0.27	0.15	0.11	0.02	0.05	0.02
Organic C %	17.23	2.73	1.53	1.27	0.27	0.64	0.18
Total P ppm	1 800	1 020	640	650	320	390	390
Total K ppm	1 500	1 600	1 750	1 900	2 050	1 800	1 650
Total Mg ppm	7 750	10 750	10 750	10 250	11 450	9 950	14 900
Available P							
(Olsen) ppm							
(Bray) ppm	15.2	4.8	5.1	8.8	27.3	8.3	46.5
Mechanical analysis							
2 mm – 200 μ %	13	43	63	77	87	48	85
200 μ % – 50 μ %	5	5	19	18	7	11	11
50 μ % – 20 μ %	3	1	2	3	1	7	2
20 μ % – 2 μ %	25	17	6	2	3	14	2
<2 μ %	54	34	10	0	2	20	0
Trace metals ppm							
Cobalt Co	60	90	100	110	110	110	80
Copper Cu	70	80	80	70	60	70	60
Chromium Cr	110	320	470	590	380	310	80
Manganese Mn	870	1 360	1 430	1 840	1 680	1 670	1 100
Nickel Ni	110	170	170	180	170	190	140
Zinc Zn	160	200	210	250	270	180	130

SAN CRISTOBAL 35	PROFILE	LAND SYSTEM	TENARU
		SOIL GROUP	TYPIC TROPOPSAMMENT

Location East San Cristobal, west of Pehuru River, about 0.4 km south-east of Pehuru village; DOS 10/162/9 898269

Site A recent beach within 15 m of sea; flat at site but within 1.5 m of convex slope. Alt. 1.5 m

Parent material Sediments derived from mainly igneous and calcareous sedimentary rocks

Microrelief Smooth

Stoniness No surface stones

Erosion Not evident

Vegetation Coconut grove — undergrowth includes *Barringtonia asiatica, Cayratia* sp.

Land use Coconut grove — leaf count of trees more than 50 years old 28, 28, 23, 25, 27, 29; leaf count of trees 15-20 years old 22, 22, 25, 28, 30, 23

Soil surface Thick covering of vines

Horizon	Depth cm	Description
1 A11	0-6	Dark reddish brown (5YR 2/2, moist); sand; massive to moderate fine to medium subangular blocky structure; very friable, moist; few rounded medium basalt stones; free drainage; common fine and medium tubular pores; common small woody and fibrous roots; gradual smooth boundary:
2 A12	6-21	Very dark greyish brown (10YR 3/2, moist); sand; massive to moderate fine and medium angular blocky structure; very friable moist; free drainage; many fine tubular pores; few large woody roots; clear smooth boundary:
3 C11	21-61	Very dark greyish brown (10YR 3/2, moist); sand; massive to very weak fine subangular to single grain structure; loose, moist; free drainage; few fine tubular pores; common small and medium woody roots:
4 C11	61-91	Very dark greyish brown (10YR 3/2, moist); sand; massive to single grain and very weak subangular blocky structure; loose, moist; free drainage; few small and medium woody roots:
5 C11	91-122	As above:
6 C11	122-152	As above.

Characteristic	Horizon (depth in cm) 1	2	3	4	5	6
	0-6	6-21.5	21.5-61	61-91	91-122	122-152
Moisture 100-105° C%	1.7	1.4	0.8	0.9	0.8	1.0
Bulk density g/ml	1.40	1.45	1.80	1.90	1.85	1.83
Loss on ignition %						
pH (1:2.5) soil:water	6.0	6.1	6.3	6.4	6.6	6.7
Conductivity mmhos	0.09	0.06	0.04	0.03	0.03	0.04
Carbonate meq %						
Exch. Na meq %	0.4	0.3	0.2	0.2	0.2	0.3
Exch. K meq %	0.1	tr.	tr.	0.1	0.1	0.1
Exch. Mg meq %	2.4	1.0	0.5	1.2	1.2	1.8
Exch. Ca meq %	4.3	3.1	2.2	2.3	2.9	4.3
TEB meq %	7.2	4.4	2.9	3.8	4.4	6.5
CEC meq %	11.2	8.2	4.7	4.9	6.1	7.3
Base saturation %	64	53	61	74	73	89
Total N %	0.24	0.12	0.03	0.01	0.01	0.01
Organic C %	2.77	1.77	0.33	0.18	0.15	0.14
Total P ppm	340	400	210	170	210	270
Total K ppm	1 600	1 750	1 750	1 750	1 500	1 350
Total Mg ppm	9 000	10 250	10 850	10 000	10 000	11 400
Available P						
(Olsen) ppm						
(Bray) ppm	10.8	6.6	5.9	10.4	10.3	12.6
Mechanical analysis						
2 mm – 200 μ %	71	75	83	81	82	73
200 μ % – 50 μ %	21	18	16	18	17	26
50 μ % – 20 μ %	2	2	0	0	0	0
20 μ % – 2 μ %	3	3	1	1	1	1
<2 μ %	3	2	0	0	0	0
Trace metals ppm						
Cobalt Co	90	100	100	100	80	60
Copper Cu	40	40	40	40	40	50
Chromium Cr	660	820	700	840	430	230
Manganese Mn	1 360	1 440	1 380	1 500	1 230	980
Nickel Ni	130	150	150	170	140	110
Zinc Zn	250	250	260	270	190	130

Appendix 2

Definitions of geomorphological parameters

Most of the following definitions and descriptions are based on those used by Speight (1967) pp 174-179, unless otherwise stated. The definitions and class limits are applicable to conditions throughout the Solomon Islands. Other definitions made by the authors are denoted thus*.

ALTITUDINAL RANGE

Mountains are distinguished from hills when all the following conditions are met:

1. The maximum altitude exceeds 1 000 m
2. The average altitude is greater than 350 m
3. The characteristic slope exceeds 30°

SLOPE CATEGORIES

TABLE 1 Definition slope categories

Category	Angle (degrees)	Category	Angle (degrees)
Almost flat	<2	Moderately steep	20-30
Gentle	2. 8	Steep	30-45
Moderate	8.20	Precipitous	45-70
		Cliffed	>70

DRAINAGE PATTERN

No rigid quantitative definitions exist, but the patterns referred to are all described by Thornbury (1954).

