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Man and Environment in Eastern Timor

Joachim K Metzner

Pacific & Southeast Asian History



Man and Environment in Eastern Timor

Errata

p.40, Fig.13. Incorrect figure. See figure on p.66.

p.66, Fig.15. Incorrect figure. See figure on p.40.

p.322, Plate 3. See picture for plate 4.

p.322, Plate 4. See picture for plate 3.

p.350, Plate 49. Caption should read: Western escarpment of Baucau Plateau: suco Uato Lari (Vemasse in dotted lines). (see Table 39)

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Man and Environment in Eastern Timor:
a geoecological analysis of the Baucau–Viqueque Area as a possible basis for regional planning

Joachim K Metzner

Series editor E.K. Fisk

The Australian National University
Canberra 1977

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J.K. Metzner

Heidelberg

1977

Summary

This study of the ecosystem of the Baucau-Viqueque area in former Portuguese Timor, the first detailed geoecological analysis of any part of the Lesser Sunda Islands, shows that the population lives under harsh physical conditions and in disequilibrium with its environment. This imbalance has been caused by the removal of population checks by the Portuguese at the beginning of this century and their failure to improve agricultural techniques which would have enabled the population to feed a larger number of people. Though the colourful spectrum of different types of land utilization bears witness to the remarkable efforts of the population to adjust agricultural techniques to local environment and to population pressure, large-scale land degradation and seasonal hunger could not be avoided. It seems that the population itself is unable to find a way out of this impasse, and help from 'outside' is urgently needed. A thorough understanding of the intricate relationship between man and his environment is considered a prerequisite for re-establishing a new balance.

Contents

		Page
Acknowledgments		v
Abbreviations		xvi
Glossary		xvii
Introduction		xxiii
Chapter 1	Population, administration and settlement	1
Chapter 2	The physical factors of the environment	20
Chapter 3	Types of land use and land ownership	116
Chapter 4	An analysis of the environment in its ecological context	151
Chapter 5	Aspects of regional planning in the Baucau-Viqueque Area	269
Conclusion		292
Appendix I	A regional differentiation of the Area under investigation into environmental zones	295
Appendix II	Alphabetical list of place names	316
Plates		321
Resumo		351
Ringkasan		354
Zusammenfassung		357
References		360
Index		373

Tables

1	Population and taxpayers by sucos, 1969	8-9
2	Linguistic composition of the indigenous population by postos	12
3	Non-indigenous population by postos, 1969	15

		Page
4	Mechanical and chemical analysis of grey calcareous soil for clay complex: CN	47
5	Mechanical and chemical analysis of calcareous psammitic regosols: RC	47
6	Mechanical and chemical analysis of medium-textured calcareous modern alluvial soil: Amc	50
7	Mechanical and chemical analysis of heavy textured non-calcareous modern alluvial soil: Ap	50
8	Mechanical and chemical analysis of coastal lowland soils: Plc	52
9	Mechanical and chemical analysis of red calcareous soil for coral reef limestone: VR	52
10	Mechanical and chemical analysis of grey calcareous soil for sandstone and coral reef limestone: CR	54
11	Mechanical and chemical analysis of brown calcareous soil for fatu limestone: PF	54
12	Mean annual rainfall for eight stations in the Baucau-Viqueque Area	64
13	Percentage frequencies of rainless days and rainy days within specified limits	68
14	Mean monthly rainfall for eight stations as a percentage of total annual rainfall	69
15	Coefficients of variation of monthly rainfall	71
16	Maximum amounts of rainfall in 24 hours	74
17	Characteristics of 'Growing Period'	82
18	Total runoff per year and length of time during which runoff occurs	83
19	Monthly mean hours of sunshine as a percentage of total possible sunshine hours, Baucau and Viqueque	87
20	Distribution of genera in the Lesser Sunda Islands and 'Malaysia'	113
21	Native rice varieties in the Baucau-Viqueque Area	164-5
22	Livestock in Portuguese Timor, 1969	187

		Page
23	'Standard Head of Livestock' and population in Portuguese Timor, 1969	188
24	Livestock in the Baucau-Viqueque Area by postos in 1969	190
25	Social distribution of buffaloes in Ossu and Posto Sede of Viqueque, 1969	191
26	Livestock population in Portuguese Timor, 1913-69	194
27	Buffalo population by postos	195
28	Livestock slaughtered or deceased due to disease, by postos, 1967-69	198
29	Meat consumption per head per year in Portuguese Timor, 1965	203
30	Agricultural calendar	206-7
31	Copra trade within the Area and to Dili	219
32	Regional price differences of major cash crops per kg bought, November 1970	220
33	Rice exports from the market centres of the Area in 1969	227
34	Rice exports by postos	228
35	Livestock trade within the Area and to the coffee growing districts	240
36	Febrile cases reported as malarial, by postos, 1956-59	243
37	Population of Portuguese Timor, 1862-1970	250
38	Livestock density per taxpayer, 1959-60 to 1969-70	256
39	Example of computation of density of occupation index	264
40	Sucos with density of occupation index above 1.0	266
41	Livestock needed for slaughter to provide 30-40 per cent of meat per person per day	278

Figures

1	Location of Timor Island in the Southeast Asian archipeligo	xxiv

		Page
2	Timor Island	xxiv
3	The Baucau-Viqueque Area, giving place names	xxvi
4	Physiography of the Area	2
5	Administrative divisions of the Baucau-Viqueque Area	7
6	Population density by sucos, 1969	11
7	Language distribution in the Area	13
8	Distribution of population on the basis of homesteads	18
9	Relief zones within the Area	23
10	Sketch map of the distribution of Bobonaro Scaly Clay	27
11	Geology of the Area	30
12	Slope map of the Area	37
13	Soil types found in the Area	40
14	Soil types along profile	43
15	Mean monthly rainfall of the Area	66
16	Accumulated weekly precipitation according to specified probability classes, Venilale, 1953-70	73
17	Diurnal rainfall variation, Viqueque and Baucau,	75
18	Mean weekly soil moisture storage	79
19	Mean weekly runoff	79
20	Median, lower quartile and upper quartile of soil moisture storage, Laga, Baucau Airport, Ossu and Viqueque	82-3
21	Mean monthly temperature (minimum and maximum) for Laga, Baucau, Ossu and Viqueque.	85
22	Climate along profile	90
23	Present vegetation of the Area	94
24	Present vegetation along profile	99
25	Land use pattern of the Area	152
26	Land use pattern along profile	154
27	Cultivation periods on natar: Laga, Baucau, Quelicai, Venilale, Ossu, Viqueque and Uato Lari	158-9

		Page
28	Rotation periods on to'os	171
29	Distribution of water buffaloes within the Area	186
30	Distribution of horses within the Area	197
31	Distribution of cattle within the Area	200
32	Per capita money circulation in Portuguese Timor, 1953-63. Source: Fortuna 1968:209, Fig. 22.	212
33	Malaria endemicity within the Area	244
34	Population changes, 1959-60 to 1969-70	252
35	Standard head of livestock per taxpayer, 1969	258
36	Density of occupation index	267
37	Environmental zones of the Area	296
38	Environmental zones along profile	297

Plates

1	Ossoala Range from Mt Mundo Perdido	321
2	Central upland from the south	321
3	Quelicai, road to Baucau, looking north	322
4	North coast, near mouth of River Seiçal, looking south	322
5	Baucau Plateau, eastern rim: peasant with bundled maize cobs	323
6	Ossu: hunter with blowpipe and killed monkey	323
7	Mouth of River Manoleden, north coast: aerial photograph	324
8	Mouth of River Seiçal: aerial photograph	328
9	Series of elevated marine terraces of Baucau Plateau: aerial photograph	326
10	Baucau Plateau, eastern escarpment, looking west	327
11	Mt Laritame and Assa Lai Tula River: aerial photograph	328
12	Mt Hak Arat Lare and gorge of River Assa Lai Tula	329
13	Mouth of perennial River Cuha: aerial photograph	330
14	Southern Littoral Plains Zone with adjacent Southern Foothill Zone	331

		Page
15	Plain of Uato Lari: aerial photograph	332
16	North west, suco Seiçal	332
17	Mt Mundo Perdido, north slope, looking west	333
18	Tu Nitan hamlet, Mundo Perdido Range, highest permanent settlement in the Area	333
19	Mundo Perdido, northern slope: *Eucalyptus urophylla* woodland	334
20	Mt Ossoala, northern slope, looking west	334
21	Floodplains of River Bicaliu: aerial photograph	335
22	Southern foothills, southeast of Viqueque: *Corypha utan* savanna	335
23	South coast, littoral plains zone, looking west	336
24	South coast, west of Bé Aco	336
25	Mt Ossoala ridge of volcanic Barique Formation: aerial photograph	337
26	Hunter with spear and catana, Mundo Perdido Range	338
27	To'os fenced in with leaf stalks of *Corypha utan*, north coast	339
28	Baucau Plateau, looking south, with bando pole reminding suco members of taboos	339
29	Tilling by means of digging sticks, south coast	340
30	Drilling holes with planting stick for dryland rice in tilled to'os, Southern Foothill Zone	340
31	Fence construction with bamboo and leaf stalks of *Corypha utan*, south coast	341
32	Trampling of irrigated rice field by buffaloes, western escarpment of Baucau Plateau	341
33	Bund repair on rice field with digging sticks, Baucau Plateau	342
34	Threshing of rice by foot, Venilale	342
35	Winnowing of rice, Venilale	343
36	Uai Beha Ana rainfed paddy field on southern rim of Baucau Plateau, suco Loilubo: aerial photograph	343

		Page
37	Quelicai, looking south from administrative centre	344
38	Irrigated maize on terraced rice fields as a second crop, Baucau Plateau, eastern scarpment	344
39	Tilling with dibble on terraced field, Quelicai	345
40	Baucau Plateau showing to'os fenced in with coral limestone blocks	345
41	Venilale and Assa Lai Tula River	346
42	Central upland, viewed from Larigutu	346
43	Southern Foothill Zone: stilted huts with overhanging roofs typical of Viqueque region	347
44	Ossu administrative centre, looking southeast	347
45	Quelicai, suco Maluro, looking west	348
46	Venilale, seen from Baucau-Viqueque road	348
47	Heavy clay soils west of Mt Ossoala ridge: aerial photograph	349
48	Mundo Perdido Range, southern slope, scarred by erosion caused by livestock	349
49	Western escarpment of Baucau Plateau: aerial photograph	350

Abbreviations

AIMT	Anais do Instituto da Medicina Tropical, Lisboa.
BAGC	*Boletim da Agência Geral das Colónias*, Lisboa. (Since 1951: Boletim Geral do Ultramar)
BCAF	*Boletim do Comércio, Agricultura e Fomento da Provincia de Timor*, Dili
BGU	*Boletim Geral do Ultramar*, Lisboa
BOT	*Boletim Oficial de Timor*, Dili
BSGL	*Boletim da Sociedade de Geografia de Lisboa*
CMB	Comissão Municipal de Baucau
CMV	Comissão Municipal de Viqueque
CSIRO	Commonwealth Scientific and Industrial Research Organization (Australia)
EA	*Estudos Agronómicos*, Publicação Trimestral da Missão de Estudos Agronómicos do Ultramar, Lisboa
GO	Garcia de Orta, Revista da Junta das Missões Geográficas e de Investigações do Ultramar, Lisboa
GT	Gôverno de Timor
JTG	*Journal of Tropical Geography*
RPSAS	Repartição Provincial dos Serviços de Saúde e Assistência Social, Dili
RPSV	Repartição Provincial dos Serviços de Veterinária, Dili
RPSAF	Repartição Provincial dos Serviços de Agricultura e Florestas, Dili
SMN	Serviço Meteorológico Nacional, Lisboa
SMT	Serviço Meteorológico de Timor, Dili

Explanation of currency

$ = Escudo (e.g. 100$00 = 100 Escudos)

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Glossary

ahi matan	clan
ahi oan	**castor** oil plant *(Ricinus communis)*
ahi oan mutin	*Jatropha curcas*
ahu	lime
ai baku moras	*Strychnos ligustrina*
ai bubur metan	*Eucalyptus urophylla*
ai bubur mutin	*Eucalyptus alba*
ai café	*Leucaena leucocephala*
ai dak	*Schleichera oleosa*
ai dassa	remuneration given to herdsman
ai dila	pawpaw *(Carica papaya)*
ai farinha	Cassava *(Manihot utilissima)*
ai feu	*Hibiscus tiliaceus*
ai funan modoc	*Tecoma stans*
ai kabas	cotton plant
ai kaqueu	*Casuarina junghuhniana*
ai lele	kapok tree *(Ceiba pentandra)*
ai suak	digging stick, planting stick
ai suak besi	digging stick with one or two metal points
ai suak boot	large digging stick (up to 2m)
ai suak kiik	dibble
ai sukair	*Tamarindus indica*
ai fahan lotuc	*Leucaena leucocephala*
ai tali	*Corypha utan*
ai tua metan	sugar palm *(Arenga saccharifera)*
akadirun	*Borassus flabellifer*
alu	pestle
arrolamento *	annual tax census
ata	slave
au hu	blow pipe
bahén	sublineage head
bahén mahibu	lineage head
bai loro boot	long dry season (depending upon the locality from May/August to October/November)
bai loro kiik	short dry season (on south coast: April)
baldio *	communally-owned land
baliza *	boundary
bando	bamboo pole at the foot of which sacrifices are made to remind villagers not to steal)
barlaque	wedding
batar	maize *(Zea mays)*
batar ai naruc	sorghum *(Andropogon sorghum)*
batar bai loro boot	maize planted during long dry season
batar bai loro kiik	maize planted during short dry season (April)
batar bé	irrigated maize
batar boot	late maturing maize
batar kiik	early maturing maize
batar labarik	early maturing maize
batar lalais	early maturing maize
batar mean	red maize
batar mutin	white maize
batar udan	maize planted during rainy season
bebak	leaf stalks of Corypha palm
bibi	goat
bibi malai	sheep
biti	mat

bua	Areca nut *(Areca catechu)*
caju *	Cashew nut *(Anacardium occidentale)*
canteiros *	compartments of a rice field
carreira *	bus service
catana *	machete
centro pecuário *	centre for animal husbandry (government-owned)
chefe de provoação	village chief
chefe de suco	*suco* chief
circunscrição *	district without a municipality
cnua	hamlet
coilão *	ponded river
comandos militares *	military districts
concelho *	district with municipality
conto *	1000 Timor escudos
contribuinte *	taxpayer
cuân	species of yams
duut manu lain	*Imperata cylindrica* grass
ema foho	upland people
ema tasi	lowland people
ema uma laran	family
enfermero *	health officer
estilo	traditional Timorese feasts (e.g. takarate = closing of the tomb)
etu	cooked rice
fae batar	to mill maize
fae hare	to mill rice
fahi	pig
fava *	broad bean *(Vicia faba)*
fatu	lit.: stone, hill; here often used for limestone hill
fehuk bé	irrigated sweet potato
fehuk Europa	potato *(Solanum tuberosum)*
fehuk midar	sweet potato *(Ipomea batatas)*
fila rai	tilling with digging sticks
foré mungo	mung bean *(Phaseolus mungo)*
foré roi	peanut *(Arachis hypogea)*
foré sikoti	cow pea *(Vigna sinensis)*
foré tali	kidney bean *(Dolichos lablab)*
fos	milled rice
gamuti	fibrous material from *Arenga Saccharifera* palm
ganta	basket
guajaba	*Psidium guajava*
guia de trânsito *	transit certificate
hafaho rai	to weed
halo to'os	to cultivate the dryland field
halo kabubo	to construct small dikes surrounding the rice field
halo lutun	fencing
halo socio	to conclude a contract between owner of buffalo and owner of wet rice field
hare	unmilled rice
hare lalais	early maturing rice
hare natar	paddy
hare to'os	dryland rice
has	mango *(Mangifera indica)*
heda	*Pandanus odoratissimus*

hoka	huge mat basket for storage of rice
hospital rural *	small hospital
hudi	banana
için malirin	malaria
imposto do gado *	livestock tax
imposto domiciliario *	annual head tax
jaca	jakfruit *(Artocarpus integra)*
kabo bé	village official in charge of distribution of water for wet rice fields
kakubo	small dike surrounding the wet rice field
kamii	candlebut tree *(Aleurites moluccana)*
kano	irrigation canal
karau	water buffalo
kare hare	to broadcast rice
katuas	clan leader
kebaya	blouse
kero	sign indicating private property
koa hare	to harvest rice
koto dian	French bean *(Phaseolus vulgaris)*
koto fuic	lima bean *(Phaseolus lunatus)*
kuan	*Dioscorea hispida*
kuda	horse
kulu	bread fruit *(Artocarpus communis)*
kumbili	yams *(Dioscorea esculenta)*
lakeru	pumpkin
lata	20 litre oil tin equivalent to 12.8kg of unmilled rice
leren ai	to cut trees
lere rai	to slash and burn trees, shrubs and grass to open up a field
lere rai bo'ot	to cut big trees for opening a new field
lere rai oan	to cut grass and bushes
lere rai kiik	to cut grass and bushes
lesu	mortar made of wood
lis	onion
liurai	local king of former times
luhul	*Ricinus communis*
lulik	sacred
lutun	fence
makair fukum	one of two heads of a princedom
major	village policeman
makleat	village forester
malus	pepper vines *(Piper bette)*
merantjah sawah (Indonesia)	trampling of paddy fields by means of buffaloes
nai boot	land owner
natar (= natar bé)	irrigated rice field (also meaning a plain)
natar main	paddy field owner
natar udan	rainfed paddy field
neçun	mortar
nele *	unmilled rice
nu	coconut tree *(Cocos nucifer)*
oe	rattan *(Calamus draco)*

pardau	measurement (equivalent to length of a palm = 22cm used to measure length of buffalo horns, which determine value of buffalo)
piri-piri	pepper *(Pimenta officinalis)*
plantação *	field with perennial crops
posto *	subdistrict
posto sanitario *	dispensary
posto sede *	posto bearing name of entire concelho
povoação *	smallest administrative unit comprising several hamlets (cnua)
que rai atama bé	to dig an irrigation channel
rai	kingdom
rai dodok	landslide
rai malirin	lit. 'cold soil' - upland
rai mean	red soil
rai metan	black soil
rai mohate	lithosolic soil
rai mutin	white soil
rai na bé	landslide
rai nama doras	landslide
rai tahu manu tem	heavy textured clay soil
rai te'en	landrent formerly paid by suco members to the liurai (king)
rai udan	rainy season
recenseamento *	tax census
rombia	*Metroxylon sagu*
sama hare	to thresh rice
sama natar	puddling of rice fields by trampling with buffaloes
servico hamutuc *	mutual help
silu batar	to harvest maize
soco	*Saccharum spontaneum* grass
socio *	partners who have made a contract for paddy cultivation
soja *	soybean *(Glycine hispida)*
suco	administrative unit consisting of several villages *(povoações)*
sunu rai	burning of trees and shrubs
ta'a	machete
tais	handwoven cloth
talas	taro
tali	rope
tali belanda	*Agave sisalana*
tasi feto	Wetar Sea
tasi mane	Timor Sea
tau karau hamutuk	pooling of buffaloes for paddy cultivation lit.: garden, either permanent or under shifting cultivation
to'os besik uma	house garden
to'os kiik	house garden
tuak	unfermented juice from palms
tuak sabo	fermented and distilled beverage from palms
tuku	threshing
tuku batar	to grind maize
tuku hare	to thresh rice
tunis	pigeon pea *(Cajanus indicus)*
turis	*Sesbania grandiflora*

uhi	species of yams
uma cnua	permanent hut in hanlet
uma lulik	sacred house
uma natar	small hut at wet rice field
uma to'os	temporary hut on shifting field

* Portuguese or Timorese Portuguese.

INTRODUCTION

Following a *coup d'état* and a demand for full independence for Portuguese Timor on 11 August 1975 this remote and little known colony in Island Southeast Asia moved into the forefront of public attention. In the wake of the *coup* civil war broke out in the course of which thousands of Timorese were reported to have been killed or made homeless. Roughly 40,000 refugees fled to the western, Indonesian half of the island. In the complete absence of Portuguese control Indonesia felt prompted to send troops to eastern Timor on 6 December 1975. This intervention finally resulted in the formal annexation of the territory as Indonesia's twenty-seventh province on 17 August 1976.[1]

While these dramatic events brought Timor to the notice of the world they largely masked the territory's fundamental problems of rapid land degradation and of finding food for its 650,000 inhabitants. There are obvious symptoms of a disequilibrium between man and his environment. They are also the most immediate challenges to be faced if large-scale development efforts are undertaken. I therefore welcomed the offer of the Development Studies Centre of the Australian National University to publish the results of my geoecological research on eastern Timor in the Monograph Series of the Centre. As a result it is hoped that the outcome of 16 months of fieldwork will be made accessible to a wider public and help contribute to the understanding of the relationship between the Timorese and their habitat.

The factual content of this monograph is essentially the doctoral dissertation which I submitted to the University of Heidelberg, Faculty of Geoscience (Germany), in July 1973. For the purpose of publication I slightly edited the thesis during my stay in Canberra in October and November 1976. The name 'Portuguese Timor' has been retained, since it applied to the area when the original study was carried out.

[1] The bill which declared Eastern Timor the 27th province of Indonesia was officially signed by President Suharto on 17 July 1976.

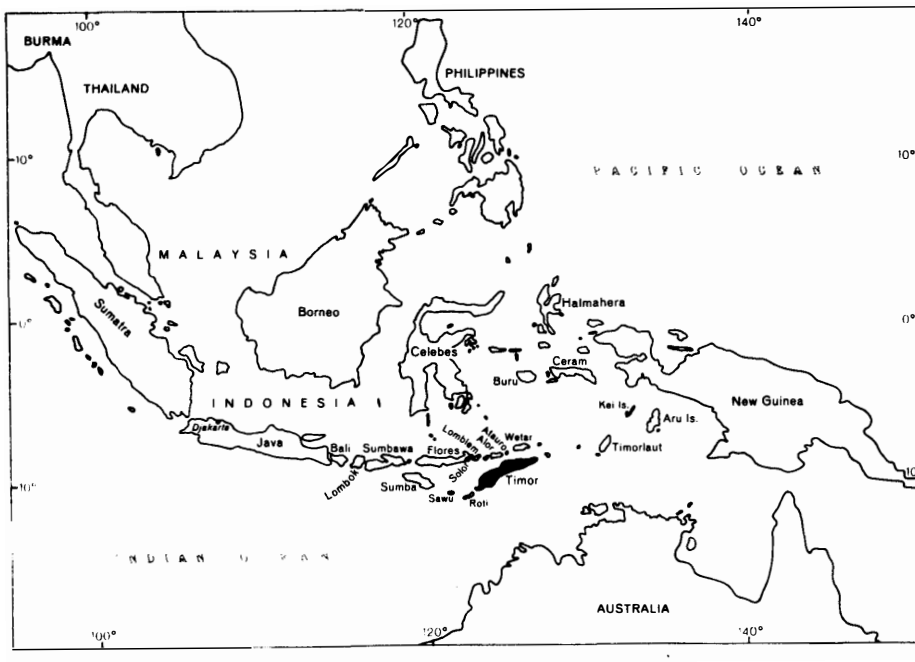


Fig. 1 Location of Timor Island in the Southeast Asian archipeligo

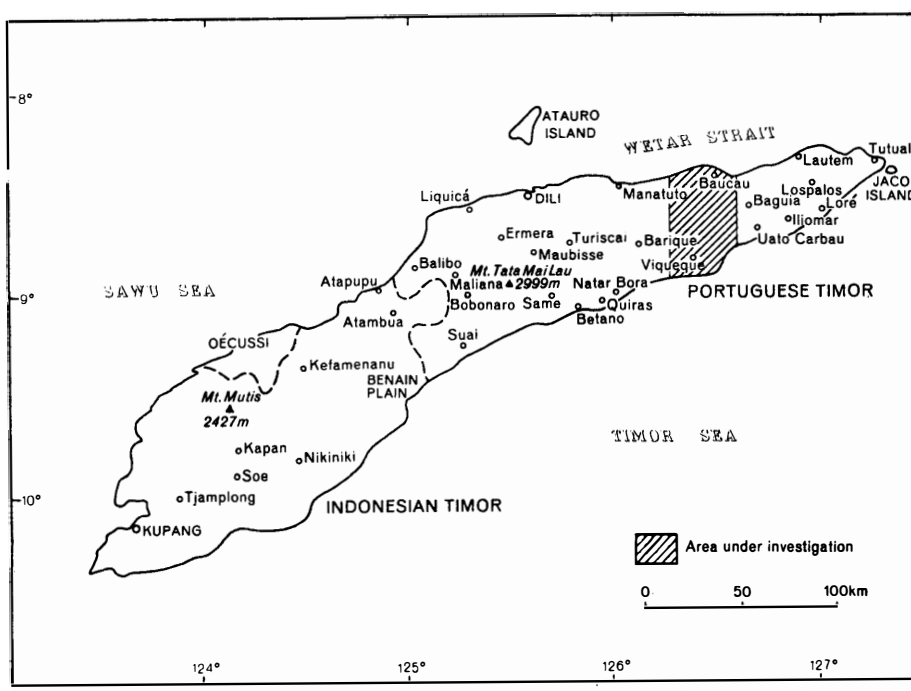


Fig. 2 Timor Island

When I began work in Portuguese Timor, in August 1969, it was clear that a detailed analysis of the present disequilibrium, as presented here, could be carried out only in a small cross-section of Eastern Timor. For this the Baucau-Viqueque area (60 km long and 30 km wide) which reaches from the north coast to the south coast was chosen (see Fig. 3). This 'corridor' was found to be most convenient for the purpose of this study on the following grounds:

(1) Because reconnaissance observations in the field of the study corridor showed clear symptoms of land degradation under stress of population pressure: one of my main objectives in choosing Timor was to examine the developing disequilibrium between man and his environment where shifting cultivation has been the traditional system.

(2) Owing to its altitudinal range from sea level to 1769m a sufficiently differentiated landscape pattern could be expected comprising all major landscapes which exist on Timor. This would enable some generalizations to be made about other parts of the island.

(3) The area includes a comparatively high portion of primary vegetation, thereby facilitating comparative studies of man's impact on the ecosystems.

(4) The Baucau-Viqueque area is one of the few places in Timor where a road, albeit primitive, crosses the island from coast to coast; transport problems were thus likely to be reduced.

(5) Last, but not least, the availability of recent large-scale aerial photographs and topographic maps from Eastern Timor was an important consideration.

The Baucau-Viqueque study corridor[2] is limited by the Wetar Strait in the north (tasi feto) and by the Timor Sea (tasi mane)[3] in the south. The western limit forms a straight

[2]We shall simply refer to this corridor as the Area throughout the study.

[3]In Tetum, the lingua franca of Portuguese Timor, tasi feto stands for 'Female Sea', as it is usually relatively 'tame', while tasi mane stands for 'Male Sea' which is often 'stormy'.

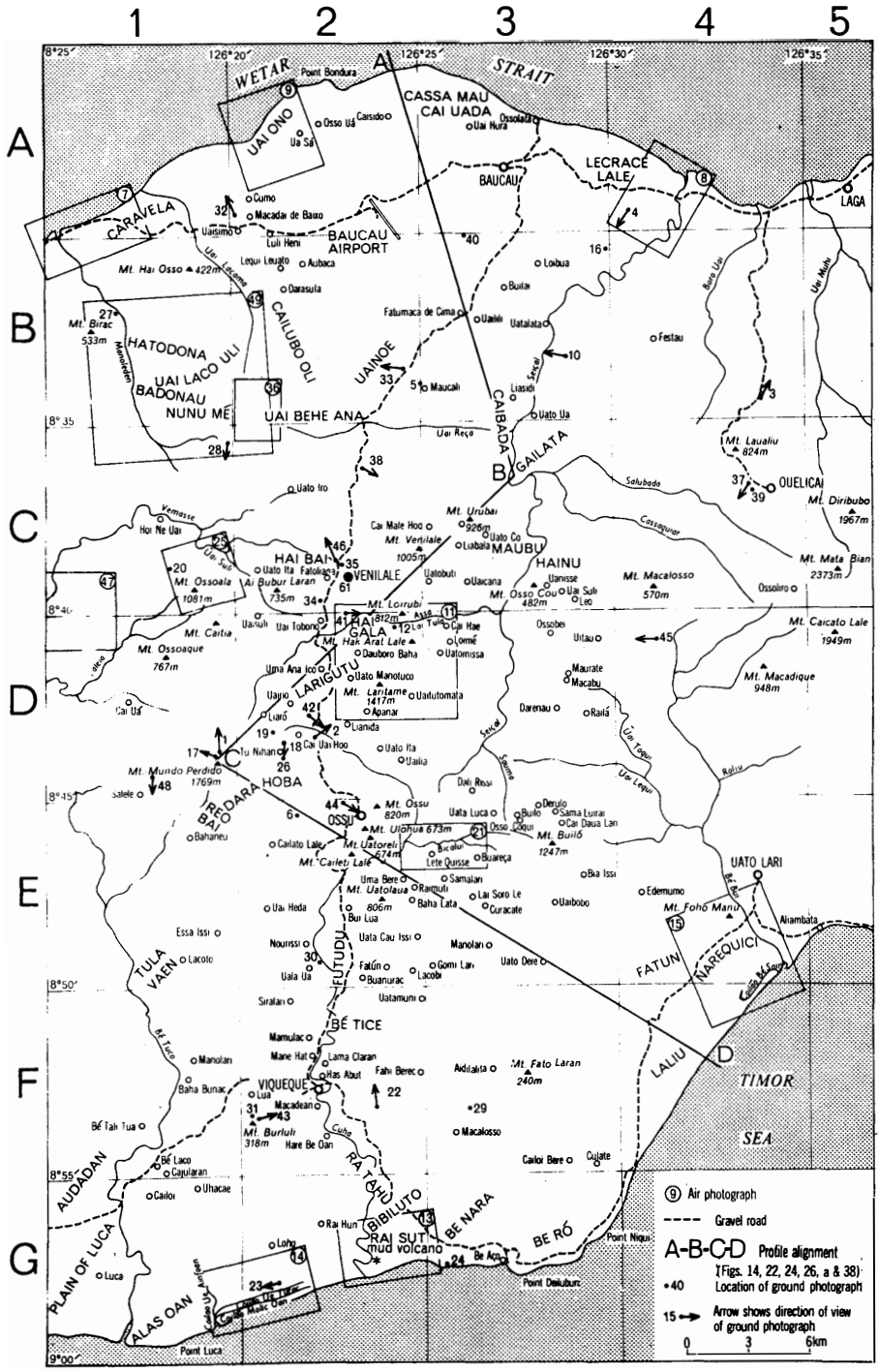


Fig. 3 The Baucau-Viqueque Area, giving place names
(For alphabetical list of place names see Appendix II)

line roughly north-south which coincides with the course of the River Manoléden in the north and the River Bé Tuco in the south. A line from the River Uai Múhi in the north, the foothills of Mt Mata Bian and the River Bé Bui in the south limit the area in the east. The study zone comprises 1783 sq. km between 126° 15' and 126° 35' E longitude and 8° 25' and 9° 00' S latitude.

The analysis of the landscape ecology of the Baucau-Viqueque area was greatly impeded by the virtual absence of any published material relating specifically to this corridor. All I could draw upon were a few publications which treat Timor in general and make only marginal reference to the Baucau-Viqueque area. Of particular value were Ormeling's *The Timor Problem* (1955), Audley-Charles' *The Geology of Portuguese Timor* (1968), Meijer Drees' *Distribution, Ecology and Silvicultural Possibilities of the Trees and Shrubs from ... Timor* (1951)[4] as well as the publication by the Serviço Meteorológico Nacional on the climate of the Province of Timor (1965).

Among the more useful unpublished sources in Dili were several official reports: annual reports of the Repartição Provincial dos Serviços de Agricultura e Florestas (RPSAF), Dili, 1959-69; annual reports of the Repartição Provincial dos Serviços de Veterinária (RPSV), Dili, 1962-69;[5] and reports of the Missão de Estudos Agronómicos do Ultramar, Brigada de Timor (MEAU), Dili, 1963-69.

If one wants to learn more about conditions in Portuguese Timor before World War I or in the interwar years, there are almost no documents. All were destroyed by the Japanese forces who occupied Timor from 1942 to 1945. Some information on the development of agriculture after pacification in the early years of this century may be found in the *Boletim de Comercio, Agricultura e Fomento*, Dili, 1914-20, in which agricultural reports submitted by the military commanders[6] to the governor in Dili were partly reproduced.

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[4] Though pertaining chiefly to western Timor.

[5] Until 31 December 1965 the Veterinary Department was a subdivision of the RPSAF. At the beginning of 1966 it became a separate department.

[6] After pacification Portuguese Timor was administered by military commanders. Our Area was divided into comandos militares of Baucau and Viqueque. After 1920 the colony was gradually brought under civil administration.

Surprisingly enough, postwar annual reports which all district officers were required to submit to Dili contain little information of value. Reliable statistics are equally hard to come by. The only available sources are the reports of the annual tax assessment (Port.: arrolamento) in which taxpayers were required to declare their wealth (chiefly livestock) and the number of dependants in their families. These comprised the only statistical source in Portuguese Timor, so there were no statistics whatsoever on the size of sucos,[7] or on migration, agricultural production, cultivated areas, interregional commerce, or on the degree of monetization and turnover at the weekly markets.