DRAINAGE TEXTURE

The modal value of half the distance between major stream beds (Wood and Snell, 1960).

TABLE 2 Definition of drainage texture categories

Category	(m)
Ultra fine	<75
Very fine	75- 150
Fine	150- 300
Medium	300- 600
Coarse	600-1 200
Very coarse	>1 200

RIDGE TEXTURE

This can be defined in the same categories as drainage texture; it is not necessarily reciprocal.

AMPLITUDE OR RELIEF (available relief, relief)

The largest difference in height commonly occurring within a land system between the altitude of a ridge crest or summit and that of the nearest valley floor. The term can refer to both microrelief and macrorelief features.

TABLE 3 Definition of categories of amplitude of relief

Relief category	Relief (m)	Relief category	Relief (m)
Negligible	<10	Moderately high Moderately deep+	75-105
Ultra-low Ultra shallow+	10-20	High Deep+	150-300
Very low Very shallow+	20-40	Very high Very deep+	>300
Low Shallow+	40-75		

+ Applied when describing degrees of dissection.

INTERNAL RELIEF*

This term is used in description of terraces in particular, and refers to the amplitude of relief within the relatively undissected terrace surfaces.

EXTERNAL RELIEF*

This term is used in descriptions of terraces in particular, an refers to the amplitude of relief at terrace margins where the sea or rivers have incised deeply. This expression and that above are also employed in the description of lava flows and cockpit karst.

TERRACETTES*

These are microrelief features similar to steps or small benches and found principally on steep, long slopes. Characteristically they have scarps or risers of 5-50 cm height and flats or treads of 10-50 cm depth and 30-300 cm width. They are covered mostly by surface wash material being trapped behind surface obstructions such as boulders or roots.

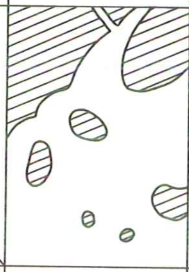
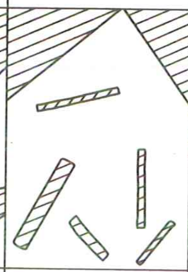
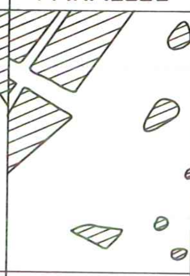
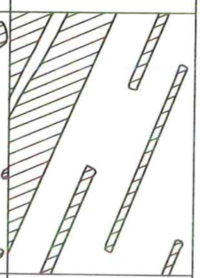
LANDFORM TERMS AND PARAMETERS

TABLE 4 Landform terms and parameters with methods of measurement and standard categories

Landform	Parameter	How measured	Categories
Crest (e.g. ridge crest)	Width*	Horizontal distance between limits of summit convexity	Knife-edged: 0- 2 m Very narrow: 2- 5 m Narrow: 5- 15 m Broad: 15- 30 m Very Broad: 30-150 m
	Profile	Visual estimate	Even: small variation in crestal slope; reversals rare Uneven: moderate variation in crestal slope; some reversals Very uneven: great variation in crestal slope Stepped: few reversals Saw-tooth: reversals common
	Crestal slope	Along the ridge crest	Defined in Table 1
High-angle planes (e.g. scarp, hill slope, valley side slope, bench)	Length	Down line of greatest slope	Ultra short: <40 m Very short: 40- 75 m Short: 75-150 m Medium length: 150-300 m Long: 300-600 m Very long: >600 m
	Curvature	Visual estimate	Straight Concave Convex Irregular Undulating
	Slope	Down line of greatest slope	Defined in Table 1
	Spur characteristics	Visual estimate	Crestal slope: defined under landform category of crests Prominence: prominent inconspicuous absent
	Microrelief	Visual estimate	Slump alcoves Slump scars Debris slide tracks Gullies
Low-angle planes (e.g. plain, terrace, flood-plain, valley floor)	Gradient of slope	Parallel to the major drainage	Defined in Table 1
	Width	Perpendicular to the major drainage, across uninterrupted areas of the land unit	Not classified; expressed in m or km
	Microrelief	Visual estimate	Height: expressed in m Type: undulating hummocky channelled terraced Local slope: expressed in degrees
Watercourses	Gradient	Along the channel	Defined in Table 1
	Width	Between bank tops or between the bases of confining hill slopes	Not classified; expressed in m

TABLE 4 (continued)

Landform	Parameter	How measured	Categories
Watercourses (continued)	Depth	From bank top level to mean thalweg	Not classified; expressed in m unless the stream is incised, when no depth is stated
	Levee character	–	Continuous Discontinuous Absent
	Bank slope	Visual estimate	Defined in Table 1
	Bar characteristics	–	Channel bars Point bars Bars absent
Miscellaneous (e.g. lava flow, doline, beach, swamp)	Not specified; to be compatible with those defined for other landform categories.		

HIGHS OCCUPY ↓	HIGHS ARE → ↓	SCHEMATIC PLAN / SCHEMATIC PROFILE	NON-LINEAR AND RANDOM	LINEAR AND RANDOM	NON-LINEAR AND PARALLEL	LINEAR AND PARALLEL
						
> 60% OF AREA	FLAT-TOPPED		1	1L	1//	1L//
40-60% OF AREA	FLAT-TOPPED		2	2L	2//	2L//
< 40% OF AREA	FLAT-TOPPED		3	3L	3//	3L//
> 60% OF AREA	CRESTED OR PEAKED		4	4L	4//	4L//
40-60% OF AREA	CRESTED OR PEAKED		5	5L	5//	5L//
< 40% OF AREA	CRESTED OR PEAKED		6	6L	6//	6L//
NO PRONOUNCED HIGHS OR LOWS			7			

Prepared by Land Resources Division LRD/BSIP/DW'1

TABLE 5 Plan-profiles of landforms (after van Lopik and Kolb, 1959)

Appendix 3

Soil analysis methods and definition of pedological parameters

1. METHODS OF SOIL ANALYSIS

Bulk density and moisture: a known volume of soil is weighed and calculated for 1 ml, the soil is then heated and % moisture calculated.

pH: measured in 1:2.5 soil-water ratio.

Conductivity: measured in 1:5 soil-water ratio.

Free carbonate: effervesces with addition of HCl: carbonate determined on samples which react.

Carbonate determination: reaction with HCl and back titration with NaOH.

Soluble cations Na and K: leaching with 80% Ind. methylated spirits; determination by flame photometry.

Exchangeable bases: leaching with neutral N ammonium acetate; Na and K determination by flame photometry on Auto Analyser and Mg and Ca by atomic absorption spectroscopy.

Cation exchange capacity: leaching with KCl at pH 2.5 after removal of excess ammonium acetate; NH_3 released determined by Auto Analyser.

Total nitrogen: a Kjeldahl digestion with a selenium catalyst followed by colorimetric determination by Auto Analyser.

Organic carbon: by Walkley and Black's method followed by colorimetric determination by Auto Analyser.

Total element analysis: perchloric acid digest and determination by Auto Analyser.

Phosphorus: Colorimetrically using ascorbic acid as reducing agent

Potassium: by flame photometry using Li as standard

Magnesium: by atomic absorption spectroscopy with Sr as releasing agent

Trace elements: by atomic absorption spectroscopy

Available phosphorus: Olsen's method for soils with $pH > 7.0$
Bray's method 2A for soils with $pH < 7.0$

Mechanical analysis: Pretreated with H_2O_2 to remove organic matter and dispersed. Particles <20μ are determined by settling. Clay and fine silt fractions (2μ-20μ, <2μ) are separated and calculated and particles of <2μ determined by settling. Sand fraction >50μ is sieved into coarse and fine sand fractions (200μ-2mm; 50μ-200μ) and % of each calculated. Coarse silt (50μ-20μ) is determined by difference.

2. DEFINITIONS AND PARAMETERS

All terms used in soil descriptions are those defined by the USDA soil Survey Staff (1951). Colour names and notations are from the Munsell Soil Color Chart.

The following are categorised or defined in Tables 1, 2 and 3 respectively: subsoil fertility; degree of clay weathering and leaching; soil depth.

TABLE 1 Subsoil fertility: component ratings for BSIP

Fertility	Bulk density g/ml	pH (H_2O)	Exchangeable meq %						Percentage			C/N ratio	Total ppm			Available P ppm	
			Na	K	Mg	Ca	TEB	CEC	BS	N	C		P	K	Mg	Olsen	Bray
High (more than)	1.00	7.0	0.5	0.5	4.0	10.0	15	25	60	0.5	10	15	500	10 000	10 000	15	50
Medium	1.00 — 0.70	7.0 — 5.0	0.5 — 0.1	0.5 — 0.2	4.0 — 0.5	10.0 — 2.0	15 — 3	25 — 6	60 — 20	0.5 — 0.1	10 — 2	15 — 2	500 — 250	10 000 — 5 000	10 000 — 4 000	15 — 5	50 — 15
Low (less than)	0.70	5.0	0.1	0.2	0.5	2.0	3	6	20	0.1	2	8	250	5 000	4 000	5	15

The ratings high, medium and low are a general assessment and do not represent the optimum or critical levels for any particular crop.

TABLE 2 Degree of clay weathering and leaching

Rating	Very strong	Strong	Moderately strong	Moderately weak	Weak
Weathering: $\frac{\text{CEC x 100}}{\text{\% clay}}$	<1.5	1.5-16	16-24	24-40	>40
Leaching: $\frac{\text{TEB x 100}}{\text{\% clay}}$	<1.5	1.5-10	10-12	12-30	>30

TABLE 3 Soil depth categories

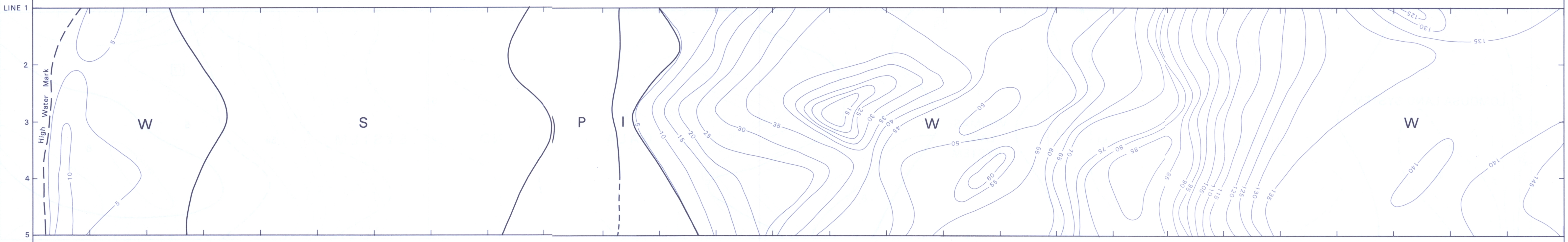
Category	Depth cm	Depth in
Shallow	0-25	0-10
Moderately shallow	25-50	10-20
Moderately deep	50-90	20-36
Deep	>90	>36