Even the few tax assessments and district reports found in various postos in 1969 were in deplorable condition. Owing to a lack of appropriate storage space, 2-3 year old files were deposited in moist rooms where they easily fell victim to mildew, rats and insects. Thus it was often impossible to collect comparable data for all districts in the Baucau-Viqueque area. In the absence of so much basic data, the excellent airphotos taken in 1962 by the Técnica Aérea e Fotogramétrica Lda (TECAFO) at an approximate scale of 1:30,000 were an invaluable help. Without them and without the topographic maps (1968) at a scale of 1:50,000 based on the airphotos, this study could certainly not have been undertaken.[8]

The bulk of the factual content of this monograph, including all but one of the thematic maps,[9] was compiled from material collected in Timor from August 1969 to August 1970 and again from October to December 1970. As far as I

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[7] These are the smallest administrative units, each of which consists of a number of villages (Port.: povoação).

[8] Considerable difficulty was encountered in the choice of appropriate geographical names, as the Timorese have no common names for mountains and rivers. Thus a mountain may have several names depending on the ethnolinguistic group and depending on the angle from where it is seen. A river may also change its name several times between its source and the sea. As far as possible I have followed the nomenclature and Portuguese spelling of the 1:50,000 topographic map (1968). This map, however valuable it is, is but a first attempt and inevitably contains a number of misspellings and mistakes.

[9] Only the geological map (Fig. 11) was taken from Audley-Charles (1968).

am aware the only other fieldwork in the area since World War II was carried out by M.G. Audley-Charles (geologist 1959-61) and David Hicks (anthropologist 1966-67). The fieldwork upon which my analysis is based was carried out chiefly on foot and on horseback; tractors and jeeps were used whenever longer distances from coast to coast had to be covered and road conditions permitted. Communication problems of a different kind in the interior were reduced with the help of several Timorese assistants who acted as translators when the need arose. Their intimate knowledge of the terrain and at least one of the seven languages and dialects spoken in the Baucau-Viqueque corridor was an invaluable asset. In the field I generally spoke Tetum which is widely understood, although in dealings with liurais (suco chiefs) and administration officers Portuguese was used.

In this study as now presented, the first chapter traces the cultural and administrative history of Eastern Timor and outlines the main aspects of population distribution and settlement in the Baucau-Viqueque area in 1969-70. Subsequent chapters (2 and 3) examine the main ecological factors - including the action of man - and how they have contributed to the present landscape (Chapter 4). This analysis leads to a differentiation of the area into environmental zones (see Appendix I) and to recognition that each zone poses its own complex of fundamental agricultural problems which require urgent attention (Chapter 5), if the wellbeing of the Timorese is to be improved in this desperately underdeveloped island. Looking beyond Timor and its special problems, I hope that those concerned with rural development throughout the wet-and-dry tropics will derive value from this study of the driest part of the Southeast Asian archipelago, where the shifting cultivation system is breaking down under the stress of population pressure.

J.K. Metzner

The Australian National University
Canberra
November 1976

Chapter 1

POPULATION, ADMINISTRATION AND SETTLEMENT

Timor's intermediate position between island Southeast Asia, Australia and New Guinea is reflected in the mixed ethnic composition of the island's population. Archaeological research in various parts of the island[1] has provided conclusive evidence that several migrations of Negritos, Proto-Malays and Melanesians have overrun the island. As a consequence Timor's population is extremely varied, with both Melanesian and Indonesian-Malay components.[2]

Terrain plays an important role in contributing to the island's cultural and physical diversity. One searches in vain for impressive volcanos and luxuriant tropical vegetation: instead, a broad upland zone with many ridges forms the backbone of the island, flanked along the southern coast by a plain up to 4 km in width (Fig. 4).

Timor's cultural history has resembled that of most other islands of the Southeast Asian Archipelago. Strong archaeological evidence, local myths and the present linguistic division of the island suggest that various waves of migration by Austronesian and non-Austronesian groups have intermingled on the island. With the exception of the Bunak who live in Central Timor, the majority of non-Austronesian speakers are concentrated toward the

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[1] Including recent archaeological work by Glover (1970) in the Baucau area of Portuguese Timor.

[2] Very little physical anthropological research has been done of Timor's population. For a more detailed account see Ormeling (1955:66-7), Meneses (1968:13-7), Bjilmer (1929), A.A.M. Corrêa (1944 and 1945) and Franklin (1944).

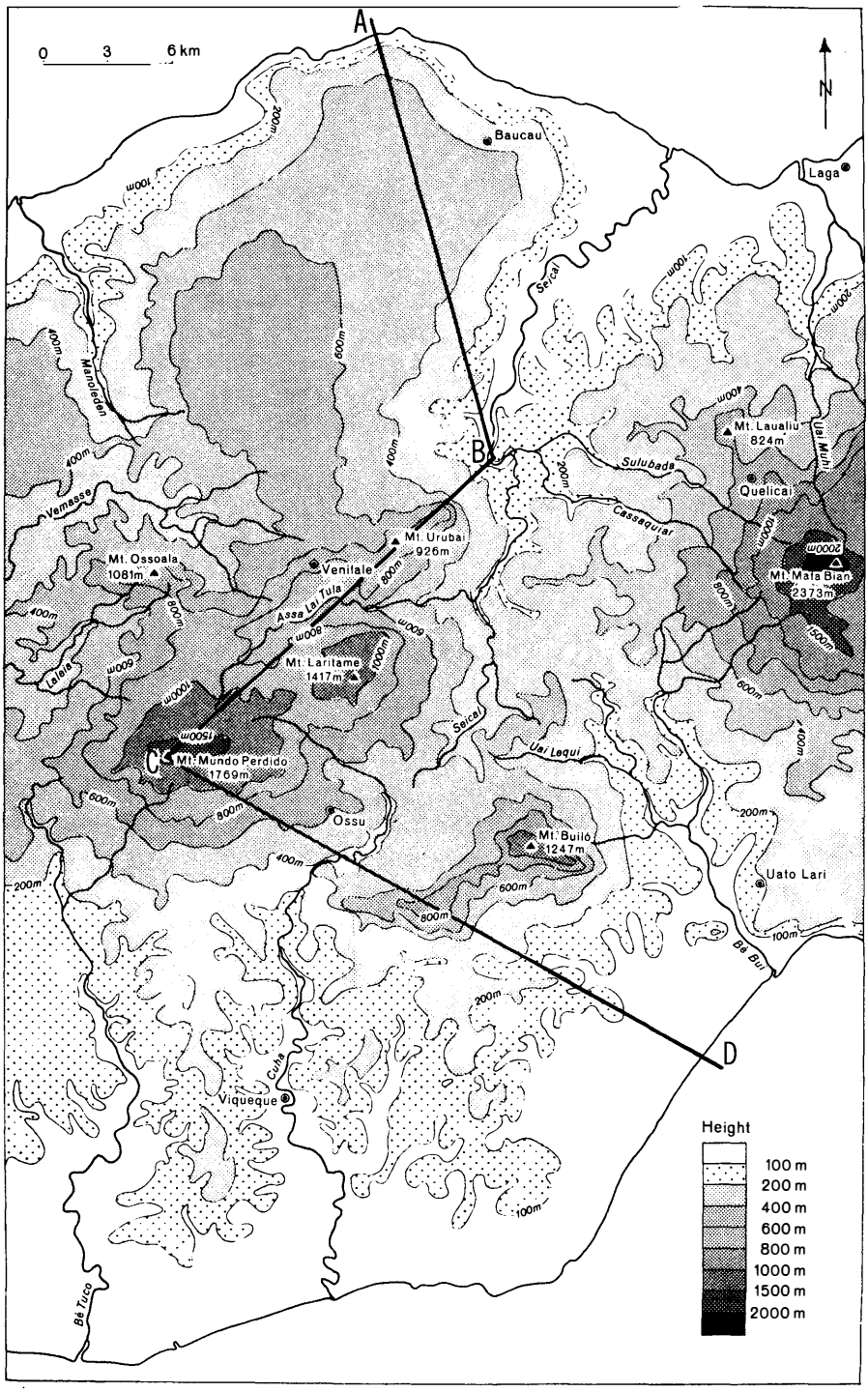


Fig. 4 Physiography of the Area

eastern end of the island (such as Dagadá and Macassai).[3] The largest single ethnic group on the island is the Tetum-speaking one. Tetum speakers can be found in large numbers in both east and west Timor. Their centre of power is considered to have been at Wehale in the Benain Plain. From there they both expanded and exerted political influence over a loose confederation that encompassed a considerable portion of the island. The Portuguese destroyed the authority of Wehale and attempted to establish their own authority among the petty states (rai) on the island.

Characteristically, in the long period before Dutch and Portuguese control became effective late in the nineteenth century, these rais were each headed by a king (liurai)[4] and comprised a number of princedoms (sucos), each governed by two rulers (macair fukum and dato uain)[5] who owed allegiance to the liurai (Hicks 1967:14). The sucos, as the principal kinship units, were divided into localized patrilineal-patrilocal or matrilineal-matrilocal clans (ahi matan). These, in their turn, subdivided into lineages (feto fuan, mane fuan) and sublineages.[6] While the office of liurai was hereditary, with the eldest son usually succeeding (Hicks ETS III:4), the suco chiefs and village headmen were elected by the people. In traditional Timorese society there were three social classes: the dato (aristocrats), the ema (or

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[3]The distinction is based on linguistic grounds for there has been very little physical anthropological research on Timor. It is interesting to note that Prof. Antonio de Almeida (Univ. Técnica, Lisbon) (cited by Meneses 1968:14) recognizes 31 languages in the Portuguese section of the island, as compared to only four or five in the less hilly western half. In the absence of a reliable linguistic map the following publications may convey a tentative idea of the regional distribution of east Timor's languages: Martinho 1943b, Capell 1944, Domingues 1947 and Rego 1968.

[4]Meaning 'beyond the earth' in the Tetum language, in which also all the following terms are given.

[5]Dato - aristocrat; uain - abundant, many; macair - one who looks after; fukum - princedom.

[6]Under the administrative division of Portuguese Timor, ideally, the clan roughly corresponds to the povoacão (village) while the lineages and sublineages to the cnua (hamlet). The latter may be separated from each other by several kilometres and hamlets of other sucos.

ema rai meaning men) and the ata (slaves).

This political structure which shows clear characteristics of Tetum influence and which was found regardless of ethnic or linguistic diversity in large parts of Timor, was gradually superseded in different parts of the island by the administrative systems introduced by the colonial powers, the Dutch and the Portuguese. After centuries of conflict and intrigue the Netherlands and Portugal reached agreement in 1859[7] defining their respective spheres of interest in Timor, although at the time their actual control was limited to a handful of coastal bases, including Dili and Kupang. Local military administration was in fact constantly threatened by tribal warfare and head hunting was still common until the end of the nineteenth century. Pacification proceeded slowly. In the Portuguese part of the island firm control by the colonial administration was not established until after a series of military campaigns under Governor Celestino da Silva (1894-1908).

Following the pacification campaigns and an unsuccessful rebellion of chiefs in 1912, a new political structure was established in Portuguese Timor. The liurais were deprived of their powerful position and the entire colony was divided into smaller administrative units (sucos)[8] which could be controlled more easily. The number of military commands was increased[9] and an internal development program was initiated. Roads were built and the natives were forced to grow a number of introduced crops on communal plantations. After 1920 the military commands were gradually transformed into civil administrative units (Felgas 1956:319), so that by 1940 Portuguese Timor comprised one concelho (Dili)[10] and five

[7] According to this treaty of Lisbon, which however did not become effective until 1914, the island was divided politically, about equally into a western Dutch (later Indonesian) half (14,933 sq. km) and an eastern Portuguese half to which also belonged the enclave of Oecussi and the islands of Ataúro and Jaco (total 18,989 sq. km).

[8] Thus the word suco has to be used with caution as it is used both for old political and kinship units as well as for present administrative divisions.

[9] In 1908 there were 15 commands (Felgas 1956:316).

[10] A concelho in contradistinction to a circunscrição is an administrative unit which has a municipality, such as Dili.

circunscrições civis, all extending north-south from coast to coast. These were, in sequence from the eastern end of Timor: Lautem, São Domingos, Manatuto, Suro and Fronteira, in addition to Oecussi on the north coast of western Timor.

After the Japanese occupation of Timor in World War II (1942-45), the Portuguese further subdivided the circunscrições to exert more direct control. In 1966 all except Oecussi (which remained a circunscrição) were transformed into concelhos, each controlled by an administrator and subdivided into postos. The postos were in turn divided into sucos, each comprising a number of villages (povoações), with sucos presided over by elected chefes de suco[11] whose appointments were subject to the approval of the Portuguese government. By retaining the suco, as the basic administrative unit for groups of villages, after the abolition of kingdoms in 1912, the Portuguese administrative system of indirect rule had in fact only partly replaced the traditional political system in Timor. As Hicks observed in the suco of Caraubalo, Viqueque (Hicks 1971:49), although the chefe de suco handled administrative affairs, in other respects immediate power was often retained by the traditional rulers, the macair fukum or dato uain. This illustrates how slight was the impact of the Portuguese administration on the traditional way of life through most of Eastern Timor. The chefe de suco played a critical role as intermediary between the administration and the majority of the population. The injunctions of the administrador or chefe de posto were passed down to village level through the chefe de suco, but in practice official requirements amounted to little more than the annual census, the levying of annual headtax on the male population aged between 18 and 60, and livestock taxes on cattle, buffaloes and horses.

People in the Baucau-Viqueque transect, 1969

This outline of administrative development in Portuguese Timor helps to explain the complexity of the administrative situation in the Baucau-Viqueque transect, as it was experienced in 1969. While the administrative boundaries of

[11] The compensation of a chefe de suco depends upon the number of taxpayers (contribuintes) as well as on the number of large livestock in his area.

concelhos and postos were described in the Government Gazette,[12] no data at all were available on the size and boundaries of suco territories. As knowledge of the size and location of sucos is essential for any appraisal of population and density, I established the suco boundaries with the help of chefes de suco and village elders,[13] chiefly on the basis of villages belonging to each suco and by consensus on the position of boundaries in relation to prominent landmarks. The task was complicated by the number of misspellings and mislocations on the new large-scale topographic maps (1968, scale 1:50,000), as well as by omissions of village and suco names. The results appear in the map of administrative units (Fig. 5) and Table 1, where the data on area and population density are based upon measurements by planimeter, and so reflect whatever errors were made in determining suco boundaries informally, from advice in the field.

The territories of many sucos shown on Fig. 5 are non-contiguous, so that one suco may be fragmented into several parts. This is the case in all postos and is usually a result of intermarriage between aristocrats of various sucos. Within the Baucau-Viqueque area the extent of fragmentation and the size of suco territories varies greatly. It is clear from Fig. 5 that relatively large units predominate near the northern and southern coasts, but the territories are smaller and more fragmented in the central mountainous section (Quelicai and Venilale) where the highest population densities occur.

At the annual census for taxation purposes in 1969 the population of the Baucau-Viqueque area was 82,064 of whom 20,810 were declared as taxpayers (contribuintes), having to pay the annual headtax of 190$00.[14] At suco level the

[12] *Boletim Oficial de Timor* (B.O.T.) LX Ano, suppl.ao numero 22, 5 de Junho de 1959. Unfortunately an exact map of these units has never been produced. Thus, the official area figures given for these administrative units have to be considered approximate.

[13] The delineation of the suco frontiers is a rather delicate subject as old territorial claims are still latent.

[14] All men between 18 and 60 years of age in good physical condition are subject to this headtax (imposto domiciliário) of which 150$00 go to the Provincial Government and 30$00 to the local municipality. The Timor escudo is roughly equivalent to A$-.03 (1970).

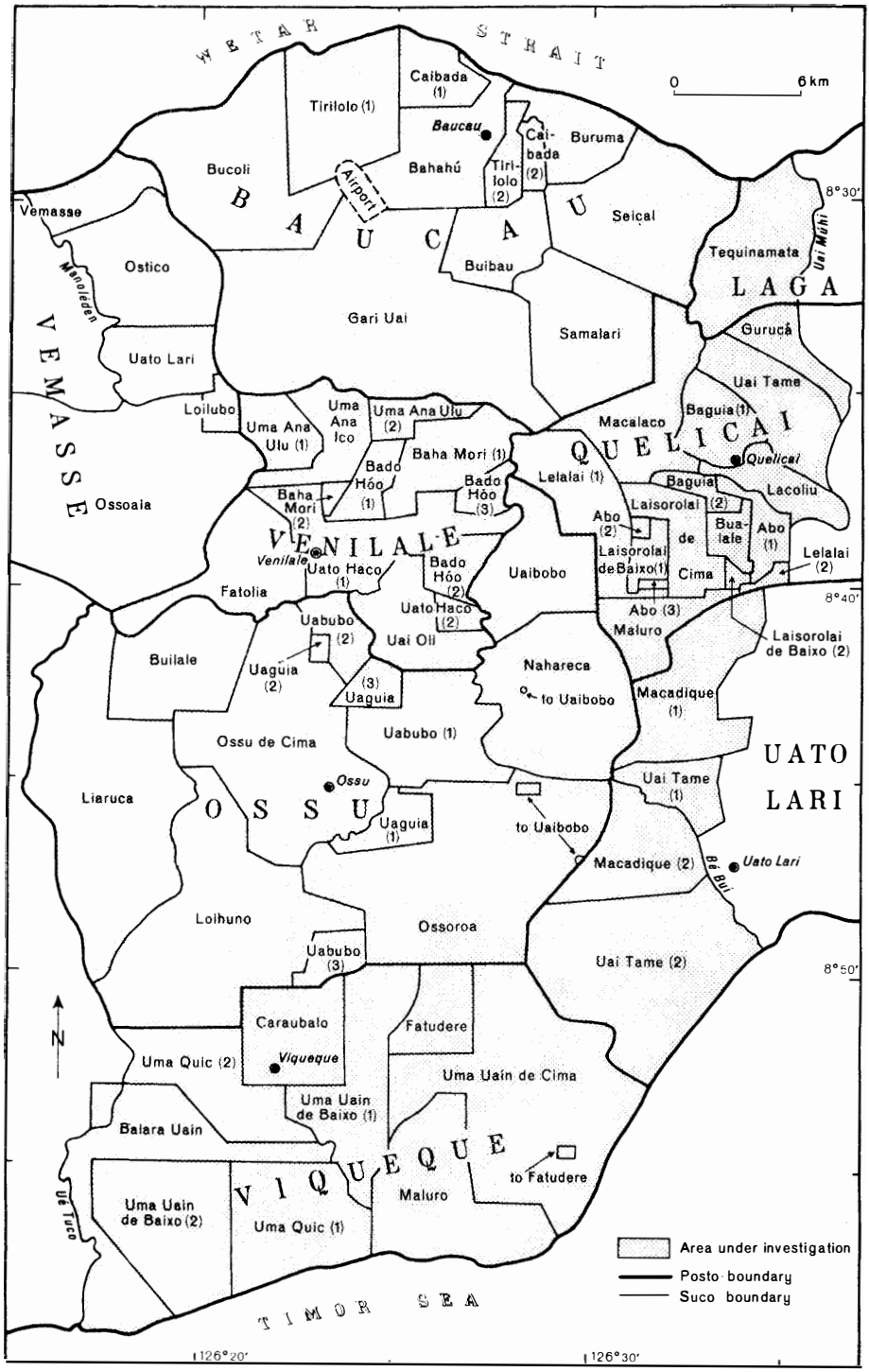


Fig. 5 Administrative divisions of the Baucau-Viqueque Area

Table 1

Population and taxpayers by sucos, 1969

Posto	Suco	Number of povoações	Inhabitants in 1969	Taxpayers in 1969	Area in sq.km.*	Inhabitants per sq.km.
Vemasse	Ostico	3	645	165	35.2	18.3
	Uato Lari	3	816	216	16.0	51.0
	Loilubo	3	863	235	6.4	134.8
	Ossoala	4	1,269	313	54.4	23.3
Total Vemasse		13	3,593	929	112.0	32.0
Laga	Tequinamata	5	888	203	36.8	24.1
Quelicai	Maluro	4	1,607	388	12.8	125.5
	Laisorolai de Cima	3	1,172	289	14.4	81.4
	Laisorolai de Baixo (1)	) 4	769	) 338	4.8	160.2
	Laisorolai de Baixo (2)	)	581	)	1.6	363.1
	Abo (1) (2) (3)	5	2,185	500	7.4	295.3
	Lelalei (1)	) 4	581	) 367	24.0	24.2
	Lelalei (2)	)	786	)	3.2	245.6
	Bualale	4	1,356	352	4.8	282.5
	Macalaco	3	1,021	283	28.8	35.5
	Uai Tame	6	2,080	525	24.0	86.7
	Guruça	5	1,559	406	11.2	57.3
	Baguia (1)	) 4	1,388	) 425	14.4	96.4
	Baguia (2)	)	302	)	4.8	62.9
	Lacoliu	4	1,912	468	9.6	199.2
Total Quelicai		46	17,299	4,341	165.8	104.3
Uato Lari	Macadique (1) (2)	15	4,588	1,267	60.8	75.0
	Uai Tame (Vessoro) (1) (2)	3	805	219	80.0	10.1
Total Uato Lari		18	5,363	1,486	140.8	38.0
Viqueque	Caraubalo	8	2,411	585	22.4	107.6
	Uma Quic (1)	) 6	817	) 515	35.2	23.2
	Uma Quic (2)	)	1,457	)	27.2	53.6
	Balara Uain	7	2,060	486	41.6	49.5
	Maluro	3	374	97	41.6	9.0
	Uma Uain de Cima	8	1,126	281	83.2	13.5
	Uma Uain de Baixo (1)	) 8	787	) 309	40.0	19.7
	Uma Uain de Baixo (2)	)	543	)	40.0	13.4
	Fatudere	3	306	94	12.8	23.9
Total Viqueque		43	9,881	2,367	344.0	28.7
Ossu	Ossu de Cima	8	2,664	759	68.8	38.7
	Loihuno	5	1,080	295	75.2	14.4
	Uaguia (1)	)	615	)	8.0	76.9
	Uaguia (2)	) 6	335	) 355	1.6	209.4
	Uaguia (3)	)	426	)	6.4	66.6
	Ossoroa	12	2,715	771	84.8	32.0
	Uabubo (1)	)	822	)	28.8	28.5
	Uabubo (2)	) 6	662	) 461	9.6	69.0
	Uabubo (3)	)	204	)	8.0	25.5
	Mahareca	5	2,134	557	48.0	44.5
	Uaibobo	7	1,767	500	27.2	65.0
	Builale	5	1,487	433	32.0	46.5
	Liaruca	4	994	279	81.6	12.2
Total Ossu		58	15,905	4,410	480.0	33.1

Table 1 (continued)

Posto	Suco	Number of povoações	Inhabitants in 1969	Taxpayers in 1969	Area in sq.km.*	Inhabitants per sq.km.
Baucau	Gari Uai	14	4,326	1,142	113.6	38.0
	Samalari	4	1,331	343	40.0	33.3
	Buibau	6	2,128	501	17.6	120.0
	Bahahu (incl. Vila de Baucau)	4	2,345	521	19.2	122.1
	Caibada (1)	) 5	998	) 366	9.6	104.0
	Caibada (2)	)	619	)	4.8	129.0
	Tirilolo (1)	) 6	1,325	) 503	33.6	39.4
	Tirilolo (2)	)	593	)	6.4	92.7
	Buruma	3	1,054	264	16.0	65.3
	Seiçal	4	924	206	32.0	28.9
	Bucoli	6	2,071	494	54.4	38.1
Total Baucau		52	17,719	4,340	347.2	51.0
Venilale	Uato Haco (1)	) 7	2,595	) 735	30.4	85.4
	Uato Haco (2)	)	493	)	4.8	102.7
	Bado Hóo (1)	)	833	)	8.0	104.1
	Bado Hóo (2)	) 5	758	) 367	4.8	59.2
	Bado Hóo (3)	)		)	8.0	
	Baha Mori (1)	) 6	1,331	) 369	19.2	69.3
	Baha Mori (2)	)	212	)	3.2	66.2
	Uai Oli	4	1,522	351	19.2	79.3
	Uma Ana Ico	4	1,149	299	16.0	71.8
	Uma Ana Ulo (1)	) 4	726	) 346	8.0	90.8
	Uma Ana Ulo (2)	)	653	)	8.0	81.6
	Fatolia	5	1,144	267	27.2	42.1
Total Venilale		35	11,416	2,734	156.8	72.8
Total AREA		270	82,064	20,810	1,783.4	46.0

* Calculated by means of planimeter.

Note 1: Only those sucos have been considered in the calculation whose territories come to lie entirely within our Area. Sucos like Vemasse (in posto of Vemasse) of which minor sections happen to lie within our Area have been omitted. On the other hand, sucos like Uato Lari (posto of Vemasse) of which a small part of the population lives outside the study area have been treated as if the entire population lived within our Area. If villages of one suco come to lie within the precincts of another suco, the population of the villages has been included in the computation of the density figures of the mother suco, e.g. villages of Dareneu (in Nahareca), Same Liurai (in Ossoroa) belonging to suco of Uaibobo (Ossu).

Note 2: Actual distribution of the population may differ from that represented above insofar as people may register in their home suco (for annual tax assessment) but live permanently elsewhere. This is the case, for instance, with many people from Quelicai. Despite the requirements for a transit permit, there is no way of finding out where the population actually lives.

Source: Annual tax assessments of concelhos of Baucau and Viqueque.

population varied greatly in 1969, from 306 (Fatudere, Viqueque) to 4558 (Macadique, Uato Lari) with a corresponding range in the number of taxpayers from 94 to 1267 for the respective sucos. Table 1 also indicates the differences in the number of villages, with many sucos having only three or four povoações, but two extreme exceptions (Gari Uai and Macadique) had 14 and 15 villages respectively.

It is evident from Table 1 and Fig. 6 that there are tremendous contrasts in population density, ranging from 9 per km^2 near the southern coast (Maluro) to 363 per km^2 in Quelicai (Laiserolai de Baixo).[15] The central uplands stand out on Fig. 6 as the area of highest population concentration, with population density reaching a peak in a number of small sucos in Quelicai near Mt Mata Bian. The unequal size of suco territories is of course one factor affecting density values, but undoubtedly the main contrasts reflect variations in natural conditions. Within the central upland, for example, Ossu has relatively low population density (with the exception of one suco, Uaguia 2) which can be attributed largely to the occurrence of agriculturally poor, heavy clay soils. A broader range of environmental conditions, discussed in the next chapter, helps to explain the overall decrease in population density at lower elevations and the occurrence of the lowest densities in sucos near the southern coast.

In the absence of detailed ethnographic studies, except for the work of Hicks (1971) on the eastern Tetum of Viqueque, linguistic data collected in the field provide some evidence of the diversity of the indigenous population. Seven languages have been distinguished in the Baucau-Viqueque area: Macassai, Tetum, Cairui, Midique, Galoli, Nau Eti and Uaima'a.[16] The relative importance of Macassai, as recorded in censuses between 1955 and 1957 (Table 2), was strongly supported by information for villages in 1969-70 from chefes de suco and elders in each suco.

The map of language distribution based on field information (Fig. 7) shows the dominance of Macassai in a broad belt of sucos extending from coast to coast. Assuming that

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[15] The average population density for Portuguese Timor was 32 inhabitants per sq. km (1970).

[16] Of the 7 languages only Tetum has been studied in some depth. Apart from the dictionaries by Dores (1905, 1907) and Pe. S. M.A. da Silva(1889), the only other language of the Area on which we have some information is Galoli (Silva 1900, 1905).

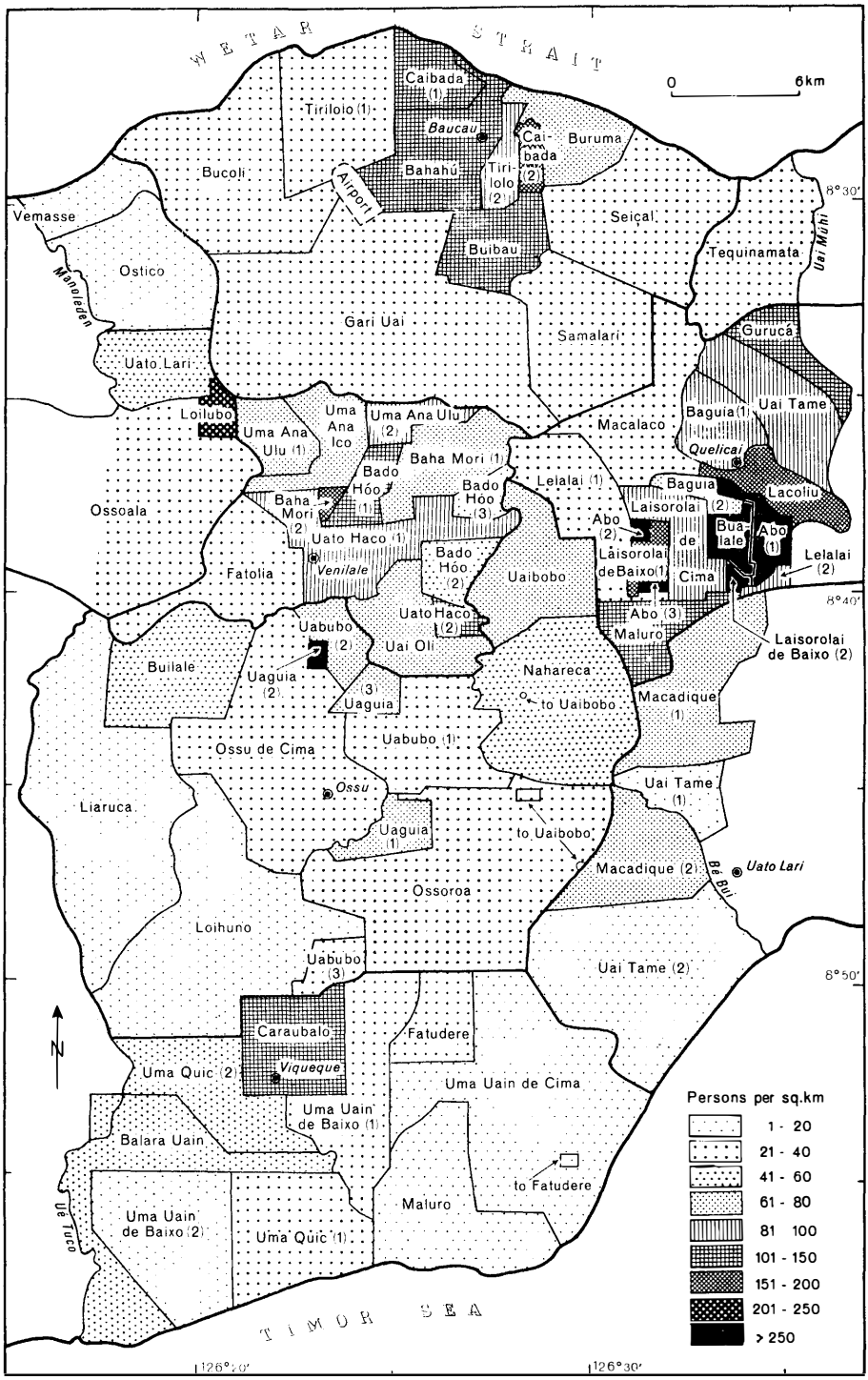


Fig. 6 Population density by sucos, 1969

Table 2

Linguistic composition of the indigenous population by postos

Posto	Year of census	Population (persons)	Macassai %	Midique %	Cairui %	Tetum %	Uaima'a %	Naueti %	Galoli %
Baucau-Sede *	1957	13,879	65.0				35.0		
Laga *	1957	no data	52.0	48.0					
Venilale *	1957	9,559	31.0	53.0			16.0		
Vemasse*	1957	5,377		18.0			64.0		18.0
Quelicai*	1957	15,336	100.0						
Ossu*	1955	14,344	80.0		20.0				
Viqueque-Sede*	1955	11,535	27.0	11.0	1.0	58.0	1.8	1.2	
Uato Lari *	1954	no data	66.0					34.0	

* Population of entire posto.