Appendix 4

Sample area studies

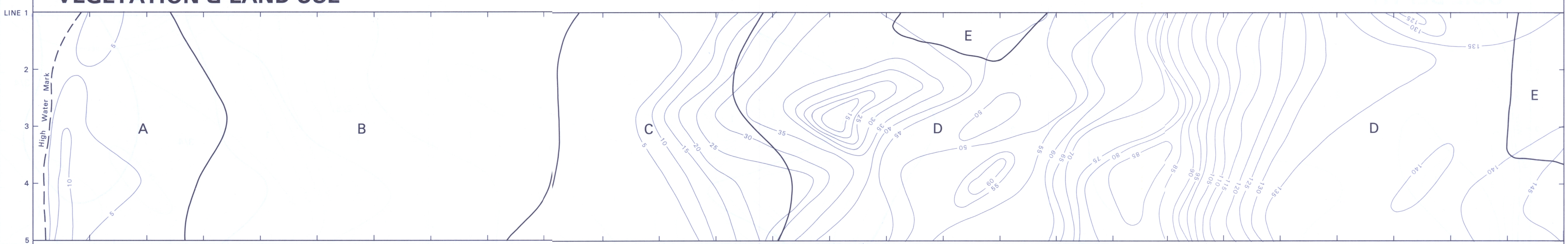
MAPS	SA	AROSI
	SB	UEI
	SC	MEURU

SOIL DRAINAGE



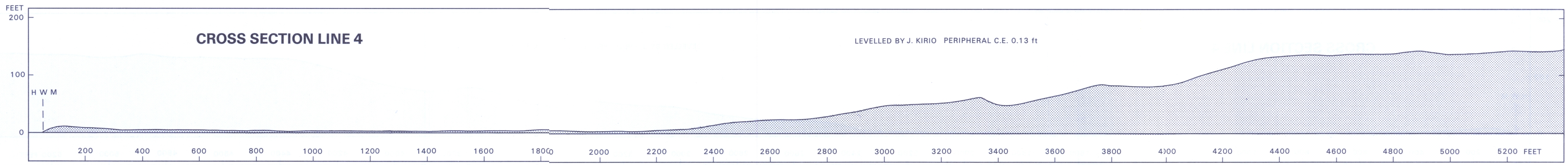
S Very poorly drained, with a watertable at or above the ground surface
P Poorly drained with a watertable between 6-24 inches below the ground surface
I Imperfectly drained with a watertable below 24 inches but with pale soil colours at depth
W Well drained

VEGETATION & LAND USE



A Cleared coastal vegetation now largely planted with coconuts but with many small regrowth trees including *Barringtonia racemosa, Ficus* sp., *Securinega flexuosa, Sterculia shillinglawii* and *Barringtonia edulis*
B Freshwater swamp forest dominated by *Inocarpus fagiferus* and *Hibiscus tiliaceus.* Other common trees include *Eugenia tierneyana, Diospyros* sp., *Horsfieldia spicata* and occasional *Terminalia brassii*
C Gardens and garden regrowth with scattered large trees mainly *Artocarpus altilis, Alstonia scholaris, Canarium indicum* and *Eugenia malaccensis*
D Lowland forest on coral terraces with a considerable degree of disturbance resulting in many secondary species. The canopy is dominated by *Pometia pinnata* but *Alstonia scholaris* and *Eugenia* sp. are common. Amongst the smaller trees *Aglaia* sp., *Dysoxylum* sp., *Buchanania arborescens* and *Amoora* sp. are dominant and smaller trees comprise the shrub layer
E Gardens with young regrowth dominated by *Macaranga* sp., *Pipturus argenteus* and *Prosopis insularis*

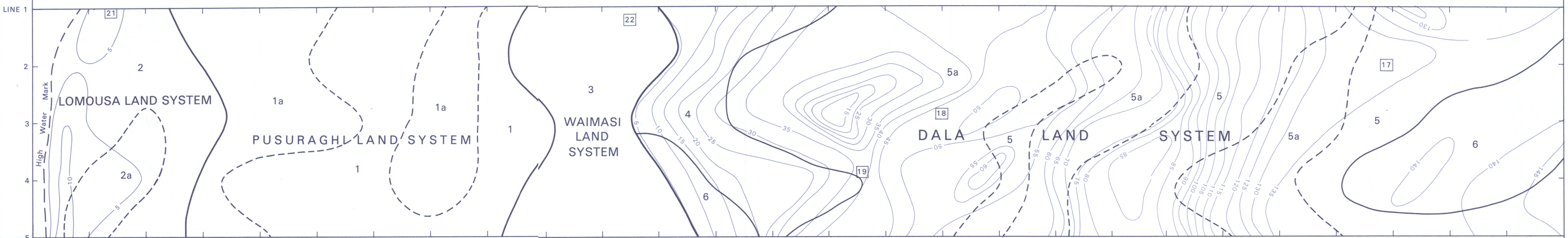
CROSS SECTION LINE 4



123-2
49x30

SAMPLE AREA SB UGI

SOIL



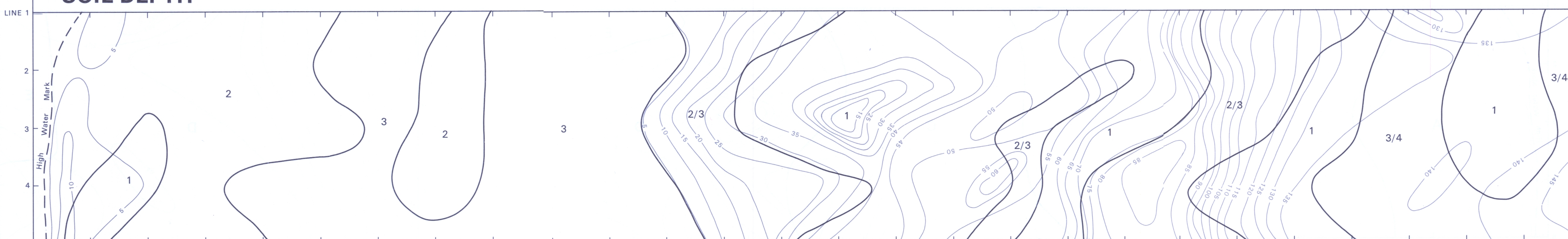
0 200 400 ft
Contour Interval 5 ft

1 Moderately shallow, very poorly drained, grey, greyish brown or olive sandy clay or sandy loam (Lithic Tropaquents)
1a As above, but soil depth very shallow to shallow with abundant coral rock fragments (Lithic Tropaquents)
2 Moderately shallow to moderately deep, well drained, light grey or yellowish grey stony sandy loam or sand (Troporthents)
2a As above, but shallow with abundant coral fragments (Lithic Troporthents)
3 Moderately deep, imperfectly to poorly drained, yellowish brown, pale brown or olive mottled clay (Aquic Tropofluvents)

4 Moderately shallow to moderately deep, wel drained, yellowish red to red clay (Oxic Tropudalfs)
5 Moderately shallow to deep, well drained, dark reddish brown or reddish brown clay loam overlying limestone (Oxic Tropudalfs)
5a As above, but shallow with abundant outcrops of coral (Lithic Tropudalfs)
6 Shallow to moderately deep, well drained, brown to dark brown stony clay (Rendolls ?)

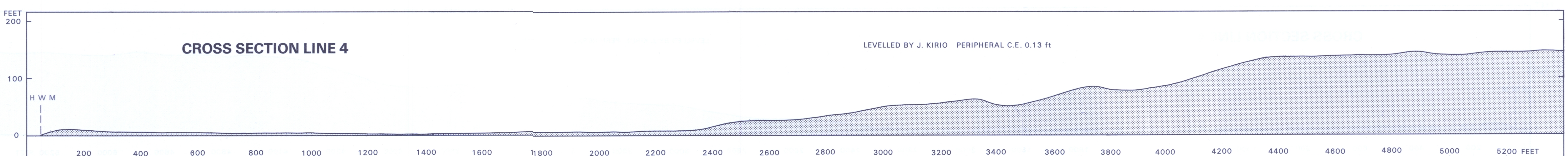
Soil pit and number 17

SOIL DEPTH



1 Very shallow to shallow 0-10 inches
2 Moderately shallow 10-20 inches
3 Moderately deep 20-36 inches
4 Deep > 36 inches

CROSS SECTION LINE 4



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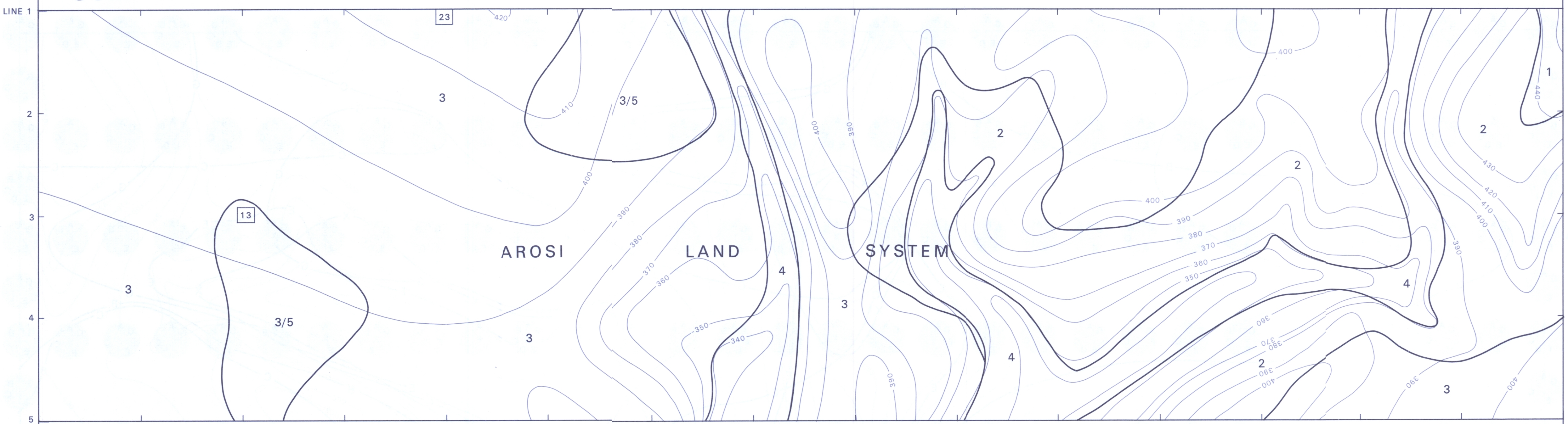
SAMPLE AREA SA AROSI

SOIL

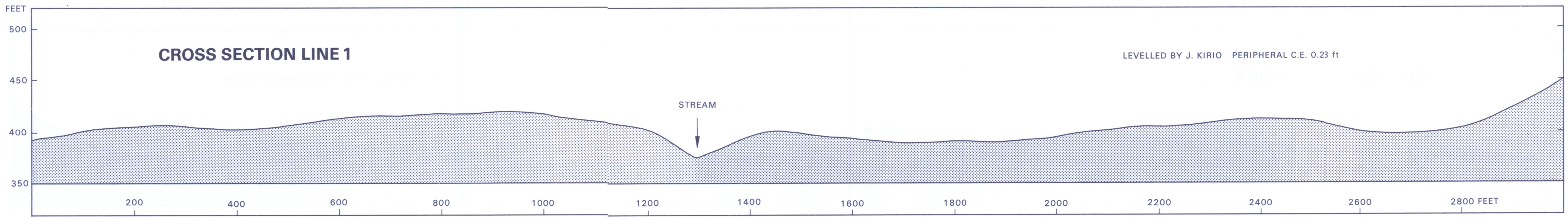


0 200 400 ft

Contour Interval 10 ft

1 Deep, well drained, red clay (Tropohumults)
2 Deep, well drained, yellowish red clay with imperfectly drained subsoil in places near streams (Orthox, Tropudalfs)
3 Moderately shallow to deep, well drained, strong brown clay with deep dark topsoil in places, scattered lithosols and imperfectly drained subsoils near streams (Eurorthox)
4 Predominantly deep, imperfectly drained, dark brown to strong brown clays and loams with mottled subsoil and locally with greenish grey, gleyed deep subsoil
5 Deep, well drained, brown to dark brown clay (Tropudalfs)