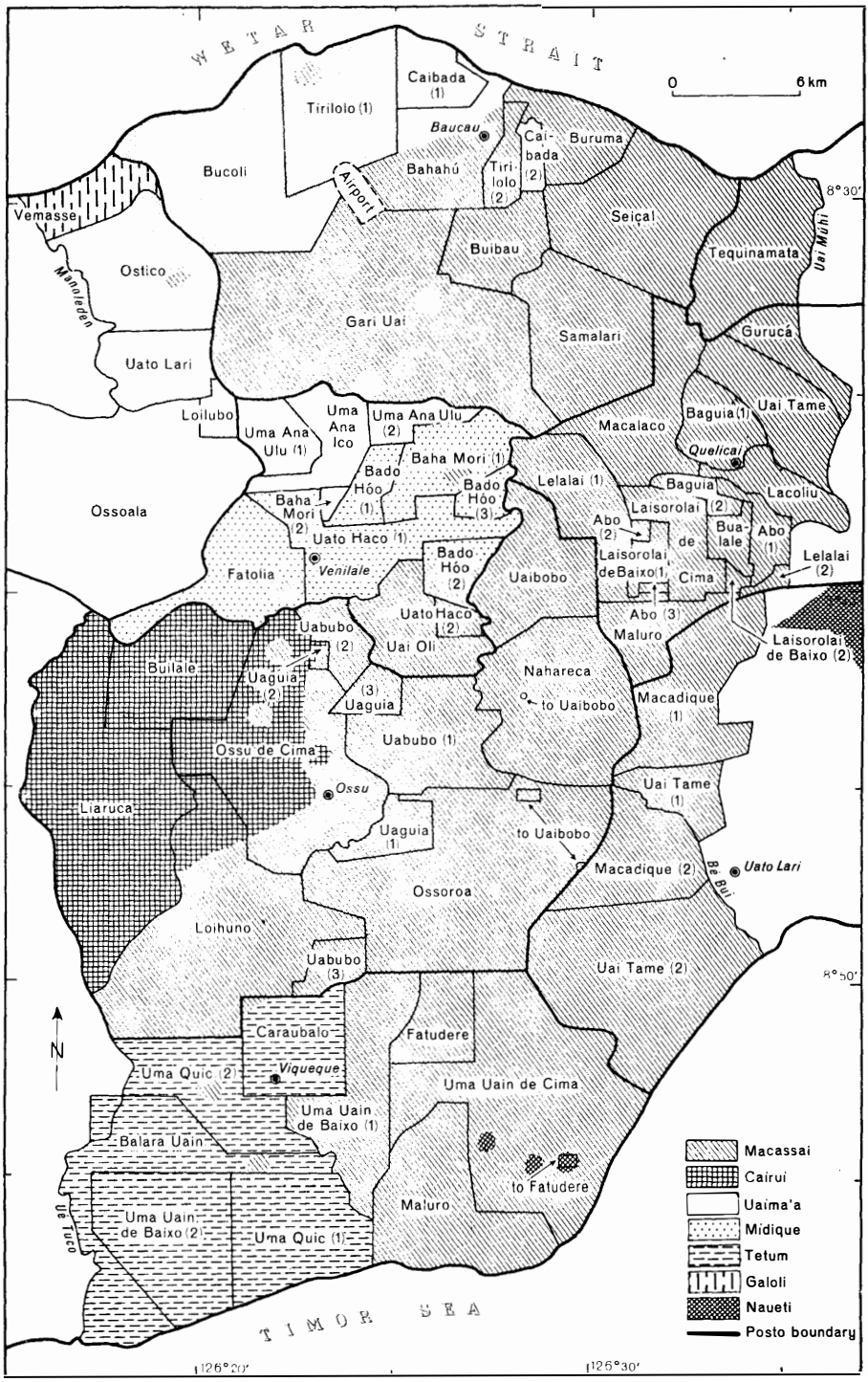


Fig. 7 Language distribution in the Area

the long-term heartland of the Macassai language has been the central mountainous country around Quelicai and Ossu, its widespread distribution north and south of the uplands by the 1960s probably reflected recent migrations of central highlands people in response to population pressure, particularly southwards to the coast. Among other factors the frequent intermarriage of members of the aristocratic (dato) class from different sucos and, secondly, administrative measures by the Portuguese, have led in past decades to the spread of various languages. Hicks (1967:2) supports this view, adding that an invasion of earlier Tetum lands of Viqueque by Macassai and also by Cairui-speaking groups from the central highlands might have occurred.[17] Certainly, the other six languages now play a much less important role and seem to be retreating with the exception of Tetum which is becoming a lingua franca for the local population in dealings with the Administration and as the language of the marketplace.[18]

The non-indigenous population reported in the Baucau-Viqueque area in 1969 was only 1019, of whom 50 per cent were Chinese (Table 3). Although numerically unimportant in a total area population of 97,160, the significance of the non-indigenes is inversely proportional to their numbers. The small group of Europeans in 1969 comprised government officials (e.g. administrador or chefe de posto) and their families, and missionaries;[19] there were no European settlers engaged in agricultural activities in this area with the exception of the Sota coconut plantation at Ra Tahu between Viqueque and Bé Aço. If we disregard this plantation, there is no dual economy so typical in other developing countries in the

[17] There is a strong contrast between highlanders (ema foho) who are regarded as more industrious, and the lowland people (ema tasi).

[18] The Tetum which is strongly interwoven by Portuguese and mainly spoken in Dili is called Tetum-Maka. The Tetum spoken in Viqueque is called Tetum-Terek (impure Tetum), while the proper Tetum, called Tetum-Loos (pure Tetum) is spoken by the Western Tetum in the Belu area of Indonesian Timor and along the Portuguese border (Hicks 1971:37).

[19] E.g. the agricultural school at Fatumaca (Baucau) run by the Salesian Mission and primary schools for girls at Baucau and Ossu run by the Canossian Mission.

Table 3

Non-indigenous population by postos, 1969

Posto	Total population	Europeans	Chinese	Mestizos
Baucau-Sede	17,719	204*	436	95
Venilale	11,416			5
Vemasse	5,913		12	4
Quelicai	19,533		9	
Ossu	15,905	4	10	12
Viqueque-Sede	13,864	4	39	174
Uato Lari	12,810	1	6	4
Total	97,160	213	512	294

* This figure seems to be exaggerated and might include temporary residents, like construction teams or airport personnel.

Source: Repartição Provincial dos Serviços de Estatistica, Provincia de Timor.

study area. In the absence of strong European or Asian competitors, Chinese merchants firmly controlled the trade of the Area. In 1969 about 85 per cent of the small Chinese community (436) lived in Baucau itself.

The settlement pattern

Within the Baucau-Viqueque area at the beginning of the 1970s the most significant obstacle preventing improvement in economic and social welfare was the dispersed pattern of rural settlement. Most of the population lived in scattered hamlets (cnua), comprising a few houses and sometimes only a single hut many kilometres from the nearest neighbour. In the absence of a road network, this pattern greatly impeded effective administration in every way, and yet it appears to be a recent development following pacification by the Portuguese at the beginning of this century.

Before the early 1900s there was almost no European contact with the rural population in Eastern Timor. As a consequence of age-old traditions of tribal warfare among the various sucos and kingdoms, the population lived in fenced, nuclear villages. These were normally built in inaccessible locations chosen for defence purposes. Remnants of the former settlement pattern survive in the posto of Maubisse and, in the Baucau-Viqueque area, on the northern slope of Mt Mundo Perdido (Builale suco) and in Quelicai. Inevitably, the village fields were located nearby and were worked jointly by villagers, to reduce the opportunities for headhunters from hostile sucos. As a further consequence of the risks involved in moving far from home, villagers often had to content themselves with the cultivation of less fertile land. To illustrate this point, one old resident of Ossu recalled in 1970 that the paddy fields (natar) in this posto were much more intensively cultivated early in the twentieth century, despite relatively poor soils (then, as now) and a major increase in population pressure during recent decades (pers. comm. Don Francisco Freitas, 8.11.1970).

In the decades following pacification the people were no longer obliged to live within fortified villages, in fear of their lives. Many moved to relatively unpopulated localities where the soils were more fertile, establishing hamlets and so eventually a quite different pattern of settlement, in different locations. Dispersal of the rural population was also stimulated as numbers increased, by the persistence

of shifting cultivation as the main form of Timorese agriculture, since shifting cultivation required much more land than the area actually under cultivation in any one year. Furthermore, the spread of people was often influenced by the scatter of more fertile land and good water supplies through the mountainous terrain in the central part of Timor.

The extent to which the rural population was dispersed in the 1960s can be gauged from Fig. 8. Each dot represents a native hut evident on airphotos taken in 1962. Even allowing for huts omitted owing to poor visibility, there are some marked differences in spatial distribution. Apart from the administrative centres and the route of the Baucau-Viqueque road, clusters of huts are most conspicuous in Quelicai and southwards at the foot of Mt Mata Bian, predominantly in areas of greyish brown soils of volcanic origin. Similarly, in the Baucau escarpment, on both sides of the Baucau Plateau, and at the foot of all major mountains in the Area (e.g. Mt Mundo Perdido, Mt Laritame and Mt Builó) relatively fertile calcareous soils and the occurrence of springs have matching concentrations of farmers' huts. On the other hand, gaps in the distribution of huts undoubtedly reflect a wider range of factors: less fertile soils formed over Bobonaro Scaly Clay have been a deterrent to farming in many localities (e.g. north of Quelicai); the threat of malaria has discouraged intensive settlement near the south coast; and suco boundaries have often contributed to the concentration of hamlets, since suco chiefs have generally been reluctant to allow people from neighbouring sucos to settle or cultivate fields across territory borders. The influence of soil variations and the incidence of malaria, as they affect the present occupation and potential of the area, are both discussed in more detail in later chapters.

Finally, although dispersed settlement is the rule today within the Baucau-Viqueque area, it has long been recognized as a major handicap to development. With population pressure increasing and the process of agricultural fragmentation continuing in accordance with traditional rules of inheritance, the fields belonging to one family are now sometimes far apart. Ormeling (1955:20) also pointed out that as a result of hamlets being so widely scattered, mutual assistance (serviço hamutuc) between villagers has lessened: tasks such as the felling of trees, the preparation of paddy fields and the protection of crops from pests (including mice, locusts and monkeys) are all now more difficult.

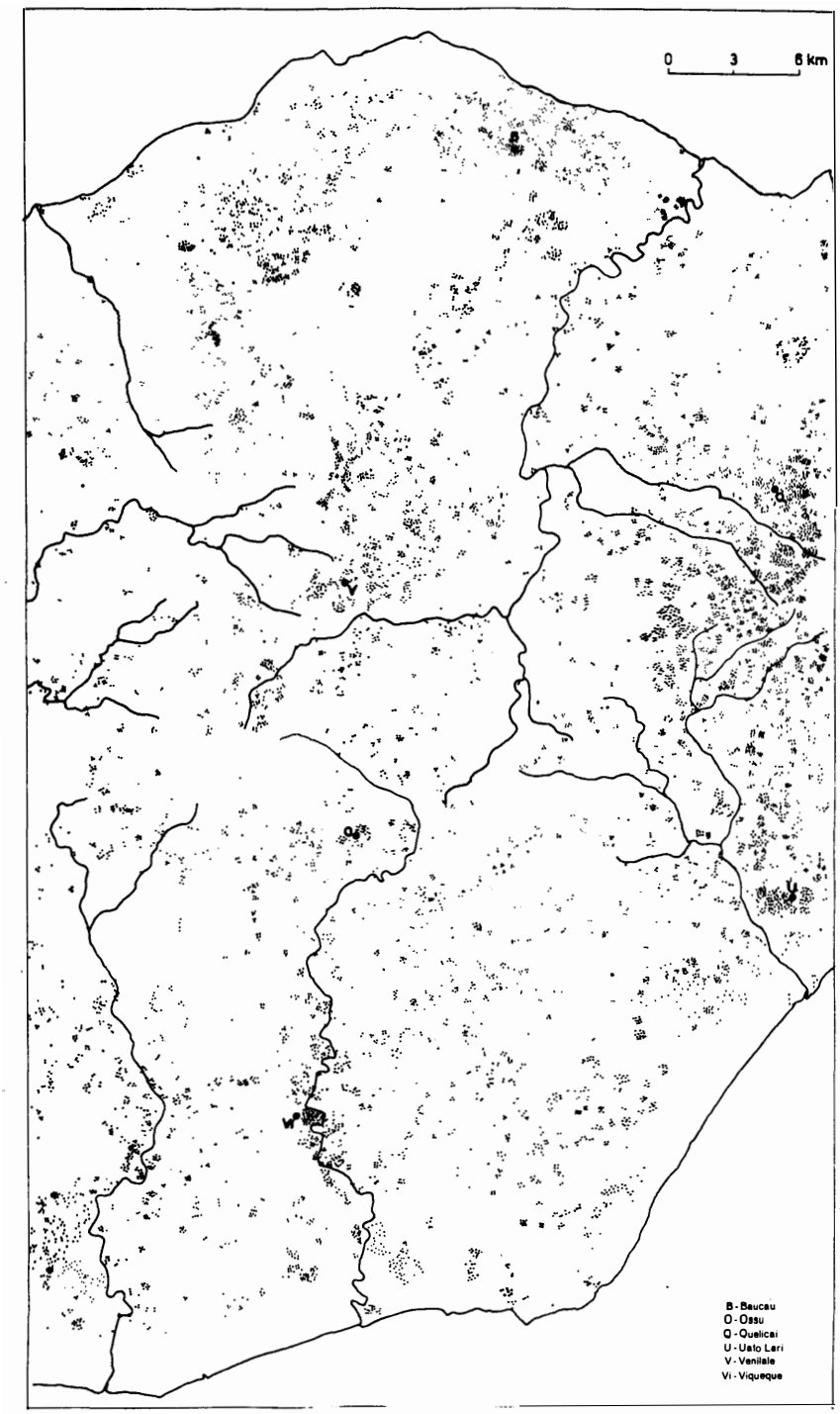


Fig. 8 Distribution of population on the basis of homesteads

At the administrative level dispersed settlement impedes contact between officials and the people (see also Martinho 1945). Medical assistance for men and livestock, and elementary education of any sort does not reach many of the inhabitants in hamlets. Intensification of contact is particularly necessary to introduce basic agricultural training, yet in 1970 there was only one agricultural officer for the whole of the eastern section of Portuguese Timor (east of Baucau, including the Baucau-Viqueque area). If agricultural methods are to be improved as an early step in economic development, or even to cope with increasing population pressure, the effect of any efforts will be reduced by the existing pattern of dispersed settlement and the poor communications network. As long ago as the 1930s, Governor Fontoura (1940:315ff) advanced the idea that the population should be grouped in nuclear villages, in the form of so-called aldeamentos indígenas. Nothing has come of the idea. Moreover, because of strong ancestral ties which bind the Timorese peasantry to the burial grounds of their forefathers - a place which is sacred (lulik) in the village compound - the Timorese are usually reluctant to abandon their hamlets (Meneses 1968:71). The problem of dispersed settlement will not be easily overcome.

Chapter 2

THE PHYSICAL FACTORS OF THE ENVIRONMENT

Physiography and relief types

Timor's impressive topography is the legacy of a turbulent geological past. Geologists commonly agree that the island's geological structure and evolution has to be considered as one of the most complicated in the archipelago. It is thus no wonder that until now it has puzzled and lured so many geologists to the island.[1] Though there are still blank spots on the geological map, recent advances in geological research, particularly in the Portuguese part of the island, were made by the British geologist M.G. Audley-Charles whose treatise (1968)[2] is based on three years of field research from 1959 to 1961. He provides the first relatively accurate geological map of the eastern half of Timor (scale 1:250,000) for which there is as yet no equivalent on the western side of the island.

It is, of course, beyond the scope and task of this study to elaborate on Timor's geological past; instead there will be a brief discussion of those characteristics which are essential for an understanding of other ecological factors like topography, soils, vegetation and land use upon which the underlying rock material has a direct bearing.

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[1] The interested reader is referred to the following publications which represent a small selection: Allied Mining Corporation 1937; Gageonnet and Lemoine 1958; Grunau 1953, 1956, 1957; Leme 1963b, 1968; Wanner 1956.

[2] The findings of his research were submitted as an unpublished Ph.D. thesis to the University of London in 1965. In 1968 a slightly revised version of this thesis was published as Memoir No. 4 of the London Geological Society under the title *The Geology of Portuguese Timor*.

Timor is a part of the Tertiary Sunda Mountain System, a fracture zone of high crustal instability and strong gravity anomalies which shows all characteristics of the so-called 'Pacific Mountain Type' - i.e. Tertiary fold mountains with volcanoes next to a deep sea trough. Along this fracture zone which encircles Island Southeast Asia from the Andaman Islands in the west to the Moluccas and the Philippines in the east, we find two roughly parallel running rows of islands: the so-called volcanic Inner Arc[3] composed of Sumatra, Java, Bali, Lombok, Sumbawa, Flores, Alor, Wetar, Ceram *et al.* and the so-called non-volcanic Outer Arc[4] to which belong the islands of Nias, Mentawei, Sumba, Savu, Roti and Timor and so on. In Pre-Permian times both arcs are believed to have once formed part of the continents of Asia and Australia (Audley-Charles 1965:2; 1968:1).

Eastern Timor's oldest dated geological formations are marine sediments, mainly marls, shale and limestone of Permian age (e.g. Atahoc Formation in our study zone). Sedimentation probably continued from the Middle Triassic to Middle Jurassic. These sediments were severely folded between the end of the Upper Cretaceous (Maestricht) to the Middle Eocene (Audley-Charles 1965:3). In the subsequent Lower Eocene a shallowing of the Timor region is believed to have occurred.

In this shallow marine environment Timor's major volcanic igneous rocks, like tuffs and lava, were deposited during the Oligocene (i.e. Barique Formation in our Area). On Timor where there are no volcanoes (except for small mud volcanoes), these igneous rocks are believed to have originated from volcanic eruptions in the Inner Arc (Audley-Charles 1968:65).

The subsequent period was an era of further sedimentation, folding of these sediments and sliding of enormous submarine deposits (called Bobonaro Scaly Clay by Audley-Charles) which are thought to stem from the region north of Timor (i.e. at present covered by the Wetar Strait). After further relatively gentle folding during the Upper Miocene, a continental uplift took place in abrupt stages after the Pliocene - particularly throughout Pleistocene and Recent times - giving rise to a series of terraces of fringing reefs from present sea level up to 500 m, while a wide coastal plain developed south of the central mountainous spine.

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[3]Also called 'Inner Banda Arc' by Audley-Charles (1968:1).

[4]Also called 'Outer Banda Arc' by Audley-Charles (1968:1).

Timor's turbulent geological past gave rise to a complicated relief[5] which is broadly characterized by a core of rugged hill and mountain land consisting of a confused mass of knife-edged, highly dissected ridges trending in various directions and craggy upland blocks, locally called fatu (Molengraaff 1912-14) with elevations up to 3000 m (Mt Tata Mai Lau, 2999 m)[6] In the eastern half of the island this central upland comprises a series of ranges and ridges which form the central divide. From the middle of the island, roughly from the former Portuguese/Indonesian border westward, this central mountain chain abuts upon a complex series of inland plateaus and longitudinal depressions which are embraced by two mountain ranges that run roughly parallel to the coasts.

Eastern Timor's central upland is flanked on both sides by narrow fringes of coastal lowland which are discontinuous on the north coast, often cut by foothill spurs and thus forming numerous embayments (e.g. between Dili and Manatuto). The littoral plains zone in the south on the other hand is much wider and up to 12 km, and consists of sandy beaches backed by a narrow swampy belt behind which grassy, mostly undulating plains reach all the way to the foothill zone.

While the major elements of the general geomorphic pattern in Eastern Timor - a central upland flanked north and south by a fringe of coastal lowland - can be neatly distinguished in our Area, the distinction into three units needs some qualification. For our purpose, the study area was further subdivided into eight major physiographic units singled out on the basis of morphological characteristics as well as on the basis of altitude (Fig. 9):

I Northern Coastal Zone
II Marine Terrace Zone
III Baucau Plateau
IV Western and Eastern Escarpment of the Baucau Plateau
V Central Upland Zone
VI Quelicai-Uato Lari Foothill Zone
VII Southern Foothill Zone
VIII Southern Littoral Plains Zone

[5] A fairly detailed account of Portuguese Timor's relief is contained in Allied Geographical Section 1943.

[6] Meaning 'grandfather of the mountains' in Mambai language (cf. Meneses 1968:10).

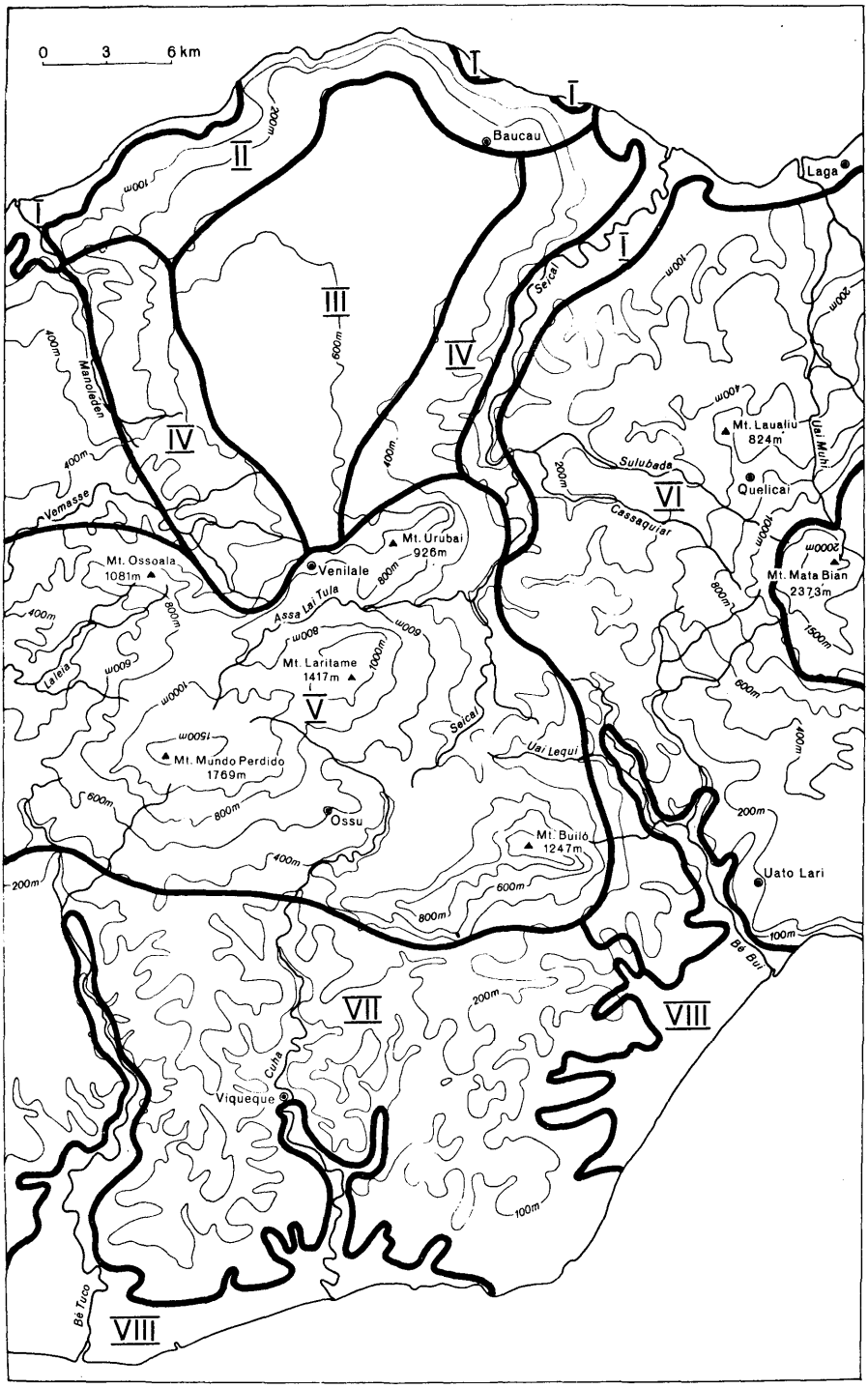


Fig. 9 Relief zones within the Area

I Northern Coastal Zone

The least extensive of all eight landform zones is the Northern Coastal Zone. It consists of a small - often not more than 100 m wide - alluvial coastal strip. The western wing of this landform unit extends from the mouth of the River Manoléden (i.e. the western limit of our Area) to Uai Ono (in the east). The eastern wing starts at Cassa Mau Cai Uada and stretches east to the mouth of the river Uai Múhi. Wedged in between these two wings is a zone of uplifted marine terraces (zone II) of the Baucau Plateau which rise straight from the sea.

In the absence of strong prevailing winds no regularized coastline has developed. Instead the north coast is heavily indented with embayments affording sheltered sites for mangroves.[7] These usually grow in the sea, frequently on coral benches, much in contrast to the south coast where they grow inland behind beach ridges and in tidal inlets.

The Northern Coastal Zone is made up of alluvial material of the Post-Pliocene Suai Formation. It is characterized by one or two sandy beach ridges, quite in contrast to the south coast. Large quantities of silt are washed down the slopes and deposited behind these beach ridges on account of the proximity of the mountains. There they form mud flats, e.g. Uai Ono and parts of Caravela (Plate 7) which are seasonally inundated by both surface runoff from the hills and seawater spilled over the beach ridge during storms. A peculiar type of vegetation covers these mud flats characterized by *Borassus flabellifer* palm trees with a dense understorey of *Jatropha gossypifolia* while grasses are absent.

Finally, the floodplains of both the River Manoléden and the Seiçal - the most significant floodplain in our Area - are part of this physiographic unit. While the Manoléden dries up completely during the dry season of the Southeast monsoon, the Seiçal is, except for the Cuha (south coast), the only river in the Area with a perennial water course. Its highly unstable floodplain stretches all the way from the foot of Mt Urubai, where the river bends round Gailata, to the sea. Near the river mouth numerous oxbows and scrolls bear witness to the river's dynamics

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[7] Although no mangroves grow within the portion of the north coast of Timor that lies within our Area.

(Plate 8). Alluvial fans formed by ephemeral tributaries are frequent. As is observed elsewhere in Timor, the Manoléden and particularly the Seiçal have riverbeds filled with rubble and casuarina-studded islets separated by a maze of braided channels.

Vestiges of two to three terraces, irregular in size, can be recognized in the floodplain of the Seiçal at Gailata at the foot of Mt Urubai where the river makes a sharp S-curve. The lower terrace is usually utilized for irrigated paddy cultivation. On the upper ones rain-fed inundated paddy is grown depending upon the availability of water from the tributaries of the Seiçal.

II Marine Terrace Zone

Wedged between the two parts of the northern coastal lowland, roughly between Uai Ono in the west and Ossolata in the east lies a zone which, though part of the Baucau Plateau, has been singled out as a separate unit because of its peculiar morphology. This zone for which I use the term 'Marine Terrace Zone' consists of a series of up to twelve upheaved Pleistocene marine terraces which rise abruptly from the sea in a step-like fashion. These terraces consist of up to 100 m high cliffs (Audley-Charles 1968:38) which at their base are often undermined by wave-cut notches[8] and which alternate with over 100 m wide abrasion platforms. Up to twelve such terraces can be observed in the Baucau area (Plate 9). These terraces tend to be correlated with successive shifts of the sea level due to epeirogenetic uplift of Timor and to a lesser degree to the phases of glaciation in these latitudes (Audley-Charles 1968:38).

At the base of these cliffs water seepages can be found which enable denser vegetation to grow. Therefore these terraces are easily recognizable on air photographs. Two major springs (Uai Leo and Uai Lia) emerge from the ground at the present site of Baucau village which is located on a platform at about 300 m above sea level. Owing to the constant water supply the terraces from Baucau village down to the sea are intensively cultivated throughout the year. Thus apart from similar sites on the eastern and western escarpment of the Baucau Plateau the region around Baucau

[8] Often these overhanging limestones form caves which served as natural refuges to Early Man as evidenced by recent archaeological excavations by Glover (1971).

village is certainly one of the most privileged agricultural zones of the Baucau-Viqueque area which, because of its near-level platforms, is particularly suited for wet rice cultivation.

III The Baucau Plateau

The dominant geomorphological feature north of the central divide is a relatively flat limestone upland, the Baucau Plateau. It is an uplifted coral reef rising through a series of high terraced cliffs from sea level to 500 m. From there it continues to rise very gradually to over 700 m at its highest point near Loilubo (southwest - tip of the Plateau). In spite of its near-level appearance (Plates 10 and 40) - affording an ideal site for the Baucau airfield - its surface is rough and pitted because of numerous solution cavities and residual low coral ridges, caused by uneven weathering of the underlying coral limestone. Limestone outcrops are common and constitute serious obstacles to agriculture. The plateau forms a big triangle with its apex in the south, west of the administrative post of Venilale. From the north where it abuts against the marine terrace zone, to the south it measures roughly 21 km. At its greatest width it measures about 15 km. Because of the permeable limestone no rivers of any significance have developed on the plateau. Only ephemeral rivulets, like the Uai Lacama (flowing north, and the Uai Behe Ana (Plate 36) and the Caibua Lori (both flowing east as tributaries of the Seiçal) flow in very shallow depressions during a few months of the year. Percolation of the water is here restricted by clays which have accumulated in these furrow-like depressions.

Subsurface drainage is, however, common as evidenced by a few holes drilled no more than 8 m deep at Uai Lia Bere. Here a Chinese from Baucau grows vegetables and potatoes on a 50-hectare plot. In addition nearby there is the semi-deciduous forest of Cailubo Oli amidst the *Eucalyptus alba* savanna common in the southern half of the plateau, which betrays subsurface rivers.

IV Western and Eastern Escarpment of the Baucau Plateau

On both sides, in the east and in the west, the Baucau Plateau is flanked by escarpments which drop from the top of the plateau down to the alluvial plains of the River Manoléden and to the Seiçal. As the plateau rises in altitude to the south, the drop of the escarpment varies

accordingly. The morphology of the escarpment reflects the underlying geological material. The Pleistocene coral limestone of the plateau is underlain by a layer of Upper Miocene Viqueque Formation, which again rests upon the Middle Miocene Bobonaro Scaly Clay. This sequence is also reflected in the escarpments.

While hardly any rivers had cut into the porous limestone of the Baucau Plateau, numerous karst springs can be found in the harder less pervious sedimentaries - largely claystones, marls, siltstones, and sandstones - of the Viqueque Formation (Audley-Charles 1968:29-30). Water seepages occur all along this geological formation because of its greater compactness. This zone is therefore of great agricultural significance.

In the eastern escarpment this formation reaches from 300 to 400 m down to the floodplain of the Seiçal River at around 50-100 m (Plate 10). It is less extensive in the western escarpment zone where it covers a belt between 400 and 700 m (near suco of Loilubo). A comparison of the geological map (Fig. 11) with the map of the contour lines (Fig. 4) makes this clear.

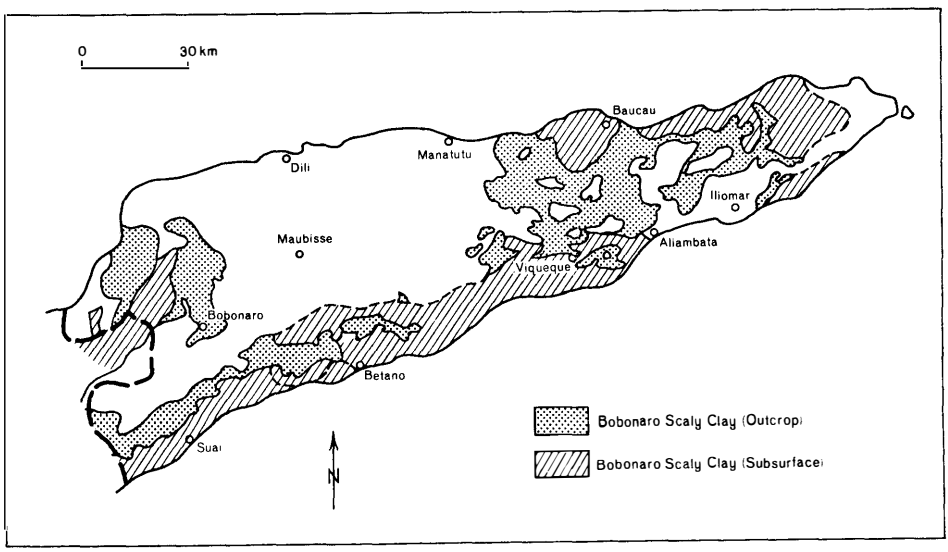


Fig. 10 Sketch map of the distribution of Bobonaro Scaly Clay (after Audley-Charles 1968:42)

Finally, the Viqueque Formation is underlain by Bobonaro Scaly Clay which covers wide areas particularly in the southwest and southeast of the Plateau. This zone is deeply eroded and cut by numerous ephemeral streams. Slumps and landslides are common.

V Central Upland Zone

The central part of the Baucau-Viqueque area consists of an upland about 600-1000 m high. From this there emerge the deeply dissected ridge of Mt Ossoala (Plates 1, 25, 28) of volcanic origin (Barique Formation), and three resistant limestone blocks (Mt Mundo Perdido 1769 m, Mt Laritame 1417 m (Plates 2 and 11), Mt Venilale 1000 m, and Mt Builó 1247 m) - called fatus, meaning 'rock' in Tetum language. These are eroded into steep slopes or vertical cliffs (Plate 12), which are considered to be resistant cores once surrounded by softer rock formations.

The central upland forms the backbone of the study area, dividing it roughly into two major lower physiographic regions. We shall refer to these in the text simply as the 'northern' and 'southern' parts of the study area.

Thus, the fatus, as well as Mt Ossoala and the surrounding foothills, have been included in this physiographic unit. From Fig. 11 it becomes clear that roughly three-quarters of this zone consists of Bobonaro Scaly Clay. This surrounds the base of the four summits and can be easily recognized by the scattered *Casuarina junghuhniana* trees characteristic of this clay formation. The clay area is deeply dissected by numerous rivers and rivulets because of its physical properties. The principal ones include the Assa Lai Tula, Seiçal, Laleia and the Vemasse River in the north and the Cuha, the Bé Tuco and Bé Bui rivers in the central and southern section. These rivers, particularly the Assa Lai Tula and the Cuha have deeply incised Mt Laritame-Mt Venilale (see Plate 41) and Mt Builó-Mt Caileti Lale respectively, cutting deep gorges. Rivers in this zone are characterized by V-shaped valleys and rapids. Erosion, gullying, landsliding and slumping have been severe in this zone.

More resistant blocks of hard rocks, in the form of both Lower Miocene Cablac Limestone (the three fatu blocks) and eruptive rocks of the Oligocene Barique Formation (Mt Ossoala), tower above this clay complex. The dominant orographical feature is mighty Mt Mundo Perdido which with

an elevation of 1769 m forms the highest point in the study area. Its crestline runs roughly in an east-west direction for about 15 km. The Mundo Perdido, also known in Cairui language[9] as Uai Nete (meaning watershed), provides the headwaters of a number of smaller rivers that run either to the Timor Sea (e.g. Bé Tuco and Cuha) or to the Wetar Strait (e.g. the Laleia, Vemasse, and the Assa Lai Tula, the major tributary of the Seiçal River). The latter cuts through the Mt Venilale-Mt Laritame fatu block, dividing it into two halves with a deep gorge. While the northern slope of the Mt Mundo Perdido range is moderately steep and concave with an average slope gradient of about 14°, almost vertical cliffs separate it from the Southern Foothill Zone (Zone VII). The less imposing Builó Range rises less than 5 km away to the southeast. It runs for almost 15 km in an east-west direction; its slope pattern shows similar features to those of the Mundo Perdido Range: rather moderately steep slopes (8-14°) on its north side and a very steep to vertical escarpment in the south.

To the north of both ranges and separated by upland plains and saddles looms the Mt Laritame-Mt Venilale fatu block which in contrast to the aforementioned two ranges follows a north-south alignment. This limestone block sticks out of the surrounding countryside with almost vertical walls at all sides (see Plate 2).

In addition to these three major fatu blocks the wildness of the terrain is further accentuated by a number of smaller fatus like Mt Ossu (820 m), Mt Caileti Lale (578 m) and Mt Olohua (673 m). On air photographs the fatu blocks are easily discernible as they are usually clothed with dense forests - either by medium altitude moist evergreen forest or by tropical montane cloud forest. Vegetation is also a useful and reliable indicator for the localization of those parts of this physiographic zone that are of volcanic origin. These are usually - unless under cultivation - studded with eucalyptus, with *E. alba* below 1000 m and *E. urophylla* above that elevation.

Of this volcanic type of mountains, Mt Ossoala (1081 m), north of the Mundo Perdido range, is prominent (Plates 1 and 25). It is a spine-like crest running for 7 km in a

[9] Cairui is one of the seven languages spoken in the Area chiefly around Mt Mundo Perdido (see Fig. 7).

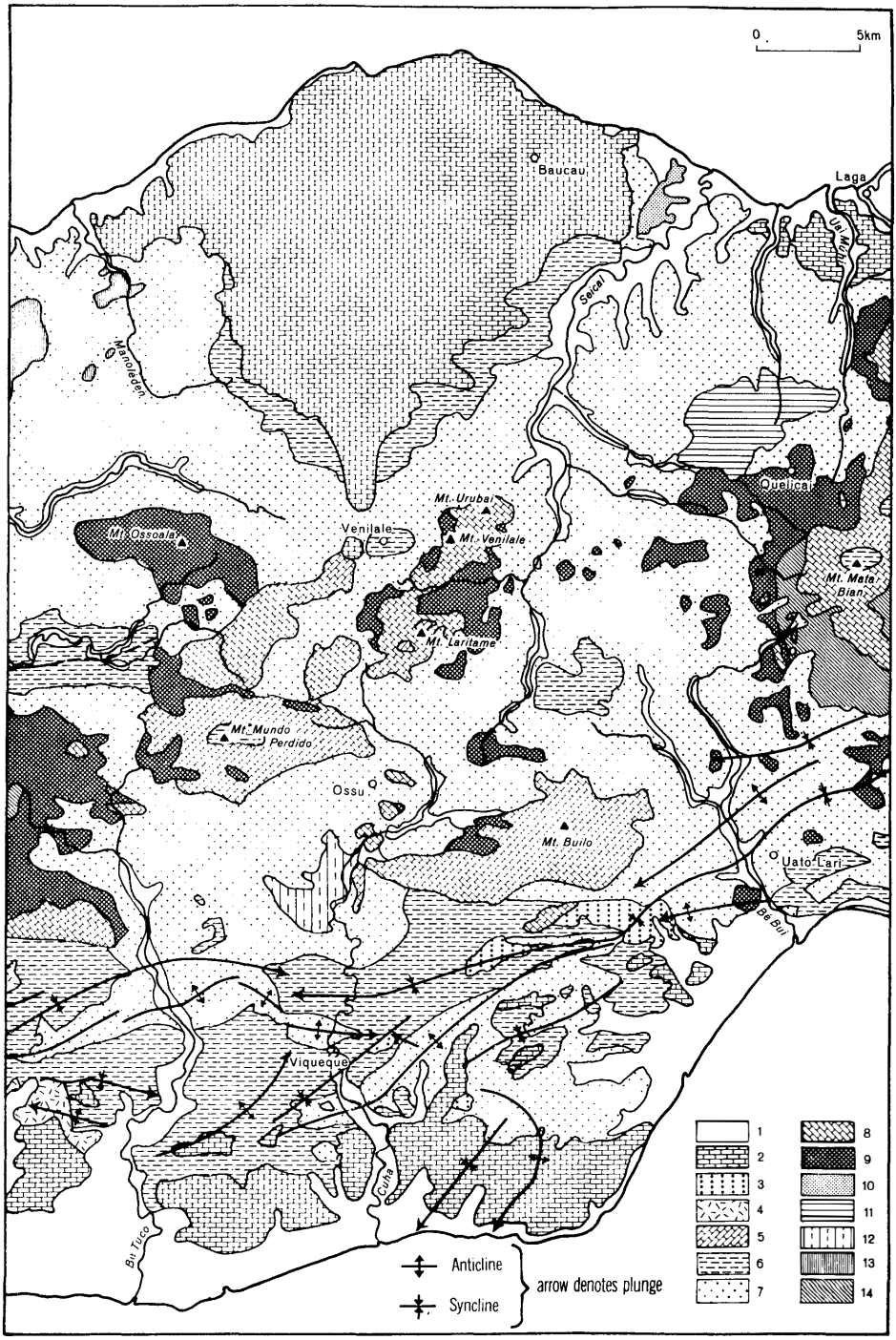


Fig. 11 Geology of the Area (after Audley-Charles 1968, with the author's amendments)

Legend to Figure 11

Pleistocene and Recent
1. Suai Formation
2. Baucau Limestone

Pliocene
3. Seketo Block Clay
4. Dilor Conglomerate

Upper Miocene
5. Larigutu Limestone
6. Viqueque Formation

Middle Miocene
7. Bobonaro Scaly Clay

Lower Miocene
8. Cablac Limestone

Oligocene
9. Barique Formation

Upper Cretaceous-Lower Eocene
10. Seiçal Formation

Middle and Upper Triassic
11. Aitutu Formation

Permian
12. Cribas Formation
13. Maubisse Formation

Pre-Permian
Lolotoi Complex

Note: My amendments to Audley-Charles' geological map of Portuguese Timor comprise an extension of the Baucau Limestone at the southern tip of the Baucau Plateau, several additional spots of Barique Formation in Mundo Perdido and east of Ossu (suco of Uabubo 1) and the Viqueque Formation around Venilale.

roughly east-west direction dissected into a landscape composed of ridges graded by erosion and ravines made up of very steep straight slopes of over 22° gradient with shallow soils and an intricate pattern of Eucalyptus-savanna (*E. alba*) on the crest and ridges, and slightly deciduous forest in the ravines. Roughly between Mt Mundo Perdido and Mt Ossoala we find two small but steep hills of igneous material (Barique Formation) - Mt Ossoaque (767 m) and Mt Caitia (897 m) - which are probably outliers of Mt Ossoala. Rock outcrops of their geological formation are also to be found on the north slope of Mt Mundo Perdido where they form slope benches at the 1200 m level (here *Eucalyptus urophylla* is conspicuous) and east and west of Mt Venilale-Mt Laritame. Whether they are in situ or not cannot be conclusively proven as long as the base of the rock is not discernible (Audley-Charles 1968:47).

In the triangle between Mt Mundo Perdido, Mt Ossoala and the village of Venilale rises a broad slightly dissected ridge made up of Upper Miocene Larigutu Limestone which lies roughly in a northeast-southwest direction. The slightly undulating ridge is mostly covered with scrub (*Tecoma stans*) and a thin grass layer. This ridge and the nearby saddle between Mt Mundo Perdido and Mt Laritame, called Larigutu Pass (= type locality of this formation), show comparatively little erosion. The Larigutu saddle (1000 m) is clothed with a fine turf of low grass, thus forming a natural pasture.

Finally, the small plateau (around 400 m) of Nahareca made of Viqueque Formation merits mentioning. In terms of land use this area contrasts with the surrounding clay complex.

As we have seen, the central upland zone is by no means easy to analyse, yet the salient features have already been pointed out: the level summit fatu blocks of Mt Mundo Perdido, Mt Laritame-Mt Venilale and Mt Builó - and the sharp ridge of Mt Ossoala apart from a few other higher hills that protrude through the mantle of the clay complex.

VI Eastern Foothill Zone of Uato Lari-Quelicai

In this zone is lumped together the entire western foothill zone of Mt Mata Bian (2373 m) in the east of our Area (Plate 37). It is a zone rising from 100 m to over 1000 m at an average slope gradient of 8-14°. It consists largely of Bobonaro Scaly Clay which is deeply eroded and

at places completely turned into badlands (in the sucos of Maluro, Laisorolai de Baixo and Lelalei). Embedded in the clay mantle there is a zone of Oligocene Barique Formation south of Quelicai village immediately at the foot of the fatu block of Mt Mata Bian, as well as a few outliers also of igneous rocks - e.g. Mt Macalosso (570 m), Mt Macadique (948 m), and Mt Osso Cou (482 m).

VII Southern Foothill Zone

A more uniform pattern than in the hill regions so far described can be observed in the southern foothill region which consists of the transitional uplands between the central divide of Mt Mundo Perdido, Mt Builó and Mt Laritame in the north and the coastal plain in the south. In altitude it ranges between 700 m and 50 m. It is composed largely of foothill ridges not trending in any particular direction and reaching down towards the sea from the central upland.

The zone is strongly dissected by three major rivers, the Bé Tuco, Bé Bui, and Cuha, as well as by numerous smaller creeks.

Depending upon underlying geological formation - be it Bobonaro Scaly Clay or Viqueque Formation - casuarina or corypha palm savannas cover the zone, while remnants of semi-deciduous forest are to be found immediately south of Mt Builó around Mt Uato Dere (467 m), Mt Fatu Sacunar (378 m) and southwest of Viqueque village at Mt Burluli (318 m). The dominating slope gradients are between 8° and 14°.

VIII Southern Littoral Plains Zone

This zone extends all along the southern seaboard of our Area from Uato Lari in the east to the river Bé Tuco in the west. It is an alluvial plains zone of between 1 and 4 km in width. This zone is not continuous as, roughly between Point Niqui and Bé Aço, the uplifted coral reef of Bé Ro reaches well to the seafront, thereby dividing the littoral plains zone into two sections. Owing to unequal water resources the economic importance of these plains differs widely. The eastern plains southwest of Uato Lari, which we shall simply call the Plain of Uato Lari,[10] is comparatively

[10] No single term is applied to the entire plain. Instead only parts of the plain are named e.g. Narequici and Fatun.

well watered and thus by far of greater economic significance (Plate 15). Since 1965 it has developed as Eastern Timor's rice granary. It contrasts with the western section of the littoral plain which, because of its proximity to Viqueque, we shall term the Plain of Viqueque. It largely lacks perennial rivers for irrigation (Plate 23).

Although this zone is made up chiefly of alluvial material, of both maritime and fluviatile origins,[11] the entire zone is underlain by the Upper Miocene Viqueque Formation and the Middle Miocene Bobonaro Scaly Clay.[12]

In spite of its relatively level topography (not rising more than 20 m above sea level), the littoral plain consists of a number of minor physiographic units which are largely determined by hydrological conditions: beaches, beach-ridges, swamps, estuaries, plains as well as the flood plains of the Bé Tuco, Cuha (Plate 13) and Bé Bui (Plate 15).

The Littoral Plains Zone, flanked in the south by a fringing coral reef,[13] consists of a gently sloping sandy beach, 10-20 m wide (Plate 24). As prevailing winds[14] are onshore the coast receives a strong southerly swell which gives rise to a low irregular foredune backed by a series of three to five evenly spaced parallel sandy beach ridges. These ridges are more prominent near the present shore where they may reach a height of 1.5m. They are generally more subdued inland, where they may pass into sandy plains locally.

Swamps have developed in the furrows between these beach ridges, as well as further inland in swales, wherever water

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[11] Audley-Charles' 'Suai Formation' after its type-locality around the village of Suai on the south coast near the Indonesian border (Audley-Charles 1968:39).

[12] Evidence of the subsurface clay layer is provided by the Bibiluto mud volcano at Rai Sut (near the mouth of the Cuha River), reportedly the only one in Eastern Timor (Teixeira 1950; Leme 1963a) which is about 10-15 m high and measures 200-300 m in diameter (Plate 13).

[13] This reef is only open at a few places which form natural anchorages for coastal vessels - i.e. Bé Aço and Aliambata (Uato Lari).

[14] 'Prevailing' in the sense that these winds are the most significant over the year for the formation of the coastline.

tends to accumulate and stagnate. These swamps may result from seawater which spilled over the beach ridges at spring tide and was trapped behind them. More frequently, they result from rivers which, upon hitting the beach ridge, are deflected, thereby running roughly parallel to the coastline in oozy swales before they breach the ridges and the beach barriers. The latter is common on the south coast (Plate 14) where river mouths tend to be barraged by beach barriers for part of the year on account of the onshore winds of the southeast monsoon.[15] River action is too weak to remove the beach barrier completely, even during the heavy northwest monsoon, because of the low gradient. Only the larger rivers prevent beach barriers from developing - i.e. the Cuha and the Bé Bui[16] - although they too tend to be deflected by beach extension (see Plates 13 and 15). Thus mangrove swamps are absent in the vicinity of these rivers.

On account of the prevailing southeast winds the south coast is a typical regularized coast and thus poor in natural landing sites or anchorages for coastal shipping. This hostility to shipping is increased by a fringing coastal reef and the rough surf of the southeast monsoon. This makes landing during the time of the southeast monsoon impossible, even at the few openings of the reef. The implications of this for the economy of the zone and its bearing on future development will be discussed later.

This description of the physiographic division makes evident the wildness of the Area's relief. The terrain is drained by a maze of small creeks with a short steep course (characterized by V-shaped valleys) from their upper catchments to the lowlands. With the exception of the Seiçal, Bé Bui and the Cuha all other rivers are ephemeral and dry up during the rainless season when their wide shallow rubble beds become avenues for native traffic. Although water is taken from rivers during the wet season, during the dry season it often has to be scooped out of holes excavated in the dried-up riverbeds.

Water availability is certainly of foremost importance for Timorese agriculture. Agricultural possibilities in the

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[15] This type of ponded river is called 'coilão' in Portuguese Timor.

[16] Only in exceptionally dry years do these two rivers also dry up.

Area are, however, also greatly handicapped by the comparatively large proportion of heavy clay (Bobonaro Scaly Clay). Fig. 10 clearly illustrates that nowhere else in eastern Timor do we find a similar concentration of this clay type either at the surface or in the subsurface. Subsurface clay deposits, when suddenly occurring close below the surface, are particularly treacherous as evidenced in the southern littoral plain, e.g. at Ra Tahu, southeast of Viqueque, and in the Uato Lari Plain (e.g. Laliu). Attempts to grow coconuts here have failed because this common tropical fruit requires sandy rather than clayey soil.

To evaluate the role and potential for agriculture in our Area a map showing the slope gradients (Fig. 12) appears to be far more significant than the usual presentation of the relief in contour lines.[17] Here we can clearly recognize the portion of near-level land with a gradient not exceeding 3°. This slope class includes the floodplains of the Seiçal, Cuha, Bé Tuco and Bé Bui; patches of coastal plains in the north and the broad littoral plain in the south, as well as the greater portion of the Baucau Plateau. Although in terms of topography, land of this slope class may be suitable for agricultural purposes,[18] considerable limitations are imposed on agriculture by rock outcrops (e.g. Baucau Plateau) and even more so by scarcity of water. This is true in the case of the Baucau Plateau, as well as along the southern littoral plains zone (e.g. south of Viqueque) where percolation is rapid. Other factors, such as climate, soils, and malaria, which will be discussed later, limit the use of these near-level soils even further. It is noteworthy that those areas which are more intensively used for cropping at present lie within the remaining slope classes; in fact, the steepest gradient on which bush fallowing - the chief form of dryland farming in Timor - is practised, was 30° as observed at Mt Burluli (318 m), south of Viqueque (Plate 43). It is

[17] These slope classes have been chosen for practical reasons according to the number of contour lines which had to be counted for the determination of the slope of the terrain.

[18] According to a CSIRO report on the Port Moresby area, New Guinea in an environment somewhat similar to that of Timor the following erosion hazard was given for New Guinea (CSIRO 1965:20-1):

less than 1.5°	no hazard
1.5°- 5.0°	minor hazard when cultivated
5°0 - 9°0°	moderate hazard when cultivated
9°0 - 17°0°	moderate hazard
17°0 - 33°0°	severe hazard

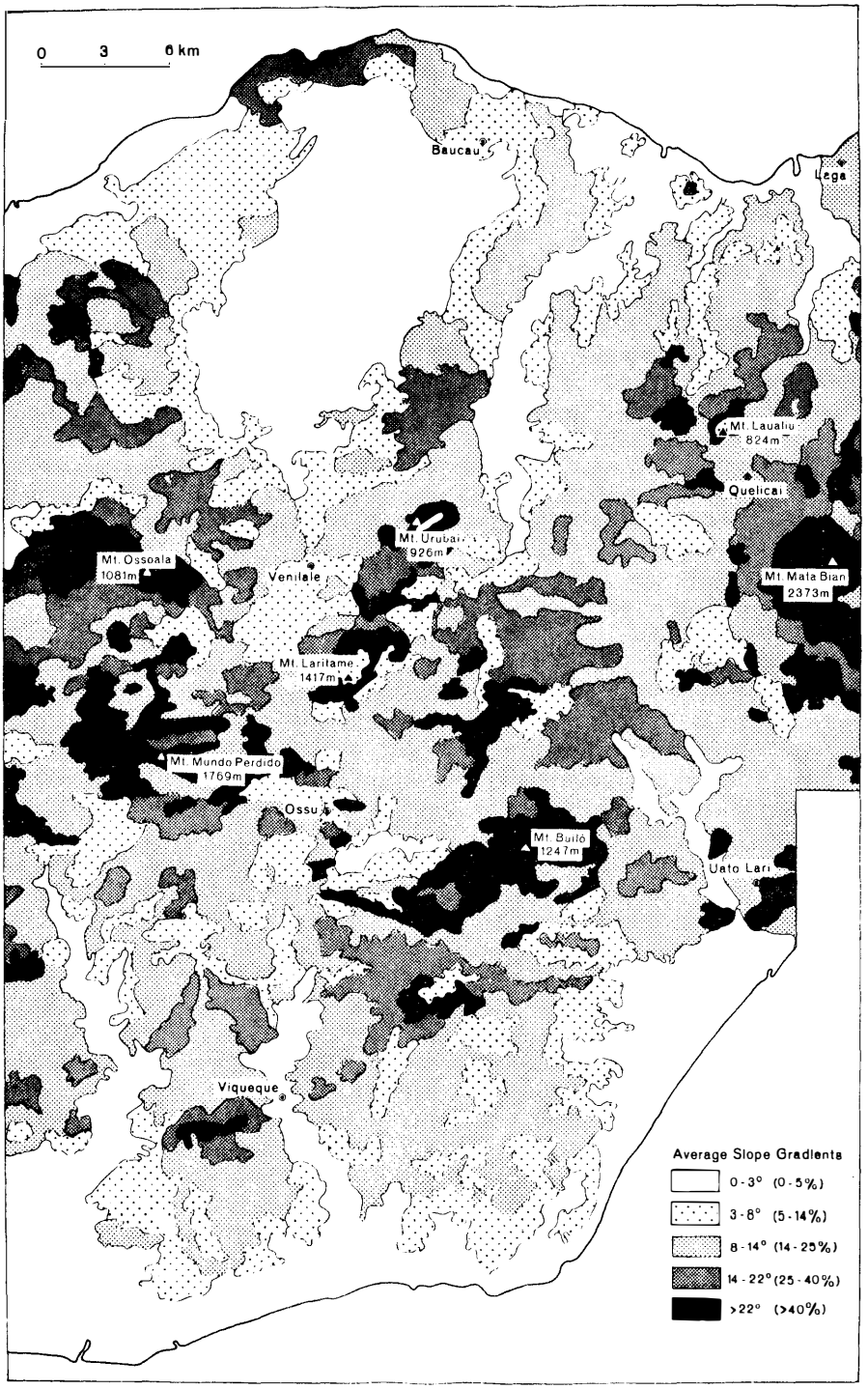


Fig. 12 Slope map of the Area

therefore no wonder that wholesale erosion has become Timor's chief problem, a recurrent theme that will accompany us throughout this study.

The wildness of the terrain and the high degree of erodibility of the soil which has been aggravated by human action, have rendered highway construction on Timor extremely difficult. This is particularly so in our Area owing to the high percentage of heavy clay soil derived from Bobonaro Scaly Clay, which is very liable to slumping. It is therefore all the more astonishing that one of the few roads linking the north coast with the south coast was laid through the Area in the 1920s (Gonçalo Pimenta Castro 1944:170-1). This road was built primarily for military purposes (with statute labour by local population) enabling the colonial administration to transfer troops quickly to the newly pacified interior when necessary. It links Baucau with Venilale, Ossu, Viqueque and Bé Aço; the road was later extended to Uato Lari. Today it is still the main link between Baucau and the south coast. Small extensions were built under Japanese occupation, 1942-45 - e.g. between Ossu and Uato Lari via the suco of Ossoroa. These roads were built under forced labour conditions by the Timorese. Their purpose was to enable the Japanese to gain better access to the south coast, from which they expected an invasion of the Allied Forces.

In addition a few feeder roads to the Baucau-Bé Aço gravel road were built in a rather primitive way by the local population under initiative and guidance of local rulers; this was the case for instance with the Ossu-Nahareca road. Except for the gravelled north-south 'highway'[19] all these roads fell rapidly into decay when the necessary maintenance was no longer performed. But even the trans-island road from Baucau to Bé Aço is difficult to keep open to motor vehicles throughout the year.[20] During the rainy season the road turns into quagmires and becomes subject to landslides. Every year at the end of the rainy season the Posto administration has to contract labour from the suco population for road repair. Since this job usually consists simply of smoothing out the road with earth, after the next rain the

[19] There were no metalled roads in Portuguese Timor until 1971.

[20] The Viqueque-Uato Lari portion of the road is only open to motor vehicles during the dry months from August to October.

road is in about the same deplorable condition as before the repair. This ordeal has to be faced by the administration every year. Moreover, as a result of the highly variable rainfall, rivers which dry up during the rainless season (except for the Seiçal and the Cuha rivers) turn into frantic torrents after the first rains which - in the absence of bridges[21] - greatly impede traffic.

This problem also applies - to a lesser degree though - to native traffic which is carried out on a dense system of foot and bridle paths; these usually follow the crests of hills and mountains (Plate 47). They are twisted as they tend to bypass obstacles like fallen trees, rock outcrops and newly cultivated gardens, which may be laid across a former path.

Soils

As outlined in the foregoing section, in contrast to the younger volcanic ash deposits of the Inner Arc (Sumbawa, Flores, Alor, Wetar) Timor consists chiefly of sediments among which coral limestone is conspicuous. From this we may assume that the island's soils are generally high in lime, and consequently alkaline in reaction. Moreover, owing to a long dry season, the soils are not subject to heavy leaching, but salinization caused by evaporation may occur locally on the surface.

While quite a lot of information is available on the geology of eastern Timor, hardly any pedological research has been carried out in this part of the island. The only data we can draw upon are those provided by a team of Portuguese soil scientists who in 1960 carried out a soil survey for the MEAU.[22] The only outcome so far of this study[23] is a short article (Garcia *et al.* 1963) which briefly describes the main soil types of the eastern end of Portuguese Timor. The accompanying soils map, which happens to include

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[21] E.g. at the Assa Lai Tula river (between Ossu and Venilale) or at the Laleia and Vemasse rivers (between Baucau and Dili) and the Seiçal (between Baucau and Lospalos).

[22] MEAU = Missão de Estudos Agronómicos do Ultramar (= Agricultural Research Organization of the Overseas Ministry in Lisbon).

[23] The soil samples were taken chiefly along the road (as

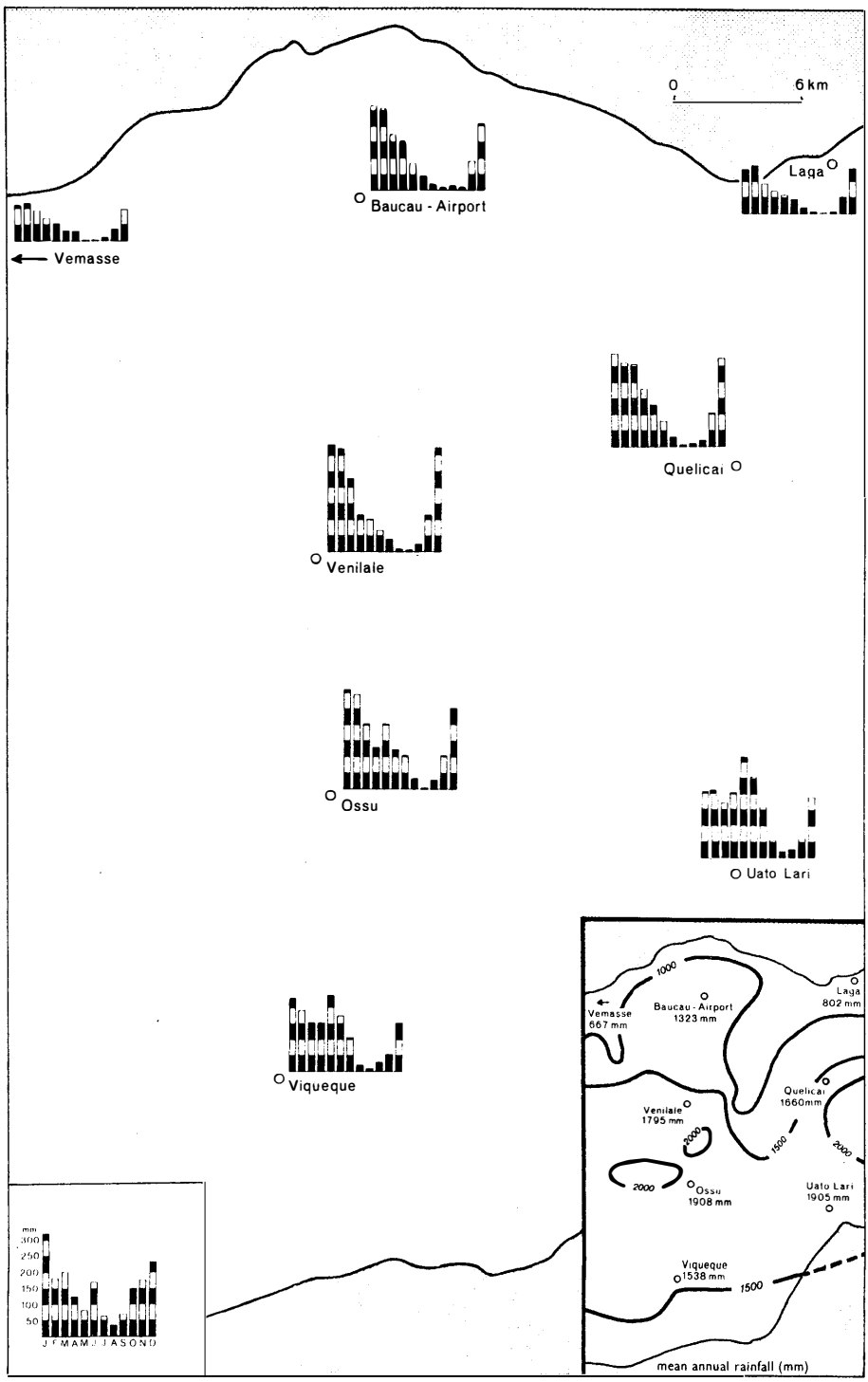


Fig. 13 Soil types found in the Area

Legend to Fig. 13

Amc	Medium textured calcareous modern alluvial soils
Ap	Heavy textured non-calcareous modern alluvial soils
CD	Greyish brown soils from non-calcareous materials (from diorite)
CMC	Greyish marly soils (from Viqueque Formation)
CN	Grey calcareous soils (derived from clay complex)
CR	Grey calcareous soils (from sandstone and coral reef limestone)
L	Lithosolic soils
PCX	Brown calcareous soils (from limestone from the Triassic associated with shales)
PF	Brown calcareous soils (from fatu limestone)
Plc	Coastal lowland soils
RC	Calcareous psammitic regosols
VR	Red calcareous soils (from coral reef limestone)
Y	Calcareous soils (from Larigutu limestone)
PF/L	Example of a mixture of two soil types (here: PF and L)

the southern half of our Area, conveys but a very rough idea of the broad distribution of the major soil types. It has to be regarded as a first attempt which for our purposes is quite inadequate and urgently needs revision.[24] Thus I felt compelled to draft a new soils map of the entire study area. For this, while adhering to the soil classification outlined in the Garcia article, I have drawn on the geological map by Audley-Charles (1968), as parent material has obviously been of major importance in soil genesis in the Area.

In addition, I used some unpublished material by Garcia (1960a, 1960b, 1961), air photos and - what proved to be most valuable - mechanical and chemical analyses (made in the MEAU laboratories in Lisbon) and profile descriptions[25] which I was fortunate to find in the MEAU files in Dili and which were set at my disposal.

The result of piecing together these bits of information is presented in Fig. 13[26] (see also profile Fig. 14) which shows the distribution of twelve distinct soil types. This map differs significantly from that in Garcia's article, particularly in the Southern Foothill Zone where certain of Garcia's soil types were omitted while others were added and boundaries of soil types were revised. Those parts for which no soil information was available were left blank. For reasons of scale not all soil types could be shown as

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23 (continued)
evidenced by a sketch map of the profiles taken and deposited in the MEAU office in Dili). Therefore the authors have extrapolated their findings by drawing too heavily on the partly outdated geological map by Leme (1963b). Although in its annual report of 1969 (Relatório Anual da Brigada de Timor 1969) the MEAU mentions that the general soil map of Timor is still being worked on, nothing had been published so far.

24 I was informed that other MEAU soil scientists, for example Eng. Agr. A. Silva Cardoso (chief of the MEAU mission in Dili 1970-71) had raised serious doubts as to the validity of the soils map reproduced in the abovementioned article by Garcia *et al.* (1963).

25 Profile descriptions were only available for some of the soils while chemical analyses were found for others.

26 This soils map should merely be regarded as a reconnaissance map pending more detailed soils research.

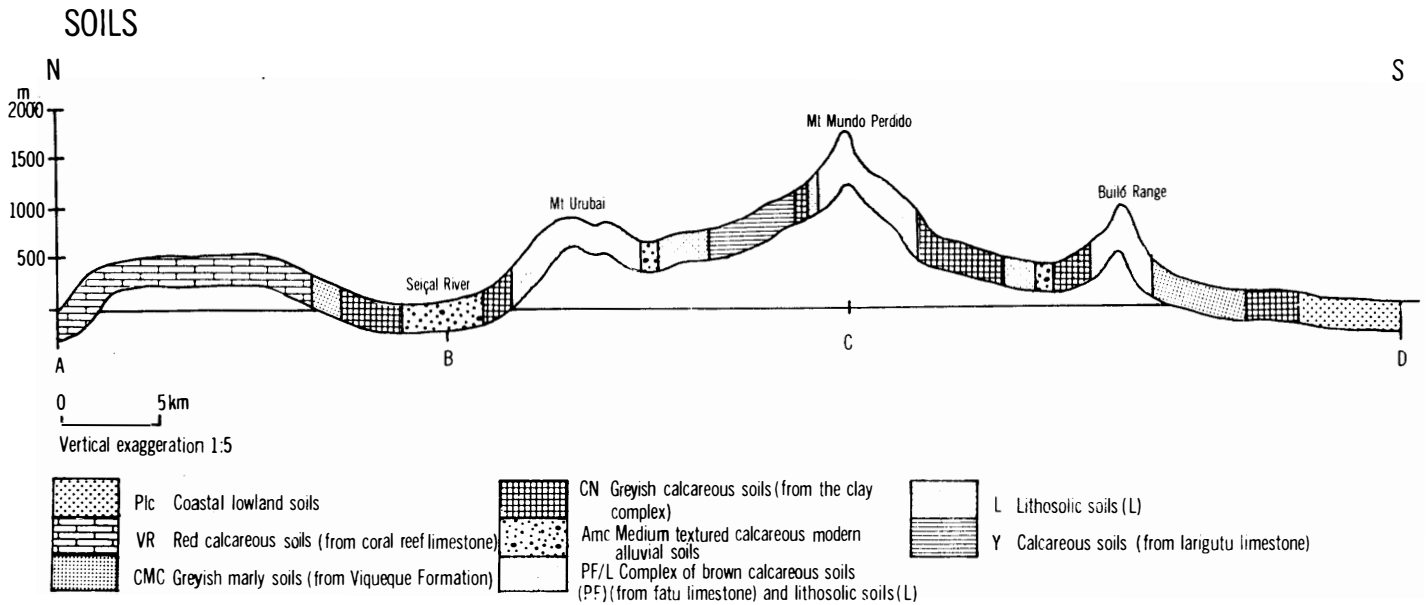


Fig. 14 Soil types along profile

distinct units. Instead, combinations of two soil types have been preferred as indicated by both symbols - e.g. PF/L or Ap/Amc.

Description of soil types

1. Greyish Calcareous Soils (from the clay complex):CN

Marked heterogeneity associated with the nature of the parent material. Dark brown, reddish brown or greyish; clay; subangular and angular blocky structure. Variable carbonate content along the profile (Garcia *et al.* 1963).

Profile description

Locality: East of road Ossu-Uato Carbau at place called Gueulari; elevation 410 m
Topography: Slightly undulating
Vegetation: Casuarina savanna and medium-sized grass
Drainage: Internal - poor; external - good

Profile morphology

Horizon	Depth	
A_h	0-30 cm	10 YR 3/1 (dry), 10 YR 4/1 (moist); clay, medium to coarse angular and subangular structure cemented together with some fine roots, strong effervescence to HCl at 10 per cent gradual transition.
A_h/C	30-125 cm	7, 5 YR 4/2 grey, with small patches of 5 Y 5/1, clayey with quartzite and some limestone angular structure, clear boundary.
C	125-180 cm	5 YR 4/3, dark reddish with some medium sized patches of 2, 5 Y 6/2, clay, with some small gravel (quartzite and limestone) fine and medium-sized angular structure.