Soil pit and number 13



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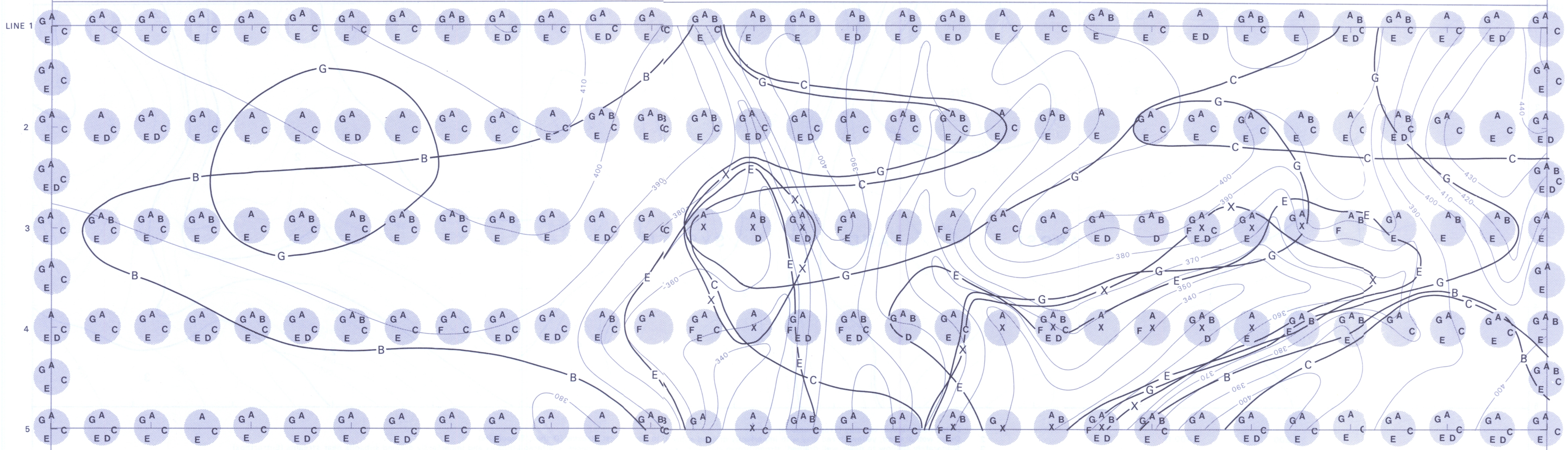
123-1
43x30

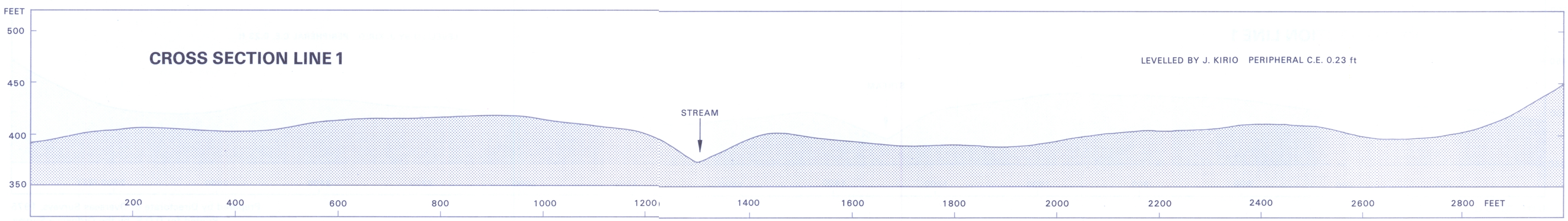
SAMPLE AREA SA AROSI

VEGETATION



All the hill land is covered by tall lowland forest with a canopy dominated by *Pometia pinnata, Neoscortechinia forbesii, Pimeleodendron amboinicum* and *Calophyllum kajewskii.* The smaller trees are widely varied but in addition to the above species contain many *Aglaia* sp., *Myristica* sp., *Aporosa papuana* and palms such as *Areca macrocalyx, Rehderophoenix subdisticha* and *Caryota rumphiana,* ferns and gingers. The valleys in addition contain patches of forest dominated by *Metroxylon salomonense:* these areas are utilised for *Cyrtosperma chamissonis* and thatch. Small hill forest areas appear to be disturbed.

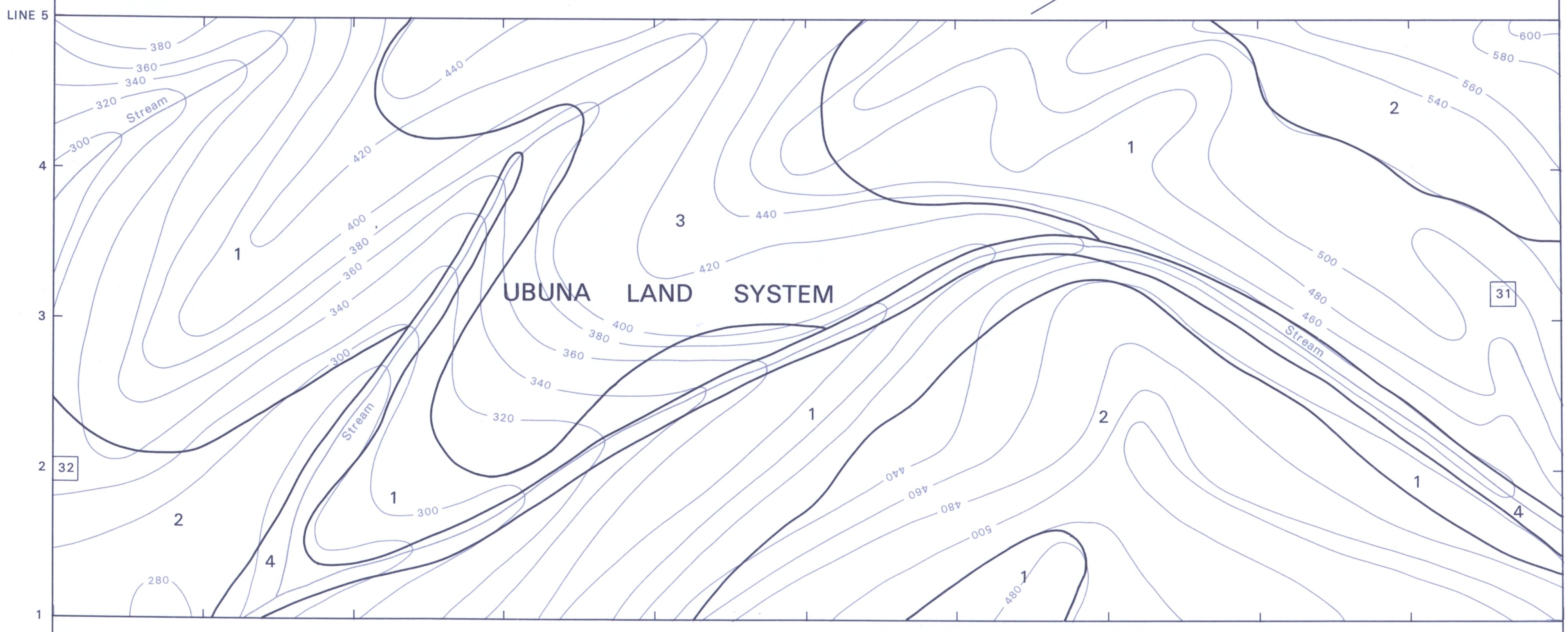
A-*Pometia pinnata* B-*Vitex cofassus* C-*Pimeleodendron amboinicum* D-*Celtis latifolia* E-*Neoscortechinia forbesii* F-*Inocarpus fagiferus* G-*Calophyllum kajewskii* X-*Metroxylon salomonense*