Mechanical and chemical analysis see Table 4.[27]

Chief characteristics

Very heavy texture of 67 per cent clay in A_h horizon, thus extremely low permeability; alkaline in reaction increasing

[27] For the interpretation of the chemical analyses the author thankfully acknowledges the help given by Dr Kurt Metzger, soil chemist, Department of Geography, Heidelberg University.

with depth; low in organic matter and nitrogen; fairly good C/N ratio, no data on phosphorus, but the soil is likely to suffer from deficiency in this mineral; high cation exchange capacity (C.E.C.); very high in Ca and Mg; high K and carbonate contents.

Agricultural potential

Owing to very heavy texture which impedes root penetration[28] and which accounts for poor soil-water relationships, these soils do not lend themselves readily to farming.[29] Moreover, because of unfavourable relief conditions in the area of their occurrence (chiefly central uplands) the soils are highly subject to erosion. They are rich in all nutrients except nitrogen and are likely to respond well to additions of bases (due to high C.E.C.) and to nitrogen because of good C/N-ratio which is enhanced by the high alkalinity. For farming purposes the texture would have to be improved and organic material be introduced (e.g. calcium cyanamide $CaCN_2$ which is inexpensive, or by the planting of legumes).

In addition, improved management practices such as draining, tillage at optimum moisture levels with proper implements, proper choice of crops and crop rotations are required. The nutrients extracted by the crop would, of course, have to be returned to the soil by fertilization.

The outstanding feature of these soils is their high degree of plasticity and stickiness when wet and their hardness when dry.[30] They are subject to significant swelling and shrinking dependent upon soil moisture content. Deep cracks, having an average depth of 70-100 cm and a width of 10 cm or more are conspicuous during the dry season (see Plate 16).

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[28] Except for a few plants like *Acacia leucophloea* (up to 300 m) and *Casuarina junghuhniana* (above 300 m) which both form characteristic savannas on these soils.

[29] H. Lains e Silva (1956:132) considers these soils completely unsuitable for farming because of their high clay content and suggests they would form excellent material for the manufacture of bricks!

[30] These distinct characteristics can never be forgotten by someone doing field research in the Area at all seasons: during the wet season travelling through regions of this heavy clay soil becomes a burden and constitutes a hazard to men and animals alike.

On account of these properties the heavy clay soils[31] which cover large parts of the Area (particularly of the central upland)[32] form natural pastures for Timor's large livestock population, since they cannot (or only with great difficulty) be used for farming purposes by the Timorese. This is greatly conditioned by the low level of technology of the people who rely only on simple stout digging sticks (ai suak) for tillage (see Plate 29). When the soils are wet and sticky, the ai suak may clog, whereas when the soils are dry and hard large clods may be turned up which do not break down to a granular structure. The latter is common in Timor where tilling (fila rai) is done before the commencement of the rainy season. Thus, as a result of the low level of technology, the Timorese do not succeed in bringing about lasting improvements in the texture of these clay soils. Dryland farming is therefore only practised marginally here.

The situation is different in the case of wet rice cultivation for which these soils are better suited because of their high water holding capacity. Ponding of water in the mostly rain-fed rice fields is common, for instance, in the central upland in the posto of Ossu (Plate 42). In contrast to dryland cultivation wet rice farming does not require textural improvement of the soil; simple puddling with buffaloes (sama natar) of the paddy field suffices. On the other hand, the low permeability of the soil makes irrigation hazardous. For, if water tends to stagnate (for instance after a brief heavy rainfall) the plant may be destroyed. Owing to the reduction of the upper layers, hydrogen sulfides (H_2S) are formed which harm root development. Since these soils contain too little iron, the hydrogen sulfides cannot be neutralized (FAO 1965:53-4). Moreover the stagnating

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[31] Although in the soils map I have adhered to the term used by Garcia - grey calcareous soil - I consider it misleading as it is not always calcareous (see e.g. El Wakeel *et al.* 1961). In neighbouring Western Timor this soil type which there is called 'Margalitic Soil' (Ormeling 1955:49; FAO 1960:48) covers extensive parts of the so-called central 'Graben'. Other names for this soil include Black Clay (Australia), Regur (India), and Vertisols or Grumosols (USA).

[32] The area depicted in Fig. 13 under CN does, in fact, locally contain large allochthonous rocks, giving rise to highly different soils - e.g. infertile red soils in southern Loihuno on which *Eucalyptus alba* savanna occurs.

Table 4

Mechanical and chemical analysis of grey calcareous soil (from clay complex): CN

Horizon	Depth	Stones > 2mm %	Coarse sand %	Fine sand %	Silt %	Clay %	pH H_2O KCl	Organic matter %	Carbon %	Nitrogen %	C/N	Soluble phosphorus %	Carbonates CO_3 %	Cation exchange (m.e./100 g moisture-free soil) Ca	Mg	K	Na	Total bases	H	Total cation exchange capacity
0 Ah 30 Ah/C 125 C	0- 30cm	29.0	0.6	3.9	29.5	67.0	7.9-7.2	2.2	1.3	0.13	10.0	no data	9.2	17.3*	7.3	1.7	1.6	27.9	0.1	28.9**
	30-125cm	19.0	0.7	3.5	24.6	68.3	8.2-7.2	1.4	0.8	0.07	11.4	no data	7.8	12.2*	12.1	1.0	4.1#	29.4	0.8	30.4**
	125-180cm	31.5	1.8	10.6	32.1	53.4	8.2-7.4	1.0	0.6	0.048	12.5	no data	8.8	8.5*	11.4	0.5	3.2#	23.6	0.8	24.4 (20.7)##

* According to method by Mehlich.
** Computed by the author.
\# These sodium values are too high as they include a substantial amount of soluble sodium.
Anion exchange capacity of 20.7 m.e./100 g of soil was obtained by barium precipitation.

Table 5

Mechanical and chemical analysis of calcareous psammitic regosols: RC

Horizon	Depth	Stones > 2mm %	Coarse sand %	Fine sand %	Silt %	Clay %	pH H_2O KCl	Organic matter %	Carbon %	Nitrogen %	C/N	Soluble phosphorus %	Carbonates CO_3 %	Cation exchange (m.e./100 g moisture-free soil) Ca	Mg	K	Na	Total bases	H	Total cation exchange capacity
0 Ah 25 C	0- 24cm	8.0	1.1	54.8	23.9	20.8	8.2-7.4			no data			43.0					no data		
	24- 72cm	9.0	1.1	50.2	26.9	21.8	9.3-8.2			no data			51.3					no data		
	72-114cm	6.0																		
	114-180cm	8.5			no data					no data								no data		

water may entail lateral sliding and slumping as evidenced in Uato Iro (suco Uma Ana Ulu, Venilale) in April 1970. Hence the Timorese speak of rai (nama) doras (sliding soil). In addition, when the soil is wet, surplus runoff is high owing to slow infiltration rates, and this makes these soils susceptible to gully and sheet erosion (see Plate 46).

On account of these drawbacks and the unstable nature of the clay soils, even terracing becomes ineffective on slopes with gradients exceeding roughly 20 per cent.[33] Thus, as we see, wet rice cultivation on heavy clay soils tends to require more attention than on other more permeable soils.

These soils are normally reserved for livestock grazing in the Area, particularly above 300 m, where the water stress is less severe during the dry season than at lower elevations. But even this is not without risk owing to the common practice of overstocking. The wet soil is trampled by the animals, reducing percolation and surface runoff. Thus, erosion is increased.

Moreover, although the fodder value of many of the grasses growing on these clay soils is relatively high, there may be an acute shortage of feed and water during the dry season which makes a seasonal shift of the livestock inevitable. In our Area, year-round livestock grazing is only possible at elevations above 800 m, except for irrigated areas at lower elevations. Unless proper pasture management is introduced, these soils are not suited to intense livestock farming.

2. Calcareous Psammitic Regosols: RC

Incipient soils derived from unconsolidated materials. Generally rather deep. Made up of coarse sandy debris. Sandy; high carbonate content. Found along the coast. (A) C type profile (Garcia *et al.* 1963).

Mechanical and chemical analysis see Table 5.

Chief characteristics

Excellent texture, highly alkaline in reaction, high carbonate content; no other data available.

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[33] On these soils I observed the effect of sheet erosion on slopes having gradients of under 5 per cent in the Ossu area.

Agricultural potential

Because of excellent texture and high carbonate content, this soil seems to be very suitable for agricultural purposes provided nutrients are sufficient. In order to increase organic matter pioneer plants should be planted. Timorese are, however, not capable of using the soil for purposes other than for coconut growing, because tilling is rendered impossible with ai suak due to the high sand content.

3. Medium Textured Calcareous Modern Alluvial Soils (Amc)

Medium and light texture (clay loam and sandy loam); greyish; high carbonate content. Found along water streams. From time to time new alluvial sediments are added (Garcia *et al.* 1963).

Mechanical and chemical analysis see Table 6.

Chief characteristics

Medium texture in upper horizons (0-55 cm); highly alkaline in reaction, low in organic matter and nitrogen; good C/N ratio, high content of carbonates, Ca, K, and Mg; moderately high C.E.C.

Agricultural potential

Owing to fairly good texture, high amount of bases and carbonates, high pH, and high C.E.C. this soil would respond well to fertilizing. Chiefly nitrogen would have to be added. This soil is among the most fertile in our Area.

4. Heavy Textured Non-calcareous Modern Alluvial Soils (Ap)

Incipient soils from stratified alluvium deposits, often receiving sedimentary additions. Deep water table, subject to fluctuations. Flooding is common. Dark; clay (Garcia *et al.* 1963).

Mechanical and chemical analysis see Table 7.

Chief characteristics

Moderately good texture in upper 40 cm; clay accumulation from 40 to 90 cm; alkaline in reaction; low in organic matter due to salts as the soil is deficient of carbonates; poor in nitrogen, but good C/N ratio; low C.E.C.; no data for individual bases. This soil may be called 'Alluvial Meadow Soil' or 'Rambla' (pers. comm. Metzger).

Table 6

Mechanical and chemical analysis of medium textured calcareous modern alluvial soil: Amc

Horizon	Depth	Stones > 2mm %	Coarse sand %	Fine sand %	Silt %	Clay %	pH H_2O KCl	Organic matter %	Carbon %	Nitrogen %	C/N	Soluble phosphorus %	Carbonates CO_3 %	Cation exchange (m.e./100 g moisture-free soil) Ca	Mg	K	Na	Total bases	H	Total cation exchange capacity
Ah	0- 35cm	15.0	3.2	34.9	33.2	28.7	8.7-7.2	2.19	1.27	0.147	8.6	no data	32.4	16.7*	3.6	1.06	0.65	22.01	0.4	22.41 (21.92)**
C	35- 55cm	24.0	38.6	39.6	8.5	13.3	8.4-7.1	0.50	0.29	0.032	9.1	no data	36.8	9.8*	3.5	0.70	0.28	14.28	0.0	14.28 (14.67)**
Ahfo	55- 80cm	21.5	7.2	27.5	31.6	33.7	7.5-6.7	1.02	0.59	0.071	8.3	no data	30.9	13.9*	4.9	0.54	0.78	20.12	0.0	20.12 (21.70)**
D1	80-110cm	25.0	7.2	18.2	28.7	45.9	7.9-7.3	0.95	0.55	0.68	8.1	no data	29.6	14.2*	5.6	0.47	1.47	21.74	0.0	21.74 (20.50)**

* According to method by Mehlich.
** Anion exchange capacity of 21.92, 14.67, 21.70 and 20.50 m.e./100 g of soil was obtained by barium precipitation.

Table 7

Mechanical and chemical analysis of heavy textured non-calcareous modern alluvial soil: Ap

Horizon	Depth	Stones > 2mm %	Coarse sand %	Fine sand %	Silt %	Clay %	pH H_2O KCl	Organic matter %	Carbon %	Nitrogen %	C/N	Soluble phosphorus %	Carbonates CO_3 %	Cation exchange (m.e./100 g moisture-free soil) Ca	Mg	K	Na	Total bases	H	Total cation exchange capacity
Ah	0- 19cm	6.0	3.6	38.5	24.2	33.7	7.6-6.4	2.14	1.24	0.125	9.9	no data	0.0						4.0	18.5
C	19- 41cm	9.0	7.7	35.5	21.2	35.6	7.8-6.7	1.40	0.81	0.091	8.9	no data	0.0						3.0	17.1
Ahfo	41- 60cm	5.5	13.4	15.3	21.1	50.2	7.7-6.2	1.03	0.60	0.074	8.1	no data	0.0						2.1	19.4
D1	60- 87cm	9.0	0.5	14.3	24.5	60.7	7.4-6.3	0.64	0.37	0.046	8.2	no data	0.0			no data			2.5	18.7
D2	87-143cm	8.5	9.6	30.7	25.2	34.5	7.9-6.8	0.62	0.36	0.058	6.2	no data	0.0						2.0	16.4
	143-176cm	6.5	1.9	47.9	21.3	28.9	8.2-7.1	0.60	0.35	0.060	5.8	no data	0.0						0.0	19.6

Agricultural potential

Because of heavy textured horizon (40-90 cm) the soil is only good for shallow rooting crops. Nutrient deficiency makes improvement, however, too costly. A warning example is the Sota coconut plantation at Ra Tahu (Viqueque) which was a complete failure.

5. Coastal Lowland Soils (Plc)

Incipient soils, found in low-lying coastal areas. Dark coloured. Water table comparatively high; normally not subjected to flooding. Do not show clearly developed genetic horizons. These soils are deep and have a high level of natural fertility. Better developed than the Recent Alluvial Soils (Garcia *et al.* 1963).

Mechanical and chemical analysis see Table 8.

Chief characteristics

Very young soil (only 50 cm), horizons are not genetic but due to different sedimentation processes; heavy texture, alkaline in reaction, relatively low organic matter and poor in nitrogen, good C/N-ratio, high C.E.C. increasing with depth; very high Ca-content and high in Mg, and carbonates, but low in K. This soil may be called 'Calcareous Alluvial Meadow Soil' or 'Paternia' (pers. comm. Metzger).

Agricultural potential

Moderately good soil (see also H.Lains e Silva 1956:130) owing to heavy texture. Nitrogen and potassium would have to be added (potassium phosphate and ammonium nitrate like superphosphate would be good as soil is alkaline).[34] Soil will respond well to base fertilizers as C.E.C. is relatively high. Consideration should be given to the water level (4.8 m.e. of H in C-horizon is indicative). Water-logging is thus possible. Only good for rice cultivation, not for coconut growing because of texture.

6. Red Calcareous Soils (from coral reef limestone): VR

Reddish brown; large amount of coral limestone fragments at the surface; variable carbonate content in the lower horizons.

[34] On an experimental ricefield (6 hectares) in the Narequici plain (Uato Lari) on Plc-soil the C.M.V. (Comissão Municipal de Viqueque) obtained satisfactory results in 1969-70 by applying superphosphate with 21 per cent nitrogen (pers. comm. Reg. Agr. António dos Santos, 9.11.70).

Table 8

Mechanical and chemical analysis of coastal lowland soils. Pl

Horizon	Depth	Stones >2mm %	Coarse sand %	Fine sand %	Silt %	Clay %	pH H_2O KCl	Organic matter %	Carbon %	Nitrogen %	C/N	Soluble phosphorus %	Carbonates CO_3 %	Cation exchange (m.e./100 g moisture-free soil) Ca	Mg	K	Na	Total bases	H	Total cation exchange capacity
(A)	0- 47cm	19.0	11.4	7.6	34.0	46.3	8.3-7.3	2.60	1.50	0.150	10.0	no data	26.6	20.6*	3.7	0.30	0.40	25.00	1.4	26.40
C	47- 72cm	29.5	26.8	2.9	24.7	45.9	8.2-7.2	0.20	0.10	0.020	5.0	no data	2.6	32.4*	7.8	0.16	1.93	42.29	+.8	47.09 (42.90)**
D1	72-145cm	41.0	7.1	6.9	33.0	53.0	8.5-7.5	0.30	0.20	0.041	4.8	no data	2.3	12.7*	6.1	0.20	12.60**	31.60	1.5	33.10 (28.00)**
D2																				

* According to method by Mehlich.
** Anion exchange capacity of 42.90 and 28.00 m.e./100 g of soil was obtained by barium precipitation

Table 9

Mechanical and chemical analysis of red calcareous soil (from coral reef limestone). VR

Horizon	Depth	Stones >2mm %	Coarse sand %	Fine sand %	Silt %	Clay %	pH H_2O KCl	Organic matter %	Carbon %	Nitrogen %	C/N	Soluble phosphorus %	Carbonates CO_3 %	Cation exchange (m.e./100 g moisture-free soil) Ca	Mg	K	Na	Total bases	H	Total cation exchange capacity
Ah	0- 60cm	19.3		no data			8.4-7.9	1.34	0.78	0.094	8.3	no data	80.4		no data				2.8	8.59
	60-160cm	49.0		no data			9.0-8.4	0.23	0.1	0.0080	13	no data	74.2		no data				0.2	8.34

Limestone shows up often at the top in large areas but soil is still found among the stones and in the hollows. Sometimes shows considerable thickness. Soils have a shallow phase (VRd) when the C horizon is found less than 50 cm deep (Garcia *et al.* 1963; Leme *et al.* 1965).

For mechanical and chemical analysis see Table 9.

Chief characteristics

Only shallow A_h-horizon, very stony, light texture, highly alkaline in reaction, low in organic matter and nitrogen, good C/N-ratio, very low C.E.C., very rich in carbonates. Other data are not available. This soil may be called 'Calcareous Rendzina with skeletal character' (pers. comm. Metzger).

Agricultural potential

Large amounts of coral limestone fragments and shallowness limit agricultural utilization of this soil, which occurs in sinkholes. Very low organic matter, poor nitrogen level and low C.E.C. make this soil one of the chemically poorest. Timorese have recognized this deficiency and have adapted themselves by applying sheep manure. Mulching of sweet potato leaves is also common. Thus, organic matter is carefully preserved and even increased. Because of light texture this soil is easy to work. Nitrogen deficiency is apparently overcome by the Timorese through the planting of nitrogen fixing legumes (peanuts) which are grown in rotation with maize.

Humic acids concentrate in swales giving rise to black soils (rai metan) which are rich in organic matter.[35] These soils are highly regarded by the Timorese - e.g. at Aubaca, Lequileuato, Fatumaca de Cima - and considered some of the best in the Area, although they are slightly heavy in texture.

7. Grey Calcareous Soils (from sandstone coral reef limestone): CR

Grey or brown; loam to clay; some quartz gravel; subangular blocky structure; high carbonate content. Normally found at lower altitudes (Garcia *et al.* 1963).

Mechanical and chemical analysis see Table 10.

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[35] For reasons of the small scale of our soils map these rai metan soils had to be omitted in the mapping.

Table 10

Mechanical and chemical analysis of grey calcareous soil (from sandstone and coral reef limestone): CR

Horizon	Depth	Stones > 2mm %	Coarse sand %	Fine sand %	Silt %	Clay %	pH H_2O KCl	Organic matter %	Carbon %	Nitrogen %	C/N	Soluble phosphorus %	Carbonates CO_3 %	Cation exchange (m.e./100 g moisture-free soil) Ca	Mg	K	Na	Total bases	H	Total cation exchange capacity
0 Ah / Ael / M2 / Ahfo 40 / M1	0-10cm	6.9	5.7	20.4	16.6	57.3	6.3-5.7	15.0	8.70	0.790	11.0	no data	0.14	19.3*	1.6	0.25	0.46	21.6	6.8	28.4 (27.1)**
	10-26cm	15.8	6.5	7.6	16.0	69.9	7.2-6.2	3.3	1.90	0.230	8.3	no data	vest							41.4
	26-35cm	22.5	4.2	6.1	15.1	74.8	6.5-5.7	1.9	1.10	0.160	6.9	no data	0.0	no soil for analysis						
	35-78cm	18.3	1.4	13.8	18.0	66.8	6.7-6.4	2.2	1.30	0.170	7.6	no data	0.0							49.0
	> 78cm	38.8	1.5	1.6	16.6	80.3	7.1-6.8	2.2	1.26	0.106	11.9	no data	vest.	34.6*	0.7	0.16	0.07	35.5	8.5	44.0 (32.6)**

* According to method by Mehlich.
** Anion exchange capacity of 27.1 and 32.6 m.e./100 g of soil was obtained by barium precipitation.

Table 11

Mechanical and chemical analysis of brown calcareous soil (from fatu limestone): PF

Horizon	Depth	Stones > 2mm %	Coarse sand %	Fine sand %	Silt %	Clay %	pH H_2O KCl	Organic matter %	Carbon %	Nitrogen %	C/N	Soluble phosphorus %	Carbonates CO_3 %	Cation exchange (m.e./100 g moisture-free soil) Ca	Mg	K	Na	Total bases	H	Total cation exchange capacity
0 Ah / 35 Cv / 80 C	0- 17cm	10.5	no data*				8.0-7.4	4.55	2.64	0.283	9.3	no data	89.1	16.4**	0.4	0.10	0.01	16.9	0.0	16.9 (16.9)#
	17- 33cm	6.0					8.3-7.7	2.83	1.64	0.188	8.7	no data	87.4	11.7**	0.2	0.05	0.00	12.0	0.0	12.0 (11.6)#
	33- 80cm	8.0	12.7	35.1	37.1	14.8	8.4-7.8	1.40	0.81	0.097	8.4	no data	37.3	5.6**	0.2	0.06	0.03	5.9	0.1	6.0 (8.6)#
	80-175cm	49.5	6.9	30.2	29.5	33.4	7.9-6.9	1.26	0.73	0.070	10.4	no data	45.0	11.9**	0.4	0.16	0.04	12.5	0.8	13.3 (13.5)#

* However, fairly good texture can be assumed in upper 35cm.
** According to method by Mehlich.
\# Anion exchange capacity of 16.9, 11.6, 8.6 and 13.3 m.e./100 g of soil was obtained by barium precipitation.

Chief characteristics

Presumably of good texture also in upper 35 cm; slightly alkaline; relatively rich in organic matter, poor in nitrogen, good C/N-ratio, however low C.E.C., very high in Ca and carbonates, while low in potassium and very low in magnesium. This soil may be called 'Pararendzina' (pers. comm. Metzger).

Agricultural potential

Because of presumably good texture and high carbonate content this soil seems to be fairly well suited to agricultural purposes. Nitrogen would have to be added. It would, however, not respond well to base fertilizing due to low C.E.C. Ammonium potassium phosphate K $(NH_4)_2PO_4$ would be a potential fertilizer.

8. Brown Calcareous Soils (from fatu limestone): PF

Little developed. Variable carbonate content along the profile. Greyish brown; clay. When shallow, contains a great deal of limestone fragments lying at the surface. Present surface cracking when thicker. Profile of the AC type, sometimes ABC type. These soils have a shallow phase (PFd) characterized by a greater amount of stones at the surface; the C horizon being less than 50 cm deep. (Garcia *et al.* 1963).

Mechanical and chemical analysis see Table 11.

Profile description

Location:	Cobisauno, Mt Mata Bian, slightly above 1500 m
Topography:	Slope at 48 per cent gradient
Vegetation:	Short grass, potato cultivation on terraced fields
Drainage:	External - regular to good; internal - regular to bad, worsening with depth

Profile morphology

Horizon	Depth	
A_h	0-6/10 cm	10 YR 2, 5/2 (dry) and 10 YR 2/2 (moist) sandy silt, small calcareous gravel at surface blocky medium and fine, moderate to strong, hard, many fine and medium sized roots well-distributed, effervescence none to HCl, gradual transition.

A_{el}	6/10-20/26 cm	10 YR 3/3 (moist) clay with some gravel of limestone. Medium angular structure composed of fine granular, moderate to strong, friable, many fine and medium-sized roots, well-distributed. No effervescence with HCl, gradual irregular transition.
M_2	20/26-35 cm	10 YR 3, 5/4 (moist) a little more clay than the previous horizon, structure cannot be defined because of humidity, perhaps angular composed of fine granular with some gravel, few fine roots, tendency towards formation of clay lenses. No effervescence with HCl, gradual transition.
$A_{h_{fo}}$	35-78 cm	10 YR 4/4 (moist) very clayey, structure cannot be defined because of humidity, friable, with some gravel and bigger rocks of limestone, very few fine roots, no effervescence with HCl, gradual transition.
M_1	> 78 cm	Horizon similar to the previous one, somewhat more clayey and compact. Locally showing whitish patches, no effervescence with HCl.

Chief characteristics

Heavy texture dependent upon relief, acid in reaction, high in organic matter in upper horizon, moderately high nitrogen level in upper horizon, good C/N-ratio; high to very high C.E.C. as dependent on clay content; extremely high Ca content which is anomalous in view of low pH; low Mg and K, while rich in carbonates. This soil may be regarded as 'colluvial clay soil' derived from calcareous brown soils on top of the fatus while skeletal calcareous soils are typical for the slopes of the fatus. This soil catena is found on top of and around all fatus in the Area.

Agricultural potential

Heavy texture may constitute a handicap for farming; otherwise very fertile soil (rai metan) and as such regarded as being one of the best in the Area by the Timorese. High

organic content; soil would respond well to mineral fertilizers because of high C.E.C. Calcium cyanamide which is inexpensive and a potassium fertilizer which should be alkaline in order not to lower the pH value, would have to be added.

9. Greyish Brown Soils from Non-calcareous Materials (from diorite): CD

Dark greyish brown; loam to clay loam; some gravel; granular and subangular blocky structure; friable; moderately well drained (Garcia *et al.* 1963).

Profile description

Location:	Slope Mt Ulo Beta, 130 m from school of Posto of Quelicai, elevation 700 m.
Topography:	Strongly undulating, about 50 per cent slope gradient
Vegetation:	Scattered wild mango and banana trees
Drainage:	External - regular; internal - moderate

Profile morphology

Depth	
5-0 cm	10 YR 4/2 (dry) 10 YR 3/1, 3 (moist), many fine roots, leaves and stalks, partly decomposed; silt and sandy silt with some gravel; structure - granular medium and fine, hard, composed of blocky fine moderate, non-adherent, non-plastic, friable, sticky, no effervescence with HCl, abrupt boundary.
0-20/25 cm	10 YR 3, 5/4 (dry) and 10 YR 3/2 (moist), with many fine and medium and some large roots. Silt to clay silt with some gravel, medium to fine moderate subangular structure composed of fine moderate granular. Little adherent and plastic, friable, somewhat sticky, no effervescence with HCl, distinct boundary.
20/25-45 cm	10 YR 3/2, 5 (dry) and 10 YR 2, 5/2 (moist), with some medium and small patches of 10 YR 4/4. Silt and clay silt with some gravel, small stones chiefly in lower part of horizon, medium and fine moderate subangular structure, partly fine granular, little plasticity and adherence, friable, a bit sticky, no effervescence with HCl, clear undulating boundary.

> 45 cm	10 YR 5/5 (dry) and 10 YR 3, 5/4 (moist), with very few large roots, almost exclusively of metamorphosed parent rock material with some soil of coarser texture by comparison to the previous horizon, a lot of gravel and small rocks, no effervescence with HCl.

10. Calcareous Soil (from Larigutu Limestone): (here tentatively designated as Y)

Profile description

Location:	Old road to Mundo Perdido near place called Uato Lesso (Posto of Ossu) at 1060 m
Topography:	Undulating at rounded hill
Vegetation:	Short grass
Drainage:	Internal - poor; external - good to excessive

Profile morphology

Depth	
0-15 cm	10 YR 5/3 (dry), 10 YR 4/2 (moist), dark grey, clayey silt to clay, medium and fine subangular structure, many fine roots, no effervescence with HCl; distinct boundary.
15-48 cm	5 GY 6, 5/1 (dry), 5 GY 6/1 (moist), greenish with small patches of 10 YR 7/6, clay, medium angular structure, cemented, no effervescence with HCl, distinct boundary.
48-70 cm	5 GY 6/1 greyish green with many small indistinct patches of 7, 5 Y 7/4. Clay, medium angular structure, fine, cemented.
70-170 cm	Similar to previous horizon, but with calcareous deposits on the surface of the aggregate.

11. Lithosolic Soils

Incipient soils derived from consolidated rocks of various types. Less than 10 cm deep. Do not show genetic horizons. Profile of the CR or (A)C type (Garcia *et al.* 1963).

12. Greyish Marly Soils (from Viqueque Formation): CMC

Shallow soils; olive grey with mottles in lower horizons; high carbonate content; somewhat poorly drained; clay; hard (Garcia *et al.* 1963).

13. Brown Calcareous Soils (from limestone from the Triassic associated to shales): PCX

Brownish; high carbonate content. Developed from limestone with alternate thin layers of greyish shales (from Naunilli). ABC type profile. They have a shallow phase (PCXd) where the C horizon is less than 50 cm deep. Generally covered by large and small limestone fragments, bare rock showing up in places (Garcia *et al.* 1963).

Over generations, the Timorese have by trial and error accumulated a fund of knowledge, which, under their local system of farming serves them well in their selection of land and crops. They judge the land by the type of soil as well as by plant indicators, particularly by those which indicate soil exhaustion. In assessing the land according to their system of land classification, medium textured calcareous alluvial soils (Amc) rank highest because they can be used every year for either wet rice cultivation (if sufficient water is available) or for permanent dryland farming.

Next in rank are soils derived from volcanic material, such as greyish brown soils from non-calcareous material (from diorite) (CD) around Quelicai and Uai Oli, as well as black soil (rai metan) which occurs on the foot and on top of all fatus (brown calcareous soil from fatu limestone: PF) - for instance at Ossoroa, Builale, around Mt Urubai and Mt Venilale.[36] Rai metan, although derived from a different parent material, is also found on the Baucau Plateau (as at Audadan, Darasula, Lequileuato, Aubaca) or particularly at its rim (e.g. Fatumaca de Cima) where it occurs in swales. The origin of these isolated pockets of black soil amidst red calcareous soil (VR) is explained by the fact that humus formed on the plateau is dissolved by water and deposited in these swales by surface runoff.

These two soil types - CD and rai metan soils - are characterized by a high level of organic matter. Therefore permanent cultivation is common. Rai metan is slightly heavy textured and has swelling properties probably due to a high content of montmorillonite. The cultivation of this soil type is thus more laborious. However, on account of

[36] Because of its relatively limited occurrence we were not able to depict this soil type separately from lithosolic soils on our small-scale map.

its higher fertility and greater water holding capacity, land of this soil type is usually all occupied. It is preferred to the red calcareous soils (rai mean) which derive from coral reef limestone (for instance on the Baucau Plateau (VR) .

Rai mean is light textured and thus easy to work with a dibble (ai suak kiik) (see Plate 39). However, since limestone outcrops are common, ultivation is restricted to small patches of soil in sinkholes. A concentration of clay particles in these sinkholes prevents water from seeping through to the underlying limestone.

Ranking next in Timorese land classification are white or greyish calcareous soils (rai mutin) depicted in Fig. 13 as greyish marly soils from Viqueque Formation (CMC), grey calcareous soils from coral reef limestone (CR) and calcareous soils from Larigutu Limestone (Y). Because of their light texture, these do not constitute any difficulty for tilling. In the eyes of the Timorese these soils are generally less fertile than rai mean. Because of their low water holding capacity, they turn dry easily. Owing to their low fertility, bush fallowing is common, although local population pressure may force cultivators to work them permanently.

Of lowest agricultural value in the eyes of the Timorese are the heavy textured clay soils (CN) (rai tahu manu tem). The heavy texture, which the Timorese, as outlined above, are not capable of improving, materially hinders root penetration. If used for cultivation it is mostly for wet rice. Of equally low agricultural value are lithosolic soils (rai mohate) (for instance at Mt Ossoala, Mt Ossoaque, Mt Foho Manu, and locally on the fatus).

Finally, the three remaining alluvial soils merit assessment. The rich stretches of coastal lowland soils (Plc) of the south coast have been of only marginal value to the Timorese to date. The heavy texture, deep rhizomes of *Saccharum spontaneum* and *Imperata cylindrica* grass (Plate 23), as well as the malaria hazard, have prevented their utilization. Only at Uato Lari has the land under these soils been turned into wet rice fields, while at Bé Nara the Commissão Municipal of Viqueque helps farmers to plough their fields with a tractor.

The areas under regosols (RC) and heavy textured non-calcareous modern alluvial soils (Ap) are of only limited extent. They are used for coconut growing. The Timorese have, as a rule, selected the more suitable sandy sites, in contrast to the European-owned SOTA coconut plantation.

In conclusion, we can observe that, with the exception of the coastal lowland soils, the Timorese have occupied the land according to the potential productivity as revealed by our analysis. We will see in the following chapters in what way they have adapted their agricultural systems to the potentialities of the land and to what extent they deviate from them.

Climate

Of all environmental factors it is climate that affects the people of Timor most. Broadly speaking, the character of the island's climate, which reflects that of the Indonesian Archipelago, is that of a typical monsoon area; it is strongly conditioned by the seasonal latitudinal movement of air masses back and forth across the equator. These air flows which result from seasonal changes of air pressure in the northern and southern hemispheres are separated from each other by the so-called Intertropical Convergence Zone (ITC).

During the northern solstice season - May to September - the ITC lies well north of the equator and Timor is enfolded by warm continental southeasterly trade winds, locally referred to as the 'southeast monsoon'.[37]

A contrasting situation develops with the southward progression of the ITC during the southern solstice season - November to April - when wet maritime northwesterly winds - so-called 'northwest monsoon' - prevail.[37] The movements of these air masses affect the incidence and distribution of the rainfall - the chief indicator of the seasons in the tropics. Therefore the year can be sharply divided into two major seasons:

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[37] According to Flohn (1950:42) the southeast monsoon is part of the Eastern Trade Winds, while the so-called northwest monsoon is part of the equatorial Westwind drift.

(1) The period of the southeast monsoon which, owing to a short trajectory across the sea, is essentially dry with a relative humidity of frequently as low as 50 per cent and at times even lower.

(2) The wet season of the northwest monsoon when warm humid air reaches the archipelago after a long trajectory over tropical seas.

These two seasons are separated by short transitional periods in April and October when the Intertropical Convergence Zone passes the Java-Timor line. Characteristic features of these transitions are the slightly hotter and more sultry conditions, occasional thunderstorms in the afternoon, as well as variable winds.

While this rainfall pattern holds generally true for the entire Indonesian Archipelago, due to its more southern position (roughly between 8 and 10 degrees south of the equator), its proximity to Australia and because of its relief features, Timor's climate differs significantly from that of other parts of the archipelago. Within the context of tropical Southeast Asia, Timor is one of the driest parts, displaying extremely pronounced climatic differences. In this respect the island occupies a transitional position between humid Southeast Asia and dry Central Australia (cf. V. Bemmelen 1912).

I want now to embark upon a more detailed discussion of the climate.[38] The objective is primarily to identify and assess regional climatic differences which are of major significance to plant growth and to land use. Since rainfall is by far the most important climatic factor limiting plant growth and agricultural activity in the Area, the analysis of the climate begins with precipitation.

Precipitation

Rainfall data are available for eight stations that are fairly evenly distributed over the area under investigation. Although by comparison to other parts of Island Southeast Asia the density of meteorological stations in the Area is

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[38] The climate of Portuguese Timor has been dealt with in general in brief articles by Vasconcelos (1930), Lencastre (1931b), Rosa (1957), Rosa *et al* (1957) and Ferraz (1964). However, in none of these articles could I find information specifically relating to the study area of Baucau-Viqueque.

far above average, there is no doubt that neither the number of stations nor the length of rainfall records can suffice for a detailed regional analysis. While long-term yearly and monthly averages usually based on discontinuous pre- and post-war records have been published by the Serviço Meteorológico Nacional of Portugal (1965), daily rainfall data are only available after World War II, i.e. for periods no longer than 20 years (in three instances even only for 13 and 14 years). Prewar records were destroyed during the Japanese occupation. Daily rainfall records are generally shorter than is considered necessary to establish stable 'normals'. Therefore comparisons between stations have to be drawn with caution.

Mean annual rainfall is lowest along the north coast, at Vemasse and Laga, with 667.7 and 802.1 mm respectively (see Table 12).[39] In fact, only two other stations in Portuguese Timor - Manatuto and Laivai on the north coast - show slightly lower yearly averages of 565.0 and 600.0 mm respectively. Mean annual rainfall increases inland from the north coast reaching 1323.3 mm on the Baucau Plateau (512m) and 1663.4 mm at Quelicai (720 m) and 1795.1 mm at Venilale (775 m). The rainfall station with the highest yearly rainfall averages of 1908.8 mm is Ossu located at 688 m on the central divide. As we cross the central upland descending to the south coast the rainfall averages decrease only slightly and reach 1538.8 mm at Viqueque (46 m). Further east at Uato Lari (257 m), where rainfall conditions become significantly wetter, 1905.7 mm was recorded. Finally, from comparative annual rainfall figures from parts of Timor at about the same elevation (i.e. Atsabe (1190 m) 2110 mm; Turiscai (1171 m) 2068.5 mm; Lete Foho (1449 m) 2525.8 mm), it can safely be assumed that those parts of our Area lying above 1000 m, like Mt Mundo Perdido, Mt Laritame, Mt Builó and Mt Mata Bian, are areas having more than 2000 mm of annual rainfall.

The low density of stations makes the delineation of isohyets somewhat arbitrary. In spite of these drawbacks, an attempt has been made at plotting isohyets which have

[39] According to Berlage (1949) only 0.6 per cent of a total of 4339 of all stations in Indonesia have an annual rainfall of less than 1000 mm (cited in Ormeling 1955:17). With 547 mm annual rainfall Palu in Central Celebes is Indonesia's driest station. This is conditioned by topography (Berlage 1949:148).

Table 12

Mean annual rainfall for eight stations in the Baucau-Viqueque Area

	Altitude	Years of observation	Annual rainfall mm	Coefficient of variation %	Standard deviation mm	Comparative figures of annual rainfall by SMN*	Years of observation
Venilale**	775	1953-1970	1795.1	17.9	321.87	1758.0	1918-41 1953-63
Ossu	688	1952-1970	1908.8	19.3	368.27	1812.6	1917-41 1952-63
Baucau#	512	1951-1970	1323.3	16.2	213.85	1177.8	1917-41 1951-63
Laga	65	1953-1970	802.1	23.2	185.76	723.2	1931-41 1953-63
Viqueque##	46	1957-1970	1538.8	23.1	354.87	1635.3	1916-41 1957-63
Uato Lari	257	1953-1970	1905.7	28.3	539.79	1790.3	1920-41 1953-63
Vemasse	6	1957-1970	667.7	23.0	153.79	697.2	1931-41 1956-63
Quelicai	720	1958-1970	1663.4	20.1	334.93	1378.8+	1920-41 1958-63

* SMN, *O Clima de Portugal*, Fasc. XII, Provincia de Timor, Lisboa 1965.

** 775 m as indicated by the SMT is incorrect as the village of Venilale where the rainfall recordings are made is located at 830 m according to the official 1:50,000 topographic map.

\# The meteorological station is located at the airport at 512 m (according to SMN, 1965) or 527 m (according to SMT, Resumo Mensais das Observações Climatológicas). In Jan. 1972 a rainfall station was also opened at Baucau village (325 m). Fortunately two of the four first-category meteorological stations of Portuguese Timor are located in our Area at Baucau and Viqueque.

In July 1972 a new rainfall station began operating at Bé Aço (2m), south coast, between Viqueque and Uato Lari. Here also water temperature is measured.

\+ While the SMN average is based on data obtained at the old village of Quelicai (400 m) our post-1958 values were recorded at the new village of Quelicai (720 m) opened in 1958.

been estimated by extrapolating the data of the recording stations according to environmental features - chiefly vegetation and altitude. The isohyetal pattern indicated on the inset of Fig. 15 is therefore at best tentative owing to the complex relief of the Area.

Agricultural activity as well as plant growth are, however, less dependent upon the total amount of rainfall than upon its seasonal distribution (Fig. 15). Owing to the proximity of Australia, seasonal contrasts are more pronounced in Timor than in other parts of the archipelago. Moreover, orographic features have a decisive bearing upon the interception of moisture. Thus a high proportion of the rain is convectional. On the basis of the seasonal variation of mean monthly rainfall three major climatic zones can be distinguished in the study area:

(1) The southern part of the Area (Viqueque, Uato Lari - i.e. the area south of the central divide) which has a bimodal rainfall pattern with maxima in December to February and April to June. The two rainy seasons are separated by a short comparatively dry season (bai loro kiik) in March (still having over 150 mm rainfall) and a longer dry season of up to four months' duration (bai loro boot) from August to November. These dry seasons are broken only by occasional thunderstorms. This more favourable rainfall distribution throughout the year is of considerable importance to agriculture as we shall see later.

(2) The zone north of the central divide (Vemasse, Laga, Baucau, Quelicai) has rainfall from the end of November to March/April and a prolonged and severe, uninterrupted dry season for the rest of the year. Rainless periods from May to October at Vemasse and Laga are not exceptional.

(3) The central mountainous section of the Area[40]

[40] For this zone Ossu on the southward slope of the central range and Venilale north of the Larigutu Pass (1000 m) are representative, although because of their location on either side of the central range their rainfall pattern reflects to some extent that of the south and north coast respectively.

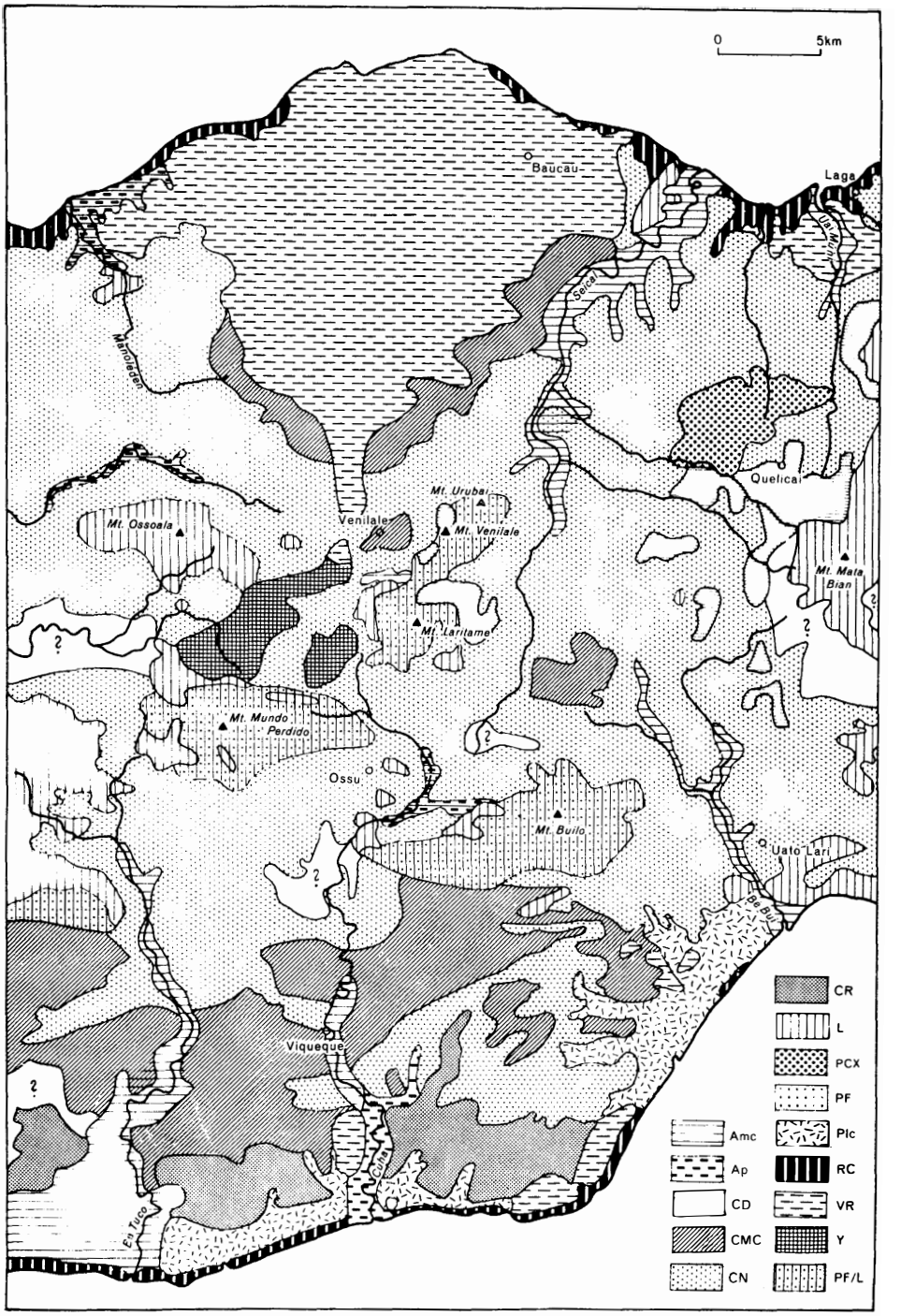


Fig. 15 Mean monthly rainfull of the Area

> assumes a transitory role between the monomodal rainfall type in the north and the bimodal one in the south in so far as a more or less continuous rainy season from November to July can be observed. The remaining months from August to October are dry.

From this rather rough differentiation, it is obvious that the seasonal incidence of rainfall is largely conditioned by altitude and exposure of the central mountain ranges to the moisture-bearing winds. These ranges lie at right angles to the prevailing winds - either northwest or southeast monsoon. Therefore, the north coast generally benefits more from the northwest monsoonal rains than the south coast.

On the other hand, the impact of the southeast monsoon, which has little chance of picking up moisture on its short trajectory across the Timor Sea, is felt most on the windward side of the mountains, while on the leeward side the southeast monsoon often arrives as a Föhn-like wind where it yields prolonged spells of dry weather of up to five months. The seasonal variation of the mean monthly rainfall is clearly reflected in the histograms of the eight rainfall stations (Fig. 15). The pronounced seasonal contrast is moreover underscored by Table 14 showing the mean monthly precipitation as a percentage of total annual rainfall. The concentration of rainfall in a few months is strongly emphasized when it is realized that nearly 90 per cent of the total annual rainfall falls from December to May in the north and December to June in the south.

A more comprehensive picture of the rainfall distribution throughout the year is given in Table 13 where a percentage frequency distribution of rainless days as well as of rainy days is plotted for specified limits. The high percentage of rainy days in the categories above 10 mm indicates that the high monthly amounts of rainfall during the respective rainy periods are chiefly the result of heavy and relatively frequent falls.

This is particularly true in the case of Ossu, Quelicai, Viqueque and Uato Lari, while the data for Baucau, Venilale and the coastal stations of Laga and Vemasse show a concentration of rainy days of the medium range between 1 and 10 mm for the rainy period.

The figures on Tables 13 and 14 reinforce the observation that in general the rain falls during relatively few

Table 13

Percentage frequencies of rainless days and rainy days within specified limits

mm	J	F	M	A	M	J	J	A	S	O	N	D
Venilale												
Nil	8	9	21	44	42	54	65	88	92	85	56	20
0.1- 0.9	25	23	23	20	27	21	15	6	3	7	18	20
1.0- 4.9	24	22	24	13	17	13	14	5	4	4	9	18
5.0- 9.9	11	14	8	8	5	5	2	0	1	1	5	12
10.0-19.9	14	13	9	8	4	3	2	1	0	2	5	11
20.0-29.9	8	9	7	3	2	2	11	0	0	1	2	7
over 30.0	10	10	8	4	3	2	1	0	0	0	5	12
Ossu												
Nil	37	37	46	51	41	48	55	80	90	89	74	44
0.1- 0.9	5	8	7	7	12	9	9	7	4	2	3	6
1.0- 4.9	16	15	15	16	17	19	18	8	3	3	9	14
5.0- 9.9	11	8	11	9	9	8	7	3	1	2	4	8
10.0-19.9	12	12	11	10	11	8	4	1	1	2	6	12
20.0-29.9	7	8	5	2	5	4	3	0	0	1	2	7
over 30.0	12	12	5	5	5	4	4	1	1	1	2	9
Baucau												
Nil	31	28	36	50	62	74	84	95	95	93	72	47
0.1- 0.9	16	13	14	13	14	9	7	3	2	3	7	11
1.0- 4.9	20	23	21	13	11	9	6	1	2	2	8	12
5.0- 9.9	11	11	12	8	5	3	2	1	0	1	4	9
10.0-19.9	9	10	9	8	4	3	1	0	1	1	3	9
20.0-29.9	5	7	4	4	1	2	0	0	0	0	3	6
over 30.0	8	8	4	4	3	0	0	0	0	0	3	6
Vemasse												
Nil	61	53	60	68	75	86	95	99	97	93	85	60
0.1- 0.9	7	9	6	3	4	1	1	0	1	1	2	5
1.0- 4.9	18	18	15	12	11	7	2	1	2	3	5	15
5.0- 9.9	5	4	10	8	5	4	1	0	0	2	5	11
10.0-19.9	6	8	5	6	4	1	1	0	0	1	2	5
20.0-29.9	2	4	2	2	1	0	0	0	0	0	1	4
over 30.0	1	4	2	0	1	0	0	0	0	0	0	0

	J	F	M	A	M	J	J	A	S	O	N	D
Laga												
Nil	53	48	57	70	75	81	90	98	99	95	77	57
0.1- 0.9	9	8	9	6	4	3	2	0	1	1	3	7
1.0- 4.9	15	18	15	12	11	6	4	2	0	2	9	15
5.0- 9.9	11	10	9	4	5	6	2	0	0	1	5	7
10.0-19.9	5	8	7	5	3	2	1	0	0	1	4	6
20.0-29.9	3	5	2	2	0	1	1	0	0	0	1	4
over 30.0	4	3	1	1	2	1	0	0	0	0	1	4
Viqueque												
Nil	40	40	52	50	40	52	55	79	90	90	78	58
0.1- 0.9	12	10	10	9	12	10	16	10	5	2	3	8
1.0- 4.9	16	20	13	18	17	18	15	6	3	3	12	12
5.0- 9.9	8	10	8	7	11	6	6	3	1	2	2	8
10.0-19.9	11	10	9	10	7	6	4	2	1	2	2	7
20.0-29.9	7	5	4	3	6	3	2	0	0	0	1	4
over 30.0	6	5	4	3	7	5	2	6	0	1	2	3
Uato Lari												
Nil	49	47	59	58	42	49	55	80	93	93	84	59
0.1- 0.9	5	7	6	4	6	5	6	4	1	0	2	5
1.0- 4.9	14	14	9	10	14	13	13	5	3	2	4	8
5.0- 9.9	10	8	8	7	8	9	10	5	1	2	4	8
10.0-19.9	10	11	8	9	12	9	8	4	0	2	2	9
20.0-29.9	5	6	4	4	5	4	3	2	1	1	2	6
over 30.0	7	7	6	8	13	9	5	0	1	0	2	5
Quelicai												
Nil	37	36	41	58	66	79	90	97	98	92	78	46
0.1- 0.9	3	3	4	2	3	1	1	0	0	0	1	0
1.0- 4.9	21	16	17	14	12	9	5	2	1	3	6	17
5.0- 9.9	8	15	9	9	7	3	2	0	1	3	4	11
10.0-19.9	13	15	15	7	5	5	2	1	0	2	4	11
20.0-29.9	9	8	7	4	4	1	1	0	0	0	4	5
over 30.0	9	7	7	6	3	2	0	0	0	0	3	10

Table 14

Mean monthly rainfall for eight stations as a percentage of total annual rainfall
(rounded up to the nearest full percentage)

Station	J	F	M	A	M	J	J	A	S	O	N	D	Dec.-May	Dec.-June
Venilale	19.0	19.0	16.0	8.0	5.0	4.0	2.0	1.0	0.0	1.0	7.0	18.0	85	
Ossu	16.0	14.0	13.0	11.0	11.0	9.0	4.0	2.0	0.0	1.0	7.0	12.0		86
Baucau	18.0	19.0	13.0	13.0	8.0	3.0	2.0	1.0	0.0	1.0	6.0	16.0	87	
Laga	15.0	17.0	12.0	15.0	9.0	6.0	2.0	1.0	0.0	0.0	5.0	18.0	86	
Viqueque	13.0	12.0	12.0	13.0	15.0	10.0	6.0	1.0	1.0	1.0	4.0	12.0		87
Uato Lari	11.0	10.0	9.0	13.0	16.0	16.0	8.0	2.0	1.0	1.0	4.0	9.0		84
Vemasse	19.0	17.0	13.0	13.0	8.0	4.0	3.0	1.0	0.0	1.0	6.0	15.0	85	
Quelicai	15.0	19.0	14.0	11.0	10.0	4.0	1.0	1.0	0.0	1.0	6.0	18.0	87	

Source: SMN, *O Clima de Portugal*, Fasc. XII, Prov. de Timor, Lisboa, 1965.

months of the year and in a few heavy showers. This feature of the Area's rainfall pattern is of considerable importance to plant growth and agriculture, as we will see later.

The character of Timor's climate and hence its impact upon agriculture is, however, not only evidenced by the seasonal distribution of rainfall. The degree of variability of annual and monthly rainfall, as well as the range of dates of the commencement and duration of the rains are also important.[41] The degree of variability is commonly measured by the standard deviation $\sigma = \sqrt{\bar{z}(x-\bar{x})^2}$ The standard deviation divided by the mean yields the coefficient of variation. Table 12 shows the deviation of the mean annual rainfall expressed by the standard deviation as well as by the coefficients of variation. On the basis of these figures it becomes clear that all lowland stations, on both the north and south coasts, such as Vemasse, Laga, Viqueque and Uato Lari, are characterized by a relatively high degree of variability, with coefficients of variation averaging over 23 per cent with a maximum of 28.3 per cent for Uato Lari. The respective figures for the remaining stations, on the other hand, are lower and range between 16.2 per cent for Baucau and 20.1 per cent for Quelicai.

As can be expected, throughout the Area the variability of annual rainfall is markedly lower than that for the individual months, as shown in Table 15. In general, the figures of Table 15 confirm the affirmation that variability increases as the amount of rainfall decreases. Moreover, increasing seasonality (i.e. on the north coast) is positively correlated with increasing monthly variability.

The great variability of the monthly rainfall distribution implies that vast differences exist in the date of commencement and duration of the rainy period. Rains normally begin in November when the ITC passes Timor on its way south. Occasional thunderstorms mark the onset of the northwest monsoon.

On occasion, November and the first half of December remain rainless. However, more often than not, after a short rainy spell of three to four days late October early

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[41] The actual duration of the rains will be discussed below under the heading 'Availability of water' (p.75).

Table 15

Coefficients of variation of monthly rainfall (in %)

Station	J	F	M	A	M	J	J	A	S	O	N	D
Venilale	24.8	42.8	44.2	60.3	104.7	89.0	133.6	271.7	178.0	103.6	96.0	41.3
Ossu	24.7	30.6	51.5	52.8	58.6	71.1	95.3	236.0	258.5	119.4	108.4	34.5
Baucau	50.7	37.2	42.7	59.8	90.3	113.5	142.1	324.7	291.4	105.0	115.6	44.6
Laga	57.6	43.0	42.5	52.5	95.1	124.0	159.4	388.4	229.0	191.4	94.1	65.4
Viqueque	49.7	52.9	63.4	54.0	52.8	76.2	113.6	77.6	163.4	190.8	162.7	51.3
Uato Lari	41.1	32.8	47.2	48.1	59.0	71.8	75.0	159.8	159.8	146.9	105.8	50.6
Vemasse	56.9	58.4	45.2	67.8	98.2	122.9	222.2	251.0	160.5	148.5	111.4	56.4
Quelicai	21.1	34.8	41.0	59.2	94.9	94.5	240.4	261.0	273.4	98.9	94.5	31.7

November, the dry period continues until the end of December. What that means for the Timorese peasant can be illustrated by the incidents of 1969 when brief rainy spells interrupted by dry periods of several weeks occurred in the Baucau-Venilale-Quelicai area. After a couple of rainy days at the end of October most of the peasants went out to their fields to sow Timor's staple crop, maize. However, a dry period of several weeks followed, and the crop failed. This incident was repeated in late November. Finally, around the middle of December 1969, the rain lasted for a sufficient length of time. Since the amount of seed available is usually limited to a single sowing, temporary setbacks caused by climate tend to be synonymous with hunger since the peasant is unable to cultivate his fields fully. Moreover, many irregularities occur with respect to the course and the length of the rainy season which is frequently interrupted by dry spells of several weeks.

The utter unpredictability - and thereby the futility to express the Area's rainfall pattern truly by means, medians, quartiles and deciles - is demonstrated in Fig. 16.[42] The curves show the accumulated weekly rainfall values for selected frequencies (4th to 9th decile) for Venilale, Although only 50 per cent of all values have been represented, the range between 16 mm and above 650 mm is already tremendous.

Another feature of Timor's climate is the high intensity of the rainfall. From the percentage frequencies of Table 13 one obtains an idea of the variation of seasonal intensity. This table suggests that the rainfall intensity generally varies more or less proportionately with rainfall distribution throughout the year. The erratic intensity of rainfall during the dry months is due to the distorting effect of a few heavy daily falls on the mean values for certain periods.

Table 16 further emphasizes this high degree of intensity, showing the maximum amounts of rainfall in 24 hours. The northern coastal station of Laga clearly shows the highest figures with over 500 mm in 24 hours; daily rainfall maxima of over 100 mm were registered at all of the eight stations at different times of the year. Annual average rainfall for Laga was only 802.1 mm 1953-70).

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[42] The curves for the remaining seven stations show similar features and have therefore been omitted.

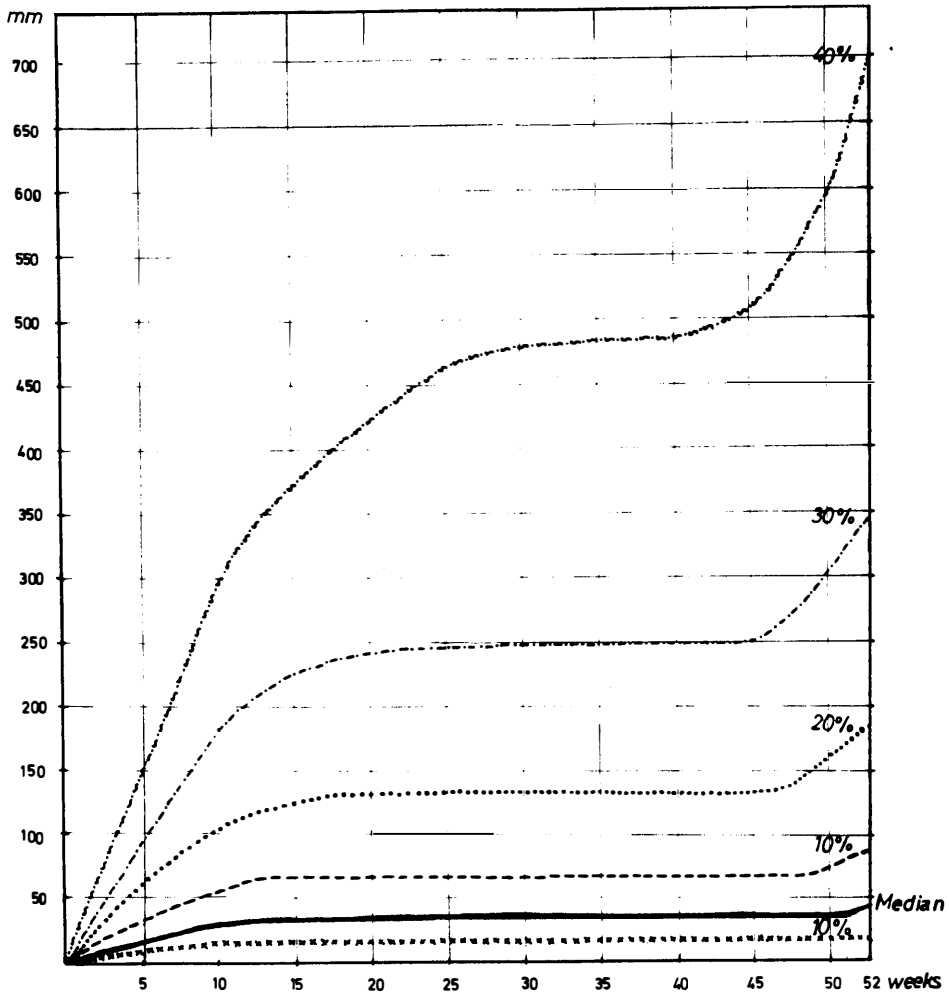


Fig.16 Accumulated weekly precipitation according to specified probability classes, Venilale, 1953-70

Table 16

Maximum amounts of rainfall in 24 hours

Station	J	F	M	A	M	J	J	A	S	O	N	D
Venilale	139.1	200.5	122.5	117.5	145.0	73.5	91.0	102.4	30.2	58.2	96.0	119.0
Ossu	101.6	103.0	97.8	242.0	154.0	130.0	111.8	126.0	36.0	60.4	140.0	104.0
Baucau	150.3	83.6	103.7	100.6	185.0	48.0	27.0	81.5	61.1	21.7	78.2	125.9
Laga	351.7	508.7	225.7	252.6	249.4	120.8	147.6	73.0	6.7	27.3	156.7	398.4
Viqueque	188.1	147.2	122.0	160.0	165.7	163.5	123.7	59.0	67.0	63.0	200.0	92.0
Uato Lari	90.5	108.5	159.8	148.0	186.5	202.3	160.0	306.5	35.5	43.0	87.5	124.5
Vemasse	150.0	75.0	64.0	71.0	78.0	24.2	40.0	72.8	14.5	40.0	44.0	65.0
Quelicai	148.5	116.0	79.4	88.2	115.0	79.2	32.0	18.0	25.0	38.0	88.0	130.4

Source: SMN, *O Clima de Portugal*, Fasc. XII, Prov. de Timor, Lisboa, 1965.

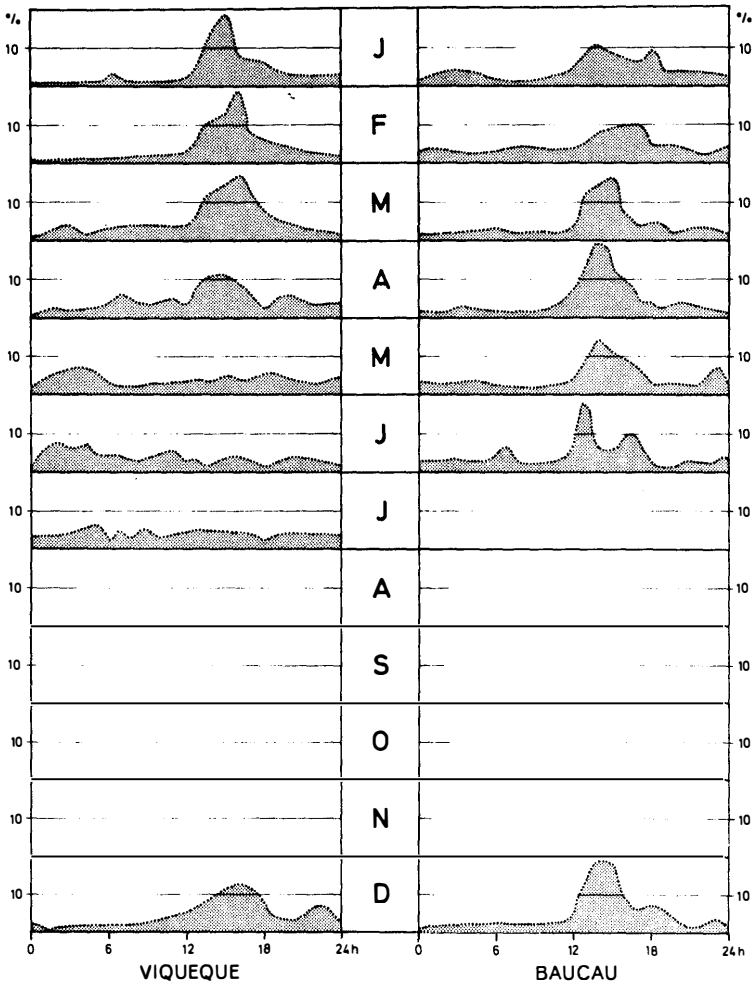


Fig. 17 Diurnal rainfall variation, Viqueque and Bacau. Percentages denote occurrence of rain at hourly observations. Observation period 1957-69
Source: SMT monthly observations sheets.

For agricultural purposes the diurnal rainfall distribution is also of importance. Hourly rainfall gauges are available only for Baucau and Viqueque for which the diurnal rainfall distribution as a percentage of the average monthly rainfall is illustrated in Fig. 17. Rainfall intensity is highest between 13h and 17h at both stations throughout the year.[43] Surprisingly this indicator suggests neither temporal nor regional differences.

While the distribution and variability of rainfall present some systematic differences in the three major physiographic units, no clear zonal pattern could be ascertained for the intensity and probability of rainfall, both of which are important from an agronomic point of view. Longer periods of recording are needed to permit more accurate statements.

Availability of water

The preceeding section has yielded some first insights into the nature of Timor's highly variable climate. However, neither the actual rainfall nor its distribution is the paramount factor controlling plant growth and crop production. Rather, it is the temporal and quantitative availability of water in the soil. To measure the latter, rainfall has to be balanced against withdrawals of water through evaporation from the soil, transpiration by the vegetation, runoff and percolation. (The availability of water is thus obviously also dependent upon wind speed and air humidity.) The determination of this so-called water balance is particularly important for areas like ours where no stored water for irrigation is available. Consequently, the cultivation of crops is restricted to the wet season. Careful timing of agricultural operations is a prerequisite for efficient use of the rainfall during the development of the crop.

In full recognition of the importance of determining soil moisture conditions relative to plant growth, an attempt has been made at assessing the water balance.[44] For this a slight modification of the method developed by Slatyer.

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[43] Except from May to July at Viqueque when rainfall is fairly evenly distributed over the day.

[44] The author is particularly grateful to Mr John McAlpine of CSIRO Division of Land Use Research in Canberra who enabled the calculation of Timor's water balance data to be calculated by CSIRO computer.

(1960:App. 35-9) was chosen. This has the advantage of assessing the growing period characteristics on a week by week basis. It was successfully applied in northern Australia, in an environment similar in many respects to that of parts of Timor. The method is considered generally applicable to most annual crops with rooting habits and soil properties allowing up to 100 mm of stored water to be utilized. The assumed soil water storage capacity would correspond to a compact heavy clay roughly one metre in thickness (i.e. soils derived from Bobonaro Scaly Clay).[45] It must be pointed out, however, that storage capacity varies with the texture and structure of the soil and that 100 mm serves only as a rough yardstick for average soil conditions in the Area.

It is further assumed that actual evapotranspiration (E_t) is related to potential evapotranspiration (E_o)[46] by the relationship $E_t/E_o = 0.8$ for those weeks with moisture storage plus rainfall exceeding 50 mm, and $E_t/E_o = 0.4$ below this level. This assumption is based upon the principle of decreasing evapotranspiration as available water is reduced. This so-called 'crop factor' of 0.8 again only represents average conditions, corresponding, for example, to pasture growth. It is clear that this ratio varies with the type of crop, as well as during the growing period.[47]

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[45] As calculated by the U.S. Soil Conservation Service.