123-3 57x30

SAMPLE AREA SC HEURU

SOIL



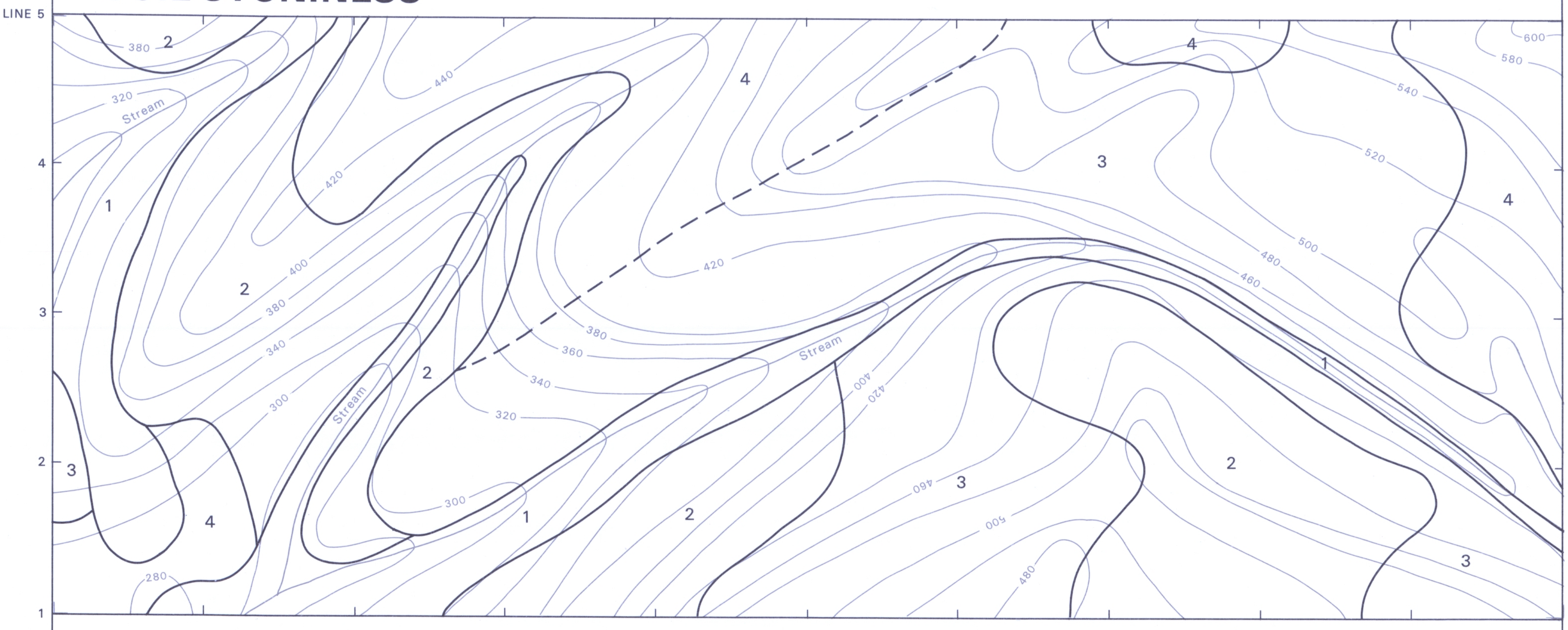
0 200 400 ft

Contour Interval 20 ft

1 Moderately deep to deep, well drained, brown, yellowish brown or brownish yellow clay loam or clay with rock fragments common in the profile (Eutropepts/Tropudalfs)
2 Deep, well drained yellowish red or strong brown clay with some weathered rock mottles at depth (Typic Tropohumults)
3 Deep, well drained yellowish red clay loam or clay overlying a yellowish brown or strong brown sandy loam or sandy clay horizon with weathered rock fragments common (Tropudalfs)
4 Exposed rock and pebbles in cliffs and stream beds (Lithic Tropofluvents/Troporthents)