[46] Evaporation data obtained from Piche evaporimeters (available for four of the eight meteorological stations in our Area) were not considered appropriate and reliable enough for our purpose. This was confirmed by Prof. G Stanhill, WMO Specialist for Agroclimatology (pers. corr.). Recourse to Fitzpatrick's method (1963) of estimating Australian standard tank evaporation on a weekly basis had therefore to be made. Evaporation loss varies - according to this method - between 22.9 and 41.2 mm/per week for Baucau; 19.0-39.6 mm for Viqueque; 15.7-35.8 mm for Ossu and 21.1-37.1 mm for Laga.

[47] Crop factors for various crops and for various soil types during the growing period are discussed in several articles in R.M. Hagan *et al.* (eds), 'Irrigation of agricultural lands', *Agronomy* 11, Amer. Soc. of Agronomy, Madison, Wisc., 1967. Herein also annual E_t/E_o ratios for forest environments are given by H.C. Pereira, 'Effects of land use on the water and energy budget of tropical watersheds', idem. pp. 435-55.

Finally, the assumption is made that, once the ground is saturated with water, any rainfall in excess of the assumed soil moisture storage capacity (100 mm) would tend to run off or percolate.[48] The method may tend to underestimate evapotranspiration when the upper parts of an otherwise dry soil profile receive rains of less than 50 mm, and overestimate it during weeks without rainfall when stored water in the upper profiles is nearing depletion. These variations, however, are considered as being of little significance in the general assessment over a number of years.

Since weekly evaporation data could only be estimated for four of the eight stations (Laga, Baucau, Ossu, Viqueque), Slatyer's slightly modified water balance method was consequently applied only to these four stations which fortunately are representative of the major environments in the Area.

The mean weekly changes in soil moisture level have been computed by the application of this method for the years of record and are illustrated in Fig. 18. These four curves reflect the different seasonal rainfall pattern of the north and the south coasts. According to these curves showing average conditions at the four stations, none reaches its full soil moisture storage capacity of 100 mm at any time of the year.

The curves of Ossu and Viqueque reflect the bimodal rainfall pattern (with high levels of saturation from December to July) and the monomodal rainfall pattern of Laga and Baucau (with high storage levels from December to April).

These curves, however, only reflect average conditions. The variation of soil moisture storage as expressed in medians, upper and lower quartiles is needed to determine the risk for plant growth and crop production. These curves are illustrated in Fig. 19. While short irregular spells of rain tend to push up the average figures as seen on Fig. 18, median values convey a much more accurate impression of actual conditions. Thus while at Laga the median curve remains well below maximum capacity, the further south and the higher we go in altitude, the longer the period during which soil moisture storage remains at full capacity level: at Baucau from January to April; at Viqueque from January to

[48] This is of course a simplified assumption as it is realized that actual runoff depends on rainfall intensities for very short intervals.

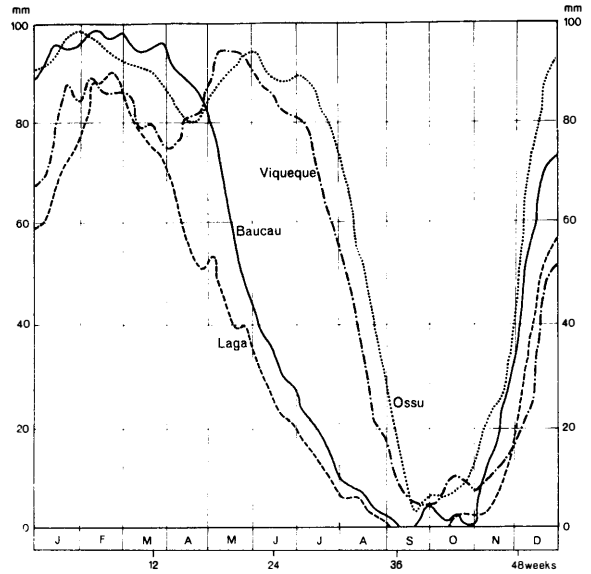


Fig. 18 Mean weekly soil moisture storage

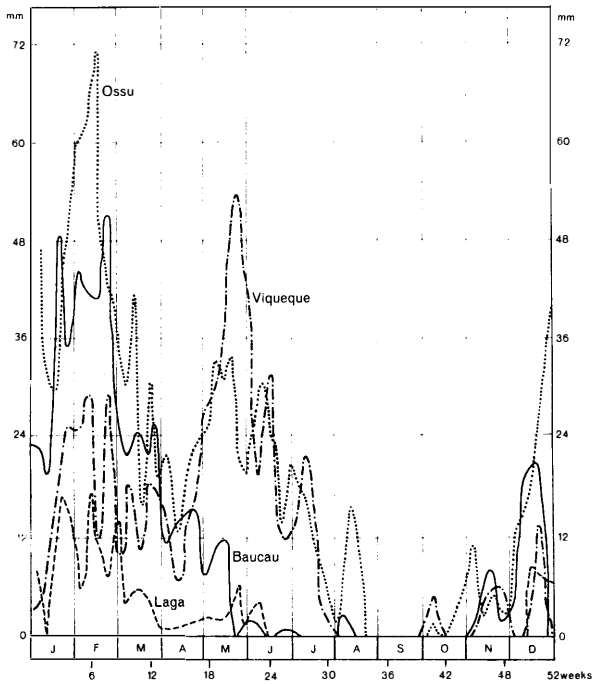


Fig. 19 Mean weekly runoff

March and May to June; at Ossu from December to April and May to July.

Conversely, the period during which the soil is completely dry decreases as we go south, at Laga June to November, Baucau July to November, Viqueque September to December and Ossu October to December.

For agricultural purposes the length of the potential growing period is of major concern. The definition of such a growing period is, of course, contingent upon the type of crop to be grown. One example may demonstrate the usefulness of Fig. 19. Assuming that plant growth can only take place if at least 50 per cent (= 50 mm) of the assumed maximum soil moisture storage capacity has been reached, the characteristics of such a 'growing period' are demonstrated on Table 17. Considering only the median values, the length of the 'growing period' so defined ranges from 16 weeks at Laga to 37 weeks at Ossu, more than twice as long. Those for Baucau and Viqueque are 23 and 31 weeks respectively.

One should, however, always bear in mind that intra-seasonal water stress can be expected, as indicated by the substantial deviations of the lower quartile curves from the median curves in Fig. 19. This might result in an early termination of crop development.

In the analysis of the water balance the importance attributed to 'runoff'[49] has been emphasized. Short intense rainy spells will lead to either runoff, which might entail erosion, or, in the absence of through-drainage, to water-logging. On the other hand, runoff might have beneficial effects, as in the case of deep soils having a storage capacity above the assumed 100 mm level, where it might enable long-rooted perennial crops to grow. Above all, runoff might be utilized as a source of irrigation whereby the water can be more evenly distributed over the year for agricultural purposes. As such, the growing period would be extended, or continuous crop production would be made possible. Given the assumptions of our water balance method, the scope of this potential is evidenced in Table 18. The distribution of the runoff over the year is shown on

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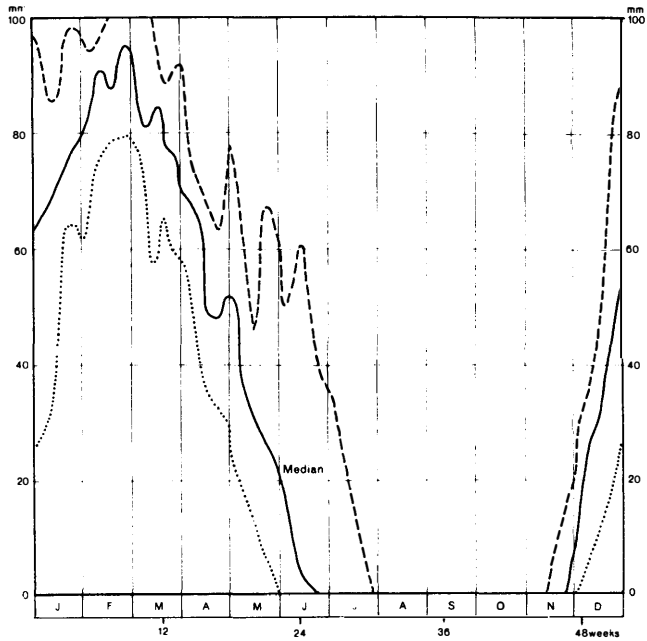
[49] i.e. water in excess of the assumed storage capacity.

Table 17

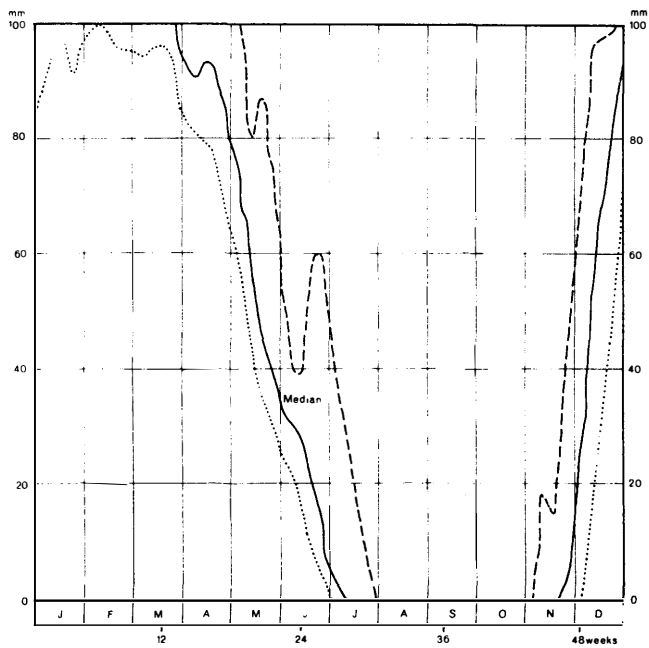
Characteristics of 'Growing Period'

	Commencement of 'Growing Period'	End of 'Growing Period'	Duration of estimated 'Growing Period'* (weeks)
Laga			
Median	25 December	15 April	16 Median
Lower quartile	11 December	8 April	21 Maximum
Upper quartile	15 January	13 May	12 Minimum
Baucau			
Median	11 December	20 May	23 Median
Lower quartile	20 November	15 May	28 Maximum
Upper quartile	18 December	3 June	21 Minimum
Ossu			
Median	4 December	20 August	37 Median
Lower quartile	13 November	6 August	41 Maximum
Upper quartile	11 December	27 August	34 Minimum
Viqueque			
Median	1 January	30 July	31 Median
Lower quartile	18 December	15 July	34 Maximum
Upper quartile	1 January	13 August	28 Minimum

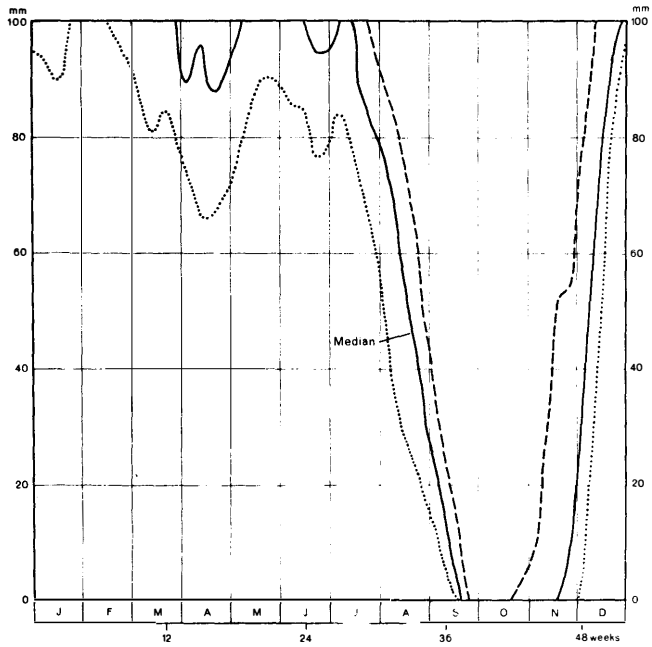
* Maximum: Upper quartile (commencement) to lower quartile (end of growing period).
Minimum: Lower quartile (commencement) to upper quartile (end of growing period).



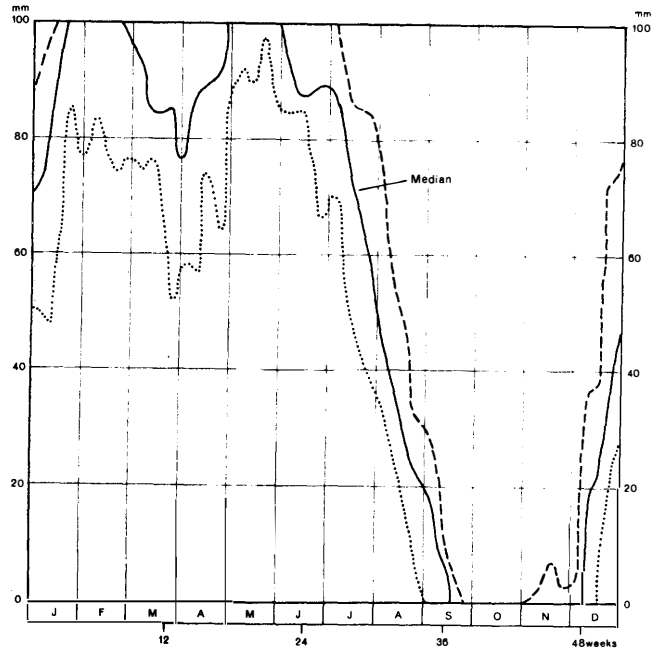
LAGA 65 m



BAUCAU - AIRPORT 527m



OSSU 688 m



VIQUEQUE 46m

Fig. 20 Median, lower quartile and upper quartile of soil moisture storage, Laga, Baucau - Airport, Ossu and Viqueque

Table 18

Total runoff per year (mean) and length of time (in weeks) during which runoff occurs

	Runoff per year (mm)	Weeks during which runoff occurs
Laga	177.3	5.2
Baucau	615.2	13.7
Viqueque	658.5	12.8
Ossu	1086.5	20.8

Fig. 20.[50] This partially reflects the rainfall pattern for these four stations. Runoff at Laga is very low and only exceeds the 10 mm mark in January and beginning of February. The figures for Baucau, however, reveal that maximum runoff occurs during the 8th week (19-25 Feb.) with 51.9 mm, while around the 20th week (14-20 May) no more sizeable runoff takes place until the 50th week (11-17 Dec.). The curve for Viqueque shows a maximum runoff during the 21st week (22-27 May) with 54.3 mm and no more runoff from the 30th week (23-30 July). Hardly any measurable runoff occurs here before the end of the year. The highest oscillations are, of course, to be found in Ossu, particularly at the beginning of February (6th week: 5-11 Feb.) with 71.2 mm. No runoff occurs between the 33rd week (14-20 Aug.) and 45th week (6-12 Nov.). The skewed rainfall distribution in conjunction with the considerable amounts of runoff suggests possibilities for irrigation.

Temperature

Timor occupies, as we have seen, a transitional position between humid 'Island Southeast Asia' and dry Central

[50] The apparent anomaly that runoff can occur (Fig. 20) in weeks in which soil moisture (Fig. 18) is less than maximum soil moisture storage (100 mm) results from arithmetic averaging of the actual weekly soil moisture storage. In reality the weekly runoff which has been averaged (Fig. 20) has occurred only in those weeks in which actual weekly soil moisture storage has exceeded 100 mm.

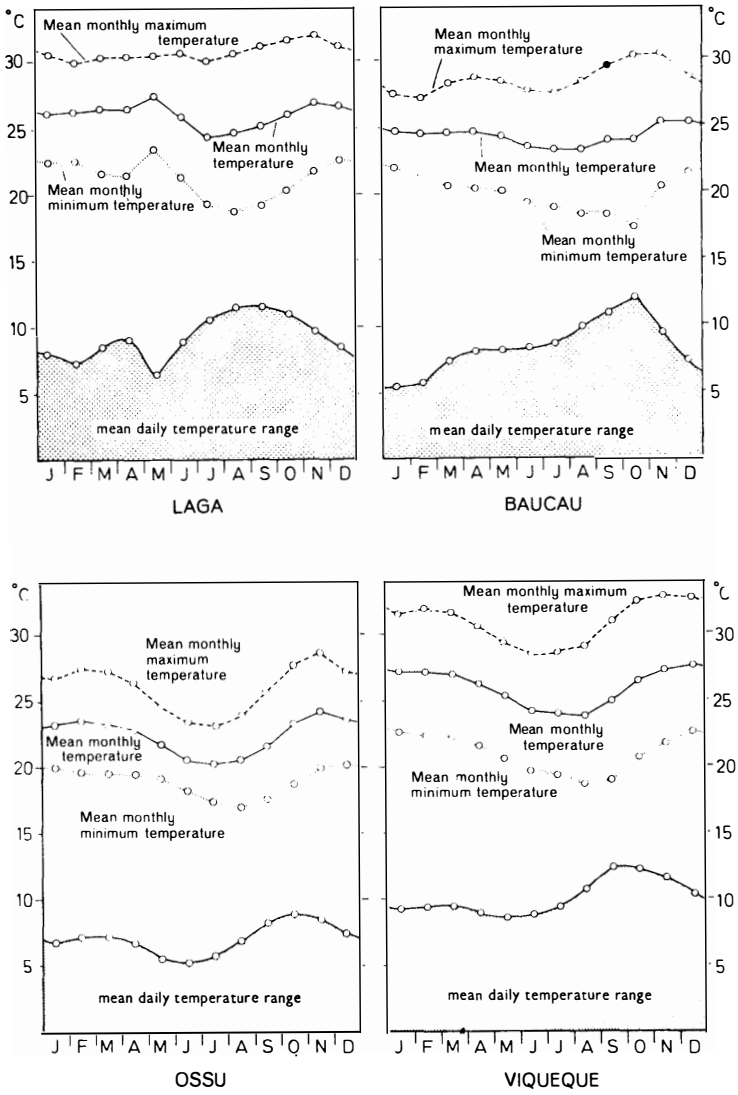


Fig. 21 Mean monthly temperature (minimum and maximum) for Laga, Baucau, Ossu and Viqueque

Years of observation: Laga 1931-41, 1953-63
Baucau 1917-41, 1951-63
Ossu 1917-41, 1952-63
Viqueque 1916-41, 1957-63

Source: SMN 1965.

Australia. This transitional position is clearly reflected in annual as well as daily temperature ranges which are significantly greater than in other parts of the archipelago nearer to the equator.

Extended temperature records are only available for four of the eight stations - i.e. Laga and Baucau in the north, Ossu in the central mountain range, and Viqueque on the south coast. These four stations, being relatively well distributed over the Area, enable us to get a fairly good idea of the major temperature characteristics. These are shown on Fig. 21. The annual temperature range (i.e. difference in the average temperature of the coldest and the warmest month of the year) hovers around 2.2°C for Baucau, 2.8°C for Laga and 3.8°C for Viqueque, and 3.9°C for Ossu.

The diurnal temperature range is high throughout the Area with a marked maximum during the dry period, i.e. July to October/November on the north coast (Laga and Baucau), and August/September to November/December in Ossu and Viqueque. Baucau and Viqueque show the greatest diurnal range with 12.3°C (October) and 12.0°C (September) respectively.[51] During the Southeast monsoon the nights and early mornings can be unpleasantly chilly. In general, temperature is not likely to be regarded as inhibiting plant growth although it certainly does slow down crop production (e.g. coconuts, maize, hill rice, etc.) in the central upland.

Humidity

High humidity is characteristic of our Area in all seasons. Throughout the Area[52] the mean annual relative humidity generally averages from 72 per cent for Laga to 79 per cent for Ossu. There is some seasonal variation; the highest humidity is reported from December to March (Laga and Baucau) and May to July (Ossu and Viqueque), while the lowest values are reported for September (Laga, Baucau) and from September to November (Ossu and Viqueque). Diurnal variation is more pronounced than seasonal variation. Throughout the lowlands relative humidity reaches its maximum level at sunrise, and is still high at 8a.m.,

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[51] For comparison: the daily temperature range in Djakarta is only 9.1°C (September) (cf. Ormeling 1955:14).

[52] Relative humidity is recorded only for Laga, Baucau, Ossu and Viqueque.

between 72 and 77 per cent. As the day warms up, it decreases to a minimum in the early afternoon (2p.m.) to 63-74 per cent, and increases again at 8p.m. to 79-88 per cent as the temperature falls.

Wind speeds

Wind speeds[53] are generally light to moderate throughout the Area. The diurnal variation in wind speed is marked at coastal stations due to the land- and sea-breeze effect. Mean velocities are generally 2.6 to 11.7 km/h, with Ossu showing the lowest, and Baucau the highest, values. At Baucau, where the highest wind velocities of Portuguese Timor occur, velocities of 45 km and more per hour are said to be no exception (Ormeling 1955:14). Timor is, moreover, subject to tropical cyclones which originate in its vicinity and in the Banda Sea. These storms are usually in an early stage of development and therefore not very intense. Soon after their genesis, they normally move out of the Timor Region in a southwesterly direction. Their frequency is about one per year, most often in April. Although they are normally not severe, on occasion the centre of the storm, with its strong winds, hits the island (Ormeling 1955:15). Heavy rainfall usually accompanies these tropical cyclones.

Sunshine

Before concluding these comments on the chief climatic characteristics of the Area, we must analyse briefly the mean duration of sunshine - i.e. the so-called photoperiod during which photosynthesis can occur. Data have been recorded for Baucau and Viqueque (Table 19), which reflect the seasonal contrast of the rainfall pattern. The number of hours of sunshine as a percentage of the possible total number of sunshine is, of course, lowest during the rainy season in January (41 per cent for Baucau and 46 per cent for Viqueque) and highest during the dry period (September/ October with 83 per cent for Baucau, and October with 79 per cent for Viqueque).

Climate and landscape

The strong seasonal contrasts in Timor's climate are reflected in the landscape. During the dry season the

[53] Wind records are available only for Baucau, Ossu and Viqueque.

Table 19

Monthly mean hours of sunshine as a percentage of total possible sunshine hours, Baucau and Viqueque

	Baucau		Viqueque	
	Hours of sunshine	In % of total possible hours	Hours of sunshine	In % of total possible hours
January	158.6	41	174.6	46
February	150.7	44	166.6	48
March	214.7	57	211.3	57
April	205.8	58	202.0	58
May	252.5	70	189.2	54
June	227.9	71	167.3	49
July	263.1	74	205.0	58
August	296.4	82	261.8	70
September	299.2	83	267.6	74
October	312.1	83	295.4	79
November	302.8	72	286.3	77
December	203.5	54	219.4	57

Source: SMN, 1965.

landscape of the Area is parched except for the few evergreen forests on the crests of the central mountains; the trees have shed their leaves. Nature appears to be dormant. All rivers dry up completely thereby affording avenues for local traffic, with the exception of the Rivers Cuha and Seiçal which still maintain a trickle of water even during the dry period. The heavy clay soils (CN) which cover extensive parts in the Area crack wide open. On account of the relatively large diurnal temperature range mechanical weathering is particularly severe during the dry period. The comparatively unprotected ground is, moreover, subject to wind erosion as wind speeds are highest in the summer months (May to October), particularly on the dry north coast. The dry season is, however, also the time of reduced relative humidity. Thus, refreshingly cool nights, particularly at Viqueque, and brisk mornings make horseback riding across rolling savanna land an unforgettable experience.

The erratic character of Timor's climate constitutes a serious hazard to Timorese agriculture. The degree of dependence upon the climate is particularly marked at so low a level of development where shifting cultivation, or rather bush fallowing, is still the prevailing form of agriculture. Lacking irrigation facilities for the production of maize, Timor's staple crop, the Timorese peasant is entirely dependent upon the short rainy season. Therefore, he has to use the dry season for preparing his fields by cleaning up and burning off his clearings. The freshly cut trees and shrubs have to dry for a number of weeks before they can be burned. Burning (sunu rai) usually takes place in August/September until the beginning of October. In this period dust and smoke fill the air. After two to three consecutive days of rain, accompanied by thunder and lightning in November/December, everybody heads for the fields to get the dryland crops planted.

The low degree of reliability with respect to the beginning and duration of the rainfall makes Timorese agriculture a gamble. If the rains arrive earlier than anticipated, the fields have not yet been cleaned. In the case of long dry spells during the rainy period the crops are destroyed. Hunger is the unavoidable consequence of a lack of food reserves.

The dry season also provides serious problems for animal husbandry, particularly on the north coast. The nutritive value of the withered grass is very low, and

CLIMATE

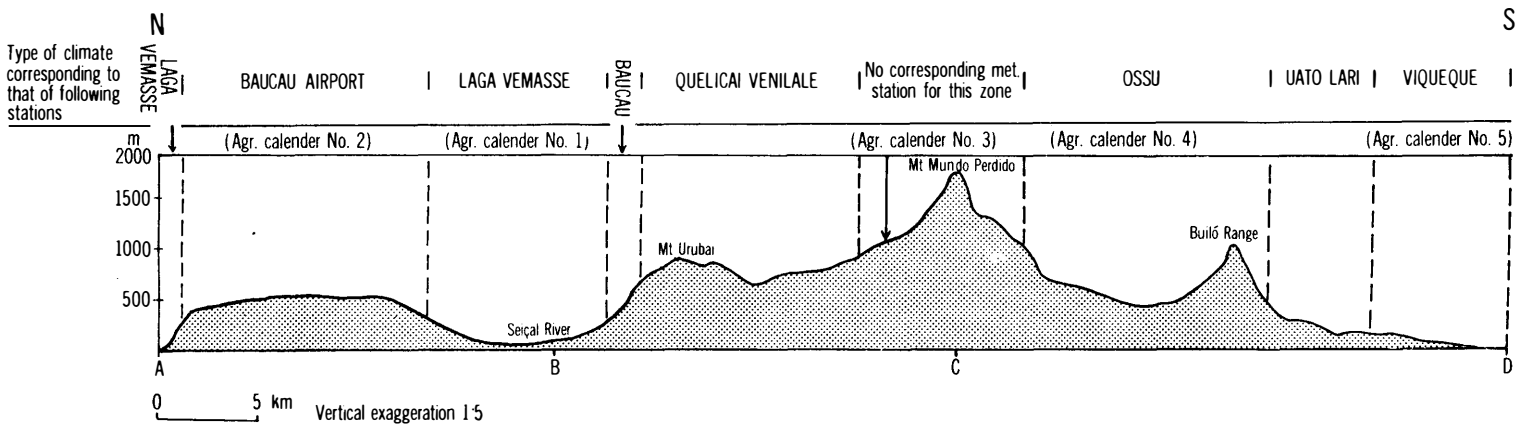


Fig. 22 Climate along profile

supplementary feeding of hay and silage is virtually unknown in the Area. Therefore the livestock usually lose considerable weight, and a sizeable number of young livestock die of hunger. To some extent livestock is either driven to the perennial rivers (Cuha and Seiçal) or to the mountains (e.g. Larigutu Pass). It is apparent that at this stage of development climate constitutes a limiting factor for the carrying capacity of the pastures.

With the onset of the rains the change in the landscape is amazing. The brownish, dried-up savannas turn into fresh tree-studded 'parks'. The air becomes clear and the rivers fill up. As a consequence of the torrential rains, however, water erosion sets in. The heavy clay soils turn into quagmires and landslides are now common. The degree of erosion is evidenced by slumping, landslides, dips, and soil creep, as well as by great quantities of coarse material carried downstream by the major rivers. The deposition of the rubble in the riverbeds results in numerous sand and gravel bars. Thus, braided rivers with wide rubble beds are typical of Timor in general and the area under investigation in particular.

Vegetation

In discussing Timor's vegetation one must first think of the island's position between humid Island Southeast Asia and dry central Australia. As a result of this transitional position the vegetative pattern of the island is characteristic of both Southeast Asian and Australian elements interwoven in such a way that the distribution of these elements is chiefly the result of the marked regional climatic contrasts. Rapid transitions of the vegetation over relatively short distances are therefore closely correlated with the orographically induced rainfall regime described in the previous section. Moreover, the vegetative characteristics which occur within the Area do suggest a considerable degree of adaptation to local differences in the length and severity of the drier season. The visitor coming from either humid Indonesia or dry Australia is therefore usually fascinated by the extremely colourful mosaic of vegetation. This ranges from scrub and thickets dominated by xerophytic shrubs and a few low gnarled trees in the driest sections of the north coast, to tree savannas dominated by either palms, eucalypts, acacias or casuarinas. These fade locally into low or tall grass savannas in the moist sections of the foothills on both

sides of the central divide. On the other extreme, this mosaic of vegetation extends all the way to the wet tropical montane rain and cloud forest on the crests of the central ridges. Apart from these regional differences, the strongly pronounced seasonal contrasts in vegetation, characterized by a lush green carpet during the rainy season, changing to a scorched brown landscape during the dry season, make the study of Timor's vegetation a fascinating task.

It would, however, not be fully correct if we attributed the wide range of vegetative characteristics of the Area solely to climatic differences. In fact, a very high proportion - probably as much as 90 per cent - of the vegetation of the Area has been modified by man. As a consequence of repeated cutting, burning, cultivation and grazing it is hard to recognize the distribution of the natural vegetation today. More specifically, fire has to be considered the major factor determining the distribution of plant communities. Grass fires occur at frequent intervals throughout the Area up to an altitude of about 800 m and occasionally at higher altitudes. Most of these fires are started intentionally by the Timorese during the dry period to obtain new grazing material by burning off old unpalatable grass or to drive game during hunting, particularly on the tall grass plains of the south coast (cf. Friedberg 1969). Fire is, however, used predominantly by shifting cultivators to clear land for cultivation. Freshly burned plots have been observed at altitudes of up to 1200 m on both sides of the Mundo Perdido Range.

As a result of this intense interference with nature, there is little non-forested land under 1200 m which has not been burned over at least once during the last 20 years, and in many places once in less than ten years. The only areas spared from these fires have been sacred groves, so-called lulik[54] groves, which are located around springs, and the crests of the ridges which have suffered least from man's destructive action and hence still support remnants of primary vegetation. Above 1200 m the fire hazard is reduced because climatic conditions are too cold and wet. However, the forest remnants below that altitude are threatened because under dry conditions grass fires, whether started by 'match-happy' Timorese (as is often the case) or by lightning, can endanger the entire landscape. The fires usually burn

[54] For the wider meaning of this term see article by Pascoal (1949).

uncontrolled, and quite often not only native coconut plantations but also houses and hamlets become their victim.

Plants vary in their tolerance to fire. While evergreen and semi-evergreen species often succumb to fire, deciduous savanna trees and associated grasses show varying degrees of resistance. Thus, fires have brought major changes in the vegetative pattern of the Area. As a result, the so-called 'fire-climax' vegetation dominates the plant life of today.

Before attempting to analyse the Area's vegetative pattern it seems useful to review the previous botanical work that has been done on the island. A comprehensive account of the botanical exploration on Timor has been given by Gomes (1950d). Among the first travellers who brought botanical material back to Europe were Dampier who visited the island at the end of the seventeenth century, and Bligh of the Bounty after his adventurous voyage in an open canoe from Tonga through the Torres Strait to Timor. Since both travellers had botanists among their crews, small plant collections of the littoral flora were made and later deposited at the herbaria of Kew and Paris. These and many other botanists who followed, among them Riedlé (in 1803), Cunningham (from 1818 to 1819), Reinwardt (in 1822), Zipelius (in 1828) and Teysmann (1830),[55] are said to have visited only the western, Indonesian half of the island. Only Wallace (from 1857 to 1860) and Forbes (from 1882 to 1883) are known to have carried out botanical studies in Portuguese Timor before the first Portuguese José Gomes da Silva dedicated himself to the Timorese flora in 1887 (see Wallace 1874; Forbes 1885). Wallace's investigations on Timor, although concerned basically with the fauna of the island, were part of his studies of the Malay Archipelago which later gave rise to his theory on the dividing line (later called 'Wallace Line') between the Southeast Asian and Australian fauna and flora.

Though these theories have since been abandoned, they nevertheless exerted a strong influence and induced further research in that part of the world. During the four months that Wallace spent in Portuguese Timor he made a small collection of grasses and was struck by the similarity of the vegetation of Timor's north coast with that of northern Australia.

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[55] See also plant lists by Spanoghe (1841) and Decaisne (1834).