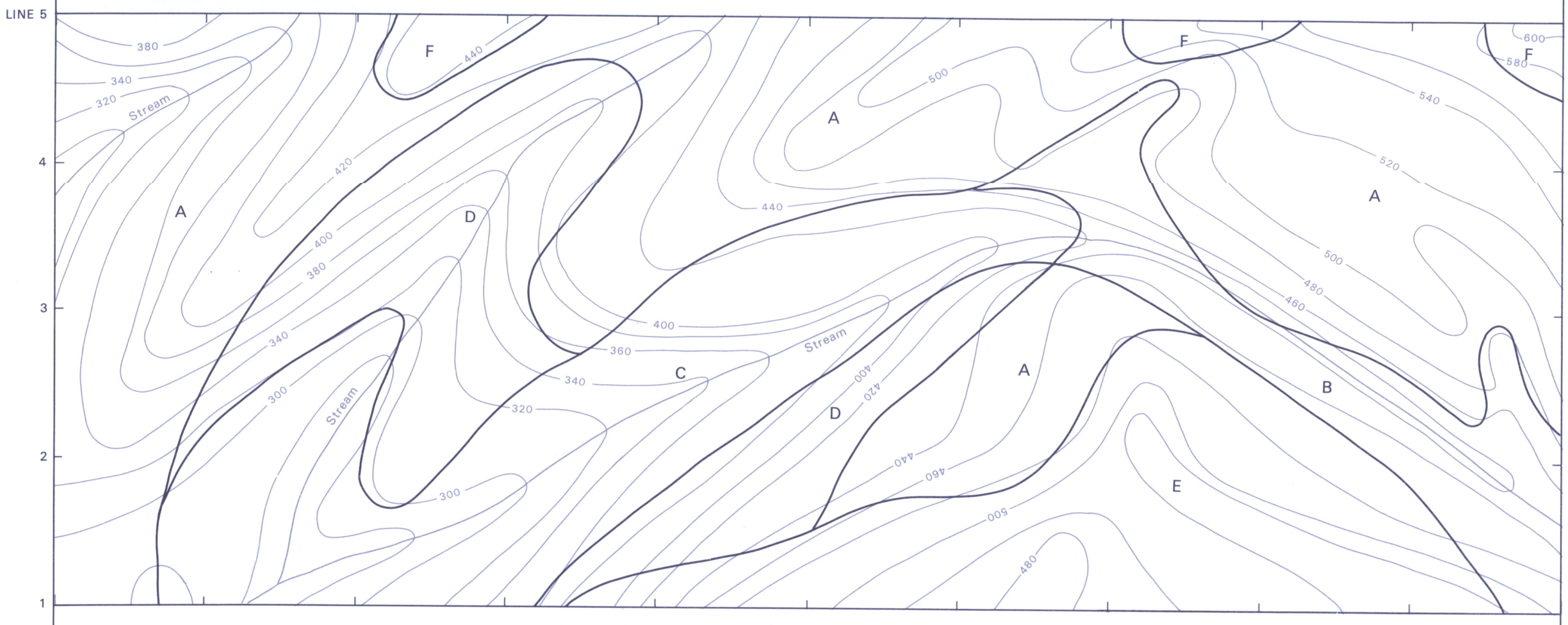
Soil pit and number 31

SOIL STONINESS



1 Numerous outcrops of sedimentary rocks and abundant surface stones; coarse material common in the profile
2 Scattered outcrops of sedimentary rocks and surface stones; stones and weathered rock present in the profile
3 No outcrops but some surface stones and weathered rock in the profile
4 No outcrops or surface stones but with weathered rock in the profile

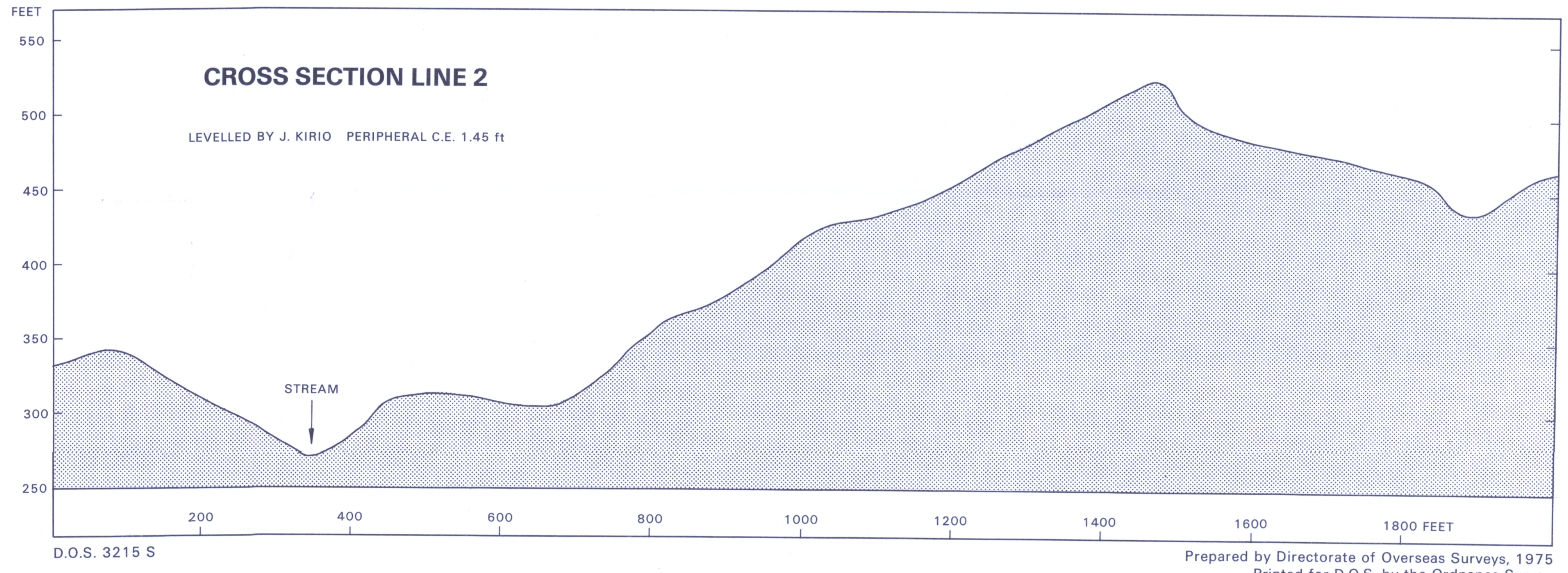
VEGETATION



A Lowland forest with a canopy dominated by *Pometia pinnata*, *Calophyllum kajewskii*, *Dillenia crenata* and *Canarium* spp. Palms, particularly *Areca macrocalyx*, are common in the lower storey
B As for A above but with *C. kajewskii* absent from the canopy
C As for A but with *C. kajewskii* and *D. crenata* absent and *Vitex cofassus* and *Pterocarpus indicus* occurring within the canopy
D As for A but with *D. crenata* absent from the canopy
E Old secondary regrowth with *Pometia pinnata* absent and a high proportion of small trees
F Secondary regrowth with no large canopy-forming trees

CROSS SECTION LINE 2

LEVELLED BY J. KIRIO PERIPHERAL C.E. 1.45 ft



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Publications of the Land Resources Division

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BAWDEN M G and STOBBS A R	1963	The land resources of Eastern Bechuanaland.
LANGDALE-BROWN I and SPOONER R J	1963	The land use prospects of Northern Bechuanaland.*
BAWDEN M G (Ed)	1965	Some soils of Northern Bechuanaland with a description of the main vegetation zones.

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** Land Resource Study No. 7 has not yet been published.

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