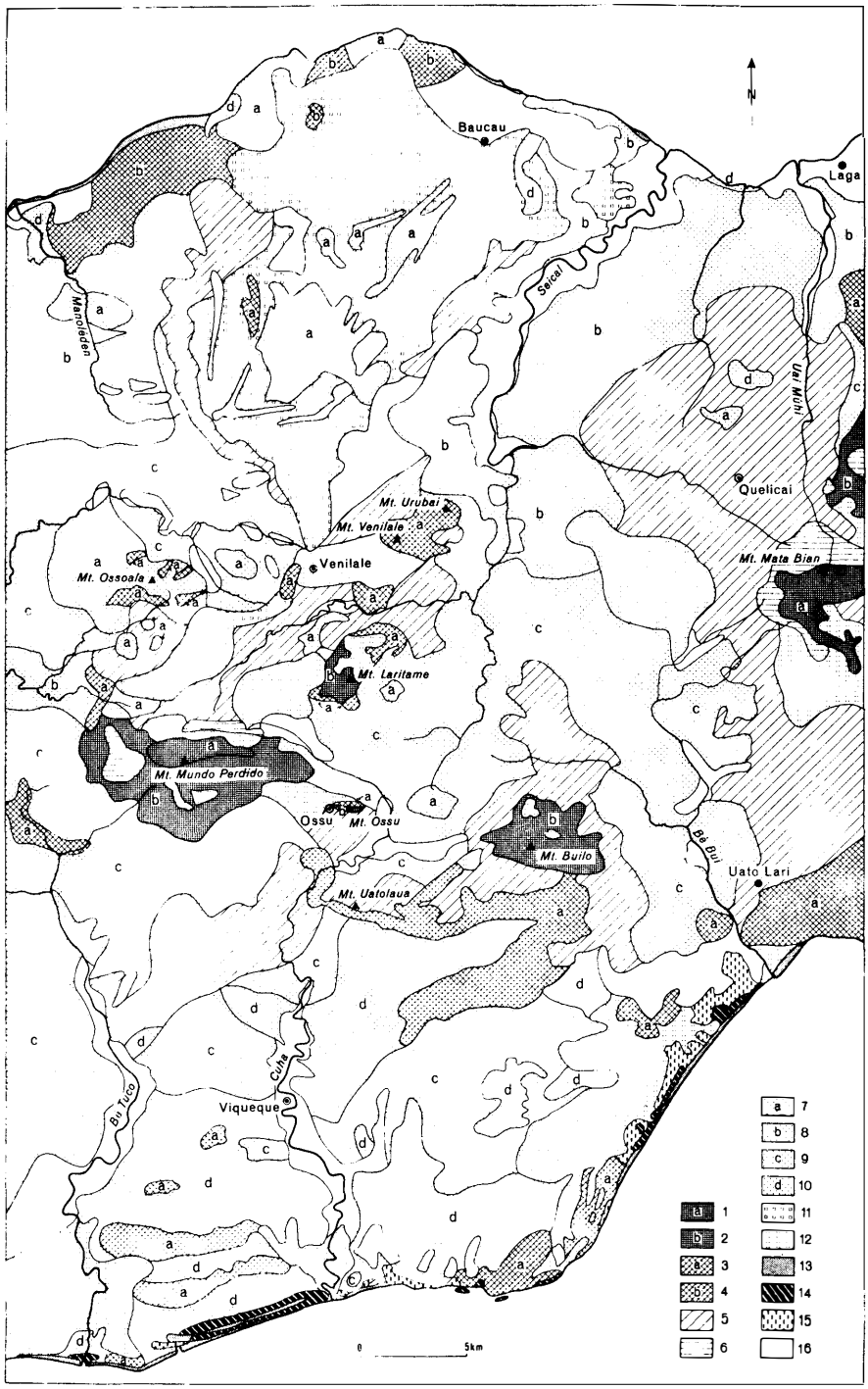


Fig. 23 Present vegetation of the Area

Legend to Fig. 23

1. Tropical montane cloud forest
2. Medium altitude moist evergreen forest
3. Semi-deciduous forest
4. Largely deciduous forest
5. Forest-savanna mosaic
6. *Eucalyptus urophylla* woodland
7. *Eucalyptus alba* savanna
8. Acacia savanna
9. Casuarina savanna
10. Palm savanna and palm woodland
11. Scrub
12. Grassland
13. Beach vegetation
14. Mangrove
15. Swamp forest
16. Cultivated area

Note: Riparian forest and thickets have been omitted for reasons of scale.

One of the most valuable contributions to the knowledge of the flora of Portuguese Timor was made by Forbes (1885). To him we owe the first detailed description of the vegetation of a north-south transect across the island. From Dili, where he arrived in December 1882 he went to Manatuto on the north coast, half way between Dili and Baucau. From there he turned south, crossed the central ridge at Barique and Turiscai (see Fig. 2), and finally reached the south coast near Luca, circunscrição of Viqueque, within our study area. When crossing the island in roughly a north-south direction, he stopped at eleven places where he made extensive plant collections. Notwithstanding the inaccuracies as to the localities described, his detailed account of the flora (Britten 1885) enables us to obtain a fairly comprehensive idea of the vertical distribution of the vegetation in those days. In the absence of detailed botanical studies in and about the specific area of our research, Forbes' account of a nearby cross-section has to be drawn upon for comparative purposes.

A number of other naturalists subsequently came to the eastern part of Timor and collected plant material, including Castro (1908-10) (cf. Alberto O. de Castro 1943); and Stein (1932) (cf. Malm 1937).[56] However, it was not before 1947 that a comprehensive classification of the island's vegetation was first attempted by the Dutch forest ecologist Meijer Drees (1951). His classification of the potential natural vegetation, so-called 'climax vegetation', is based on extensive fieldwork in both west and east Timor and although he never attempted to map his plant communities his publication still has to be considered the most authoritative work and thus the standard source of reference on the plant ecology of Timor. Meijer Drees' classification is based on the major environmental elements like temperature and available precipitation as well as on the physiognomy of the vegetation.

The only available vegetation map of eastern Timor is that of Gomes (1950c). In this, he makes the rather rough distinction of mangrove, mixed primary forests (subdivided into four groups according to altitude), secondary forests and savannas at a scale of 1:500,000. However, on account of the small scale and a great number of inaccuracies in the

[56] Useful lists of plants from eastern Timor are also found in *Plantas de Timor* (1935) and Santos (1934).

delimitation of the zones, the value of this map for an ecological analysis of the vegetation of our Area is very limited. Not even his distinction between primary and secondary vegetation types can safely be relied upon. It is against this background that I have attempted to analyse and map the vegetative pattern of the Area.

When mapping the plant communities of the Area one problem arises. Should the vegetation the land carried before it was affected by human activities be mapped, or should the mapping be based on the vegetation as modified by man and actually found in the Area at the time of the survey? The choice between these two approaches is largely contingent upon the objective of the survey.

Since the assessment of the land use potential is the major objective here, this analysis is based on inherent ecological zones. However, in the complete absence of plant-geographical studies of the Area it seems clearly inadvisable to attempt to map these ecological zones directly. Instead, I preferred to map the existing vegetation first. Only then is one in a position to single out ecological units which are to serve as a basis for the assessment of the land use potential. In accordance with this approach the existing vegetation was analysed and subsequently mapped on the basis of structural rather than floristic characteristics. For this purpose recent vertical aerial photographs (1962) at a scale of about 1:30,000 proved to be of particular value. On the basis of these airphotos the rough boundaries of the main physiognomic types in the Area - forest, woodland, savanna, scrub, grassland and swamp - were plotted first. The recognition and delineation of the more subtle distinctions between individual units was achieved in a second step by intense ground observations and more detailed photo-interpretation. During the fieldwork plant material was collected for further identification - about 270 items in all.[57] This was later identified by and deposited with the

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[57] As far as possible vernacular names of the collected plants were recorded. At times also recourse to lists of vernacular names of Timor's flora (Meijer Drees 1950, Hildebrand 1953, Gomes 1954) was made for purposes in the field pending final identification in the Herbarium.

Rijksherbarium at Leiden, Holland.[58]

The mapping of the vegetation is therefore based on a combination of fieldwork and aerial photographic interpretation. The data were originally compiled on a map at a scale of 1:50,000. From this further reductions have led to the present vegetation map (Fig. 23) (cf. also profile Fig. 24). The smallest area depicted on this map is slightly less than 0.25 sq. km.

The knowledge of native assistants and village elders about the local flora was initially drawn upon before final identification of the collected plant material was secured. Native names in Tetum or in Macassai were added to the botanical names wherever possible. The individual species have been listed in Appendix I in which a regional differentiation of our Area into ecological zones has been attempted. Fifteen vegetation types were distinguished on the basis of physiognomy. They should serve to indicate less strict groupings intended to depict existing vegetation. Less than 10 per cent of these can be considered so-called 'climatic climax forest'.

1. Tropical montane cloud forest

The tropical montane cloud forest occurs at altitudes above 1500 m - thus in our Area exclusively on top of Mt Mundo Perdido.[59] It reflects the misty and cloudy conditions prevailing at this altitude during the greater part of the year. This forest type, which most likely has been largely untouched by man, owing to its being lulik (= sacred), belongs to one of the few remnants of Timor's primary vegetation.

This evergreen cloud forest is comprised of non-fire-resistant species with straight bole and medium-sized to broad leaves. It consists of two often vaguely distinguishable tree layers. The upper layer largely forms a compact canopy

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[58] The author wishes to express his gratitude particularly to Professor C.G.G.J. van Steenis as the Director of the Rijksherbarium who with his colleagues Dr Bakhuizen, Dr van der Brink and Dr Veldkamp have gone to the trouble of identifying this collection.

[59] A general description of this vegetation type for the archipelago is given by van Steenis (1957:87-8).

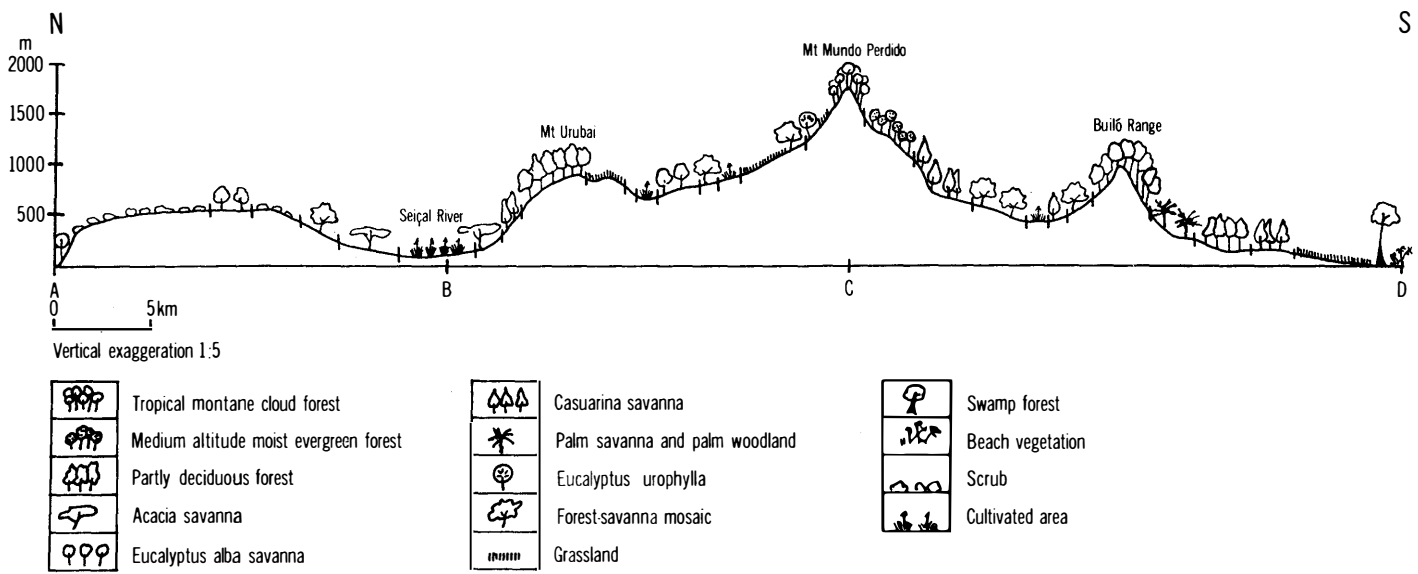


Fig. 24 Present vegetation along profile

particularly at wind-exposed localities (Plate 17) while emergent trees occur at sheltered sites. In this tree layer, coniferous trees of the *Podocarpaceae* family (particularly the giant emerging *P. imbricatus* and *P. amarus*) are conspicuous, reaching heights of 30 to 40 m and more. Other species include *Eleocarpus* sp., *Artocarpus poniformis*, *Drypetes* sp., *Olea paniculata*, and *Putranjiva roxburghii*. This upper tree layer is enveloped by a dense tangle of climbers, lichens and epiphytes as well as orchids. Lianas are absent. Below it a second rather irregular tree layer between 15 and 20 m in height occurs, consisting chiefly of *Pygeum* sp., *Actinodaphne velutina*, *Celtis wightii*, *Cleistocalyx operculata*, and *Olea paniculata*. The sparse ground flora is made up of tree ferns which sometimes form decorative groves along rivulets, and of shrubs, among which *Vaccinium varingiifolium*, *Euonymus japonicus*, and *Viburnum cylindricum* are abundant. Stems and branches as well as the forest floor are festooned by beard mosses (*Usnea* sp.),[60] while other mosses and liverworts abound on the forest floor. Characteristic also is the great number of birdsnest ferns, like *Asplenium nitidus*.

2. Medium altitude moist evergreen forest

This type of forest (Plate 18, also Plate 2) is roughly confined to altitudes between 1000 and 1500 m. Thus, it lies below the altitudinal belt which is commonly enshrouded in clouds. There is far less moisture than in vegetation type no. 1, and this is reflected in the absence of mosses on stems, branches and on the forest floor. Moreover, in contrast to the montane cloud forest, Podocarpaceae are absent. The extent of this forest type has been much reduced by fire, and relict patches remain only on Mt Mundo Perdido, Mt Laritame, Mt Builó (south side) and frequently on very steep slopes and along broken limestone cliffs. As far as the structural composition is concerned this forest has affinities with the tropical montane cloud forest into which it gradually merges. Thus, two tree layers are conspicuous: while most of the understorey species (15-25 m) are evergreen, some of the emergent trees shed their leaves for short periods at irregular times of the year. The canopy layer consists of large spreading crowns at 30-40 m. Species that dominate in the canopy layer include: *Elaeocarpus petiolatus*, *Ehretia acuminata*, *Putranjiva roxburghii*, and *Plachonella abovoidea*.

[60] For comparison see Mt Egmont, New Zealand (Schweinfurth 1966:137) and Figs 3, 4 and 5 in Troll (1959).

Trees commonly found in the second layer include *Acer niveum*, *Pithecellobium junghuhnianum*, *Olea paniculata*, *Mischocarpus sundaicus*, *Neolitsea cassifolia*, *Mallotus philippensis*, various Myrtaceae and Araliaceae, as well as various species of Ficus, climbing bamboo and some tree ferns. These may be richer in species but not very dense in cover. The ground layer includes ferns, herbs, orchids and mosses. The extent of this forest has been reduced by fire and cultivation. *Eucalyptus urophylla* woodland (vegetation type no. 6), forest/savanna mosaic (vegetation type no. 5) and low grassland (vegetation type no. 9) have partly replaced the medium altitude moist evergreen forest. In our zone of investigation this forest chiefly occurs in areas with annual rainfall in excess of 1700 mm and a maximum of up to 3 dry months during the year.

3. Semi-deciduous forest

There is no sharp distinction between evergreen and semi-deciduous forests. On account of the dry season a gradual increase in the number of species that shed their leaves occurs. Deciduous forests tend to be contingent upon edaphic conditions. Their composition therefore varies considerably. On wetter soils it assumes transitory forms towards the moist evergreen forest; on drier soils it grades into savannas.

To the visitor these so-called monsoon or deciduous forests usually convey a very contrasting impression because of the marked physiognomic differences they offer at different times of the year. A lush green during the rainy season contrasts with a partly scorched appearance during the dry season. As a consequence of this long dry season, monsoon forests have been destroyed and converted into grasslands suitable for grazing. Burning and girdling were the principal means by which man has destroyed these forests. As a result it is rare to find any primary monsoon forest in the Area. Only patches of it occur at places unsuitable for agriculture. Van Steenis (1957:90) even questions the existence of any natural 'climax' of this vegetation type in the Malaysian floristic region.

The semi-deciduous forest consists structurally of two tree strata (Plate 12). An upper tree layer forms an open canopy of trees between 20 to 25 m with emergents reaching over 30 m. This consists of roughly one-third

deciduous species which shed their leaves during part of the dry season. Trees forming this canopy are: *Acacia leucophloea, Sterculia foetida, Garuga floribunda, Tetrameles nudiflora, Carallia brachiata, Parinarium corymbosum,* and *Planchonella nitida.*

Below this upper tree layer we find a second tree stratum with an average height of 10-15 m, largely consisting of evergreen species such as *Santalum album, Timonius sericeus, Milettia xylocarpa, Albizzia saponaria, Antidesma ghaesembilla, Mischocarpus sundaicus* and *Glochidion zeylanicum.* This lower layer is more compact and is made up of a greater number of different species than the upper layer. Finally a shrub layer of mixed evergreen and deciduous species covers the ground.

On account of frequent burning a rigorous selection has taken place leading to a dominance of deep-rooting, thick-barked, fire-resistant species. Buttressing and epiphytes occur to a smaller extent than in the vegetation type no. 2, while woody lianas abound.

In the area under investigation this forest type is confined to a few isolated patches between roughly 400 and 1000 m in the north and from 200 to 1000 m in the south as well as at sea level (e.g. Bé Ro, near Bé Aço, south coast) because of edaphic conditions. Palms, if present, are mainly *Corypha utan* and *Arenga saccharifera* (Plate 43). Thus, this type of forest occurs in areas where water stress is restricted to a maximum of four to five months of the year with annual rainfall in excess of 1000 mm. On account of significant human interference the original extent of this forest has been much reduced and largely replaced by moist *Casuarina junghuhniana* savanna or forest/savanna mosaic.

4. Largely deciduous forest

This type of forest occurs only in low rainfall areas, such as the lower sections of the coastal hills up to an altitude of 300 to 400 m, for instance on both sides of the Baucau Plateau along the River Manoléden (Plates 7 and 9) and the River Seiçal. Although similar in structure to the previous vegetation type, the canopy of this forest is lower, averaging only 15 to 20 m. The second tree stratum is between 6 and 10 m. Below these trees a shrub layer of up to 4 m and a grass layer cover the ground. The upper tree

layer is dominated by deciduous species such as *Dracontomelon mangiferum*, *Homalium tomentosum*, *Garuga floribunda*, *Celtis wightii*, *Albizzia lebbek*, *Schleichera oleosa*, and *Melia dubia*. Because of a few evergreen species, like *Tamarindus indica*, and because of other species which shed their leaves irregularly (e.g. *Albizzia procera*) this forest appears somewhat to be evergreen. The lower tree layer which is densely interwoven by lianas, some *Usnea* sp. lichen and a few orchids, consists of *Antiaris toxicaria*, *Fagara rhetsa*, *Protium javanicum*, *Pterocarpus indicus*, *Cassia fistula* and *Schoutenia ovata*.

The rather dense evergreen shrub layer consists mainly of scrambling and spiny shrubs.

5. Forest/savanna mosaic at medium altitudes

The forest has been partially destroyed between 300 m (south coast) to 400 m (north coast) and 1500 m as a result of fire and cultivation. It has given way to a motley mosaic of forest remnants of both medium altitude moist evergreen forest and slightly deciduous forest, patches of savanna (mostly moist *Casuarina junghuhniana* savanna with low grass) and patches of scrub at various stages in the succession back to forest. The proportions of forest and savanna trees vary according to land use history. Savanna species abound in areas that have been much cultivated as well as in drier areas, while relics of forests are to be found near springs and at precipitous slopes, i.e. in habitats less accessible to man.

At the lower limit of altitude this vegetation type merges gradually into *Casuarina junghuhniana*, *Acacia leucophloea* and *Corypha utan* savanna, while at the upper limit it grades into the medium altitude moist evergreen forest and into *Eucalyptus urophylla* woodland. This mosaic occurs on the northern slope of Mt Mundo Perdido, on Mt Builó, on parts of Mt Laritame, on the mid-slopes of Mt Mata Bian as well as in the escarpment zones of the Baucau Plateau (Plate 10).

6. *Eucalyptus urophylla* woodland

This vegetation type occurs gregariously as pure stands

of fire-resistant evergreen *E. urophylla* (S.T. Blake ined.)[61] (ai bubur metan). These woodlands, which without any significant shrub layer are easily recognizable on aerial photographs, have neither the many-layered structure of the forests nor the dense grass cover of the savannas. The crowns of these very tall, straight bole trees touch each other, with the canopy remaining light. The grass stratum is usually sparse and patchy.

The Eucalyptus woodland is clearly confined to altitudes between 1000 and 1200 m.[62] In the Area it occurs only on soils derived from volcanic material such as on both sides of Mt Mundo Perdido, Mt Laritame and although only parenthetically because it is outside our Area, also on Mt Mata Bian (Plate 19).

7. Savanna

Savannas are by far the most widespread kind of vegetation not only in the Area but throughout the Lesser Sunda Islands.[63] Savannas are characteristic of the coastal plains, foothills, as well as the hills of medium altitude up to

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[61] Until 1972 this species of Eucalyptus had been known by the name *E. decaisneana*. Extensive research by botanists of the Queensland Herbarium in Australia has led to the recent renaming of this species *E. urophylla*. The results of these efforts are expected to be published by the Queensland Herbarium. Throughout the present study the name *E. urophylla* is used. Since this study was completed an important new work has been published on the Eucalyptus of the Lesser Sunda Islands by Martin and Cossalter (1975-6). It was, however, not possible to amend the body of the present study to take account of this publication.

[62] In Portuguese Timor *Eucalyptus urophylla* occurs as high up as 3000 m on Mt Tata Mai Lau, which according to Dr M.R. Jacobs, Director-general of the Forestry and Timber Bureau, Department of National Development, Canberra, Australia, is presumably the highest elevation at which Eucalyptus grows (pers. comm. 10 Feb. 1970).

[63] For comparison see also von Malm (1934) and Rensch (1930) who collected plants on Lombok, Sumbawa and to a lesser degree on Flores. See also Elbert (1911-12) whose plant collections were made on Lombok and Sumbawa.

approximately 1000 m. In Timor savannas are generally recognized as being the result of man's influence (van Steenis 1957:90).[64] As such, the meagre number of species is characteristic of these secondary vegetation types and thus depends on edaphic and climatic conditions. Only a few species tend to dominate. According to the dominant tree species four types of savannas have been recognized:

(a) *Eucalyptus alba* savanna
(b) *Acacia leucophloea* savanna
(c) *Casuarina Junghuhniana* savanna
(d) Palm savanna and palm woodlands

Savannas occur in a wide range of environments in Timor. *Eucalyptus alba* savanna is found chiefly on the red calcareous soils (VR) of the Baucau Plateau and on soils derived from volcanic material (CD) up to 1000 m. The *Acacia leucophloea* savanna occurs mainly on heavy clay soils (CN) below 300 m in the monomodal rainfall zone of the north coast. *Casuarina junghuhniana* savanna is exclusively associated with heavy clay soils (CN) above 300 m in the monomodal and from sea level in the bimodal rainfall zones of the south coast. Palm woodlands are restricted to sites with a high water table, such as in shallow alluvial embayments of the coast (e.g. Uai Ono, north coast) and along the water seepages on both sides of the Baucau Plateau. On the other hand, palm savannas occur extensively in the coastal plains and foothill zones up to approximately 300 m in the bimodal rainfall zone of the south.

7a. *Eucalyptus alba* savanna

This savanna type consists of almost pure stands of the Australian white trunked evergreen *Eucalyptus alba* (ai bubur mutin), which nearly always has a contorted stem. This savanna type is made up of a single open tree layer which reaches a height of no more than 15-20 m, below which an open shrub layer of young eucalypts sprouts from stumps. Short grasses of *Panicum* sp., *Sporobolus* sp., *Setaria verticillata*, *Cynodon dactylon*, *Desmodium laxiflorum* and *Rhynchosia minima* with a tussock spacing form the ground layer on skeletal or highly permeable soils. This savanna type occurs up to 1000 m, locally even up to 1250 m. Above

[64] For the discussion of whether savannas are man-made or natural see, for instance, Holmes (1951) and Troll (1963).

1000 m *E. urophylla* takes over with which *E. alba* frequently forms hybrids.[65] In contrast to *Casuarina junghuhniana* and palms, *Eucalyptus alba* avoids areas with permanent or periodically high ground water tables and thus usually grows on reddish soil of either sedimentary (calcareous) (CR) (e.g. Baucau Plateau), or volcanic (CD) origin (e.g. Mt Ossoala) (see Plate 25). Owing to its fire resistance this eucalyptus species has gained a lead in regularly burned regions (Plate 20). This eucalyptus species is believed by Meijer Drees (1951:89) to have originally occurred in the so-called 'monsoon forest' which is roughly synonymous with our 'strongly deciduous forest'.

7b. *Acacia leucophloea* savanna

In contradistinction to the eucalyptus savanna which consists chiefly of pure stands of *E. alba* trees, the acacia savanna is made up of a number of different, mostly deciduous tree species among which the wide-branched umbrella-shaped *Acacia leucophloea* predominates. This type of savanna occurs in the driest parts of the Area.

Structurally it consists of a single tree layer of mostly deciduous species; besides *Acacia leucophloea* chiefly *Schleichera oleosa, Zizyphus timorensis, Zizyphus mauritiana, Cassia fistula, Pterocarpus indicus, Aegle marmelos, Vitex pubescens, Bauhinia acuminata* and a shrub layer. The ground layer consists of grasses in which *Andropogon* sp., *Dichantium caricosum, Bothriochloa glabra, Setaria geniculata, Heteropogon compressus* are co-dominant. Epiphytes are rare, while lianas are absent. This vegetation type is particularly abundant on heavy clay soil (CN) below 300 m under low rainfall conditions (below 1000 mm annual rainfall) such as the monomodal rainfall zone of the northern section of our Area. Thus we find this vegetation type on both sides of the Baucau Plateau along the Rivers Manoléden and Seiçal, i.e. in the driest parts of the Area.

[65] This is the result of research carried out in Timor in 1963 and 1969 by Dr M.R. Jacobs and Egon Larsen, both from the Forestry and Timber Bureau, Department of National Development, Canberra. The taxonomy of the Timor Eucalypts has been reviewed by M.S. Blake, Queensland Herbarium, Indooroopilly.

7c. *Casuarina junghuhniana* savanna

Of all vegetation types the Casuarina savanna covers the largest area (Plates 2 and 21). The fire-resistant *Casuarina junghuhniana* (ai caqueu) is found in pure open colonies with intermittent patches of slightly deciduous forest. It occurs predominantly on heavily degraded, often sliding deep clay soils (CN)[66] (Plate 46) - i.e. on soils with imperfect drainage - at altitudes between 300 and 1000 m in the monomodal rainfall zone of the north. As scattered individuals it is found up to 1200 m while it descends to almost sea level in the bimodal rainfall zone of the south.[67] The tree layer is open and there is no shrub layer. The low grass cover consists chiefly of the following co-dominant species: *Eleusine indica*, *Cynodon dactylon*, *Dichanthium caricosum*, *Digitaria argyrostachya* and *Coelorhachis rottboellioides*.

On airphotos this vegetation type is easily recognizable and serves as a reliable indicator of soil conditions.

7d. Palm savannas and palm woodlands

Besides palm savannas which occur on alluvial plains and lower hills, dense palm woodlands or thickets (Plate 9) have also been summarized under this heading. The dominant features which the widely differing habitats of these vegetation types have in common are excellent to excessive ground water conditions. Palm savannas consist of the two chief palm species of Timor, *Corypha utan* (Plates 22 and 23) and *Borassus flabellifer* (Plate 3), which are similar in appearance and give a characteristic aspect to the landscape. Both palms are fire-resistant and thus pioneers on regularly burned land. In the Area *Borassus flabellifer* occurs on comparatively drier soils, e.g. southeast of Baucau near small water seepages of the Baucau Plateau, as well as at around the 300 m level east of the road to Quelicai on the sandstone/shale composed Aitutu Formation. In addition it occurs as dense woodlands often with an understorey of *Jatropha gossypifolia* shrubs on alluvial flats which are

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[66] On these soils casuarina has to be regarded as a true pioneer plant.

[67] Casuarina trees are also found along rivers and along the coast where another species, *C. equisetifolia*, is chiefly to be found.

periodically inundated at Uai Ono (north coast) (Plate 9) and around the mouth of the River Bé Tuco (south coast).

In contrast to the borassus savanna/woodlands the area of which is confined to drier habitats on the north coast, *corypha* palms prefer comparatively wet soil conditions. The latter are confined to the bimodal rainfall zone from sea level up to approximately 300 m. In the Littoral Plains Zone of the south coast it grows in clumps forming sometimes dense thickets together with semi-deciduous trees amidst the high grass (up to 5 m) savanna of *Saccharum spontaneum* (Plate 23). Corypha often grows in rows behind beach ridges in water-logged swales and on back plains. It also usually grows on calcareous soils from the Viqueque Formation (CMC) and from coral reef limestone (CR) in the lower foothill zone of the south coast up to 300 m, together with trees of the slightly deciduous forest. Here *Imperata cylindrica* grass (duut manu lain) is commonly associated with this savanna type.

8. Scrub

Scrub comprises a vegetation type characterized by deciduous shrubs and, at most, a few scattered low crooked trees. Owing to severe water stress, scrub usually occurs in areas unsuitable for dense forest growth. The two prominent scrub areas are the Baucau Plateau, the largest single scrub area, and the Larigutu Limestone ridge between Mt Mundo Perdido and Mt Ossoala. Both areas are dominated by yellow flowering *Tecoma stans* scrub in association with a few *Schleichera oleosa* and *Sterculia* sp. trees. On the reddish calcareous soil in the pitted, sinkhole-studded surface the following short grasses are abundant: *Heteropogon contortus*, *Chloris barbata*, *Eragrostis elongata*, *Panicum caudiglume*, *Dichantium caricosum*, *Rynchelythrum roseum*, *Apluda mutica*, and locally the up to 2 m tall *Coelorhachis rottboelliodes* grass.

9. Grasslands

In our Area large tracts of land were entirely treeless at the time of my visit (1969-70). In places a scanty growth of grass was the only remnant of vegetation on shallow top soils. The transition from park-like savannas to grasslands is very gradual, and thus it is not possible to give an exact number of trees per hectare to distinguish the two vegetation

types from each other. In the vegetation type under discussion grasses dominate the landscape.

It is not known to what extent natural grasslands existed in Timor before the advent of man. Yet it is generally believed (van Steenis 1954; Troll 1952) that the greater part of the existing grasslands is caused by regular burning. Although we find patches of grassland of varying size in most of the described vegetation types, only the more extensive ones with mappable dimensions of at least 0.25 sq. km will concern us here. The open grasslands, which constitute the island's natural pastures (i.e. ranges), are usually owned by the entire suco. They are set aside as grazing grounds for buffaloes, horses, and nowadays also for cattle.

Extensive grasslands occur on Bobonaro Scaly Clay in the central section of the Area and particularly at Larigutu pass (on limestone). These lands of short grasses such as *Coelorhachis rottboellioides*, *Dichanthium caricosum*, *Eleusine indica*, *Digitaria argyrostachya*, *Cynodon dactylon*, *Chrysopogon aciculatus*, *Themeda australis*, *Digitaria pertenuis*, var. *glabra*, *Paspalum conjugatum*, *Paspalum orbiculare* and *Eragrostis zeylanica* appear to have been derived from forest by repeated burning. Since the topsoil is often compacted and deeply cut by cattle trails, there are numerous signs of sheet erosion.

The second type of grassland appears to have been derived from moist savannas. As a result of repeated burning and clearing for cultivation, this type of grassland is extensive on fluvial and littoral plains which are flooded for a short period of the year (Plate 23). These grasslands may extend into the swamp zone along levees and adjacent back plains as well as into the coastal hill zone, such as near the river mouth of the Bé Tuco River. They are dominated by tall perennial species, mostly *Saccharum spontaneum* (up to 5 m) (soco) as well as *Imperata cylindrica*. Other grass species may occasionally be present, including *Brachiaria ramosa*, *Themeda intermedia* and *Eragrostis elongata*. A few trees - like *Corypha utan*, *Schleichera oleosa* or shrubs may be present as very scattered individuals.

10. Beach vegetation

The distinguishing feature of this vegetation type, which floristically is pan-'Malaysian' (term used by van

Steenis for the entire archipelago) or even pan-tropical, and usually growing on sandy beaches, is a combination of creeping herbs (*Ipomea-pes-caprae)* which often grow gregariously, and grasses *(Spinifex littoreus, Perotis hordeiformis, Scleria lithosperma).* Both herbs and grasses grow particularly on accreting beaches. Behind this community we find scrub which occasionally forms a dense, almost impenetrable wall up to 6 m high owing to the shearing action of the wind.[68] It consists of shrubs and low trees of *Scaevola taccada, Barringtonia* sp., *Terminalia catappa, Hibiscus tiliaceus, Thespesia populnea, Clerodendrum* sp., *Grewia* sp., *Premna* sp., *Hernandia* sp., *Herietiera* sp., *Calophyllum ionophyllum* (Plate 24). This scrub is interrupted locally by a conspicuous line of *Casuarina equisetifolia* and *Pandanus tectorius* which usually grow on sandy beach ridges and foredunes. Some lianas such as *Flagellaria indica* also occur. This relatively low beach vegetation changes its composition according to edaphic conditions and disappears at very dry and rocky coasts such as on the north coast where the Baucau Plateau drops into the sea. Moreover, due to the more severe influence of man on the north coast the beach vegetation in that part of the Area appears to be less complex and varied. In more accessible places the trees and shrubs have been cut, and only fragments of this vegetation type are to be found today.

11. Mangrove

Under this term will be discussed a vegetation type - pan-'Malaysian' (van Steenis) in character - upon which Timor's climate, lacking frost, has no significant influence.

It shows no distinct layered structure. It is found where silt accumulates, thus in the Area only on the south coast at a few shallow bays where tidal creeks have broken through the beach barrier, as well as along oozy coilões (see p. 35). In the latter, mangroves only occur in narrow fringes (Plate 14). Here, one observes no convenient zonation of the various mangrove species according to salt content or number of days during which they are inundated. As sand bars prevent the rivers from flowing to the sea for part of the year, the effect of tidal action is hence also interrupted.

[68] The shearing action of wind on the beach vegetation in its most obvious form has been observed on New Zealand's west coast which is exposed to the west-wind drift (Fig. 18, 103 in Schweinfurth 1966).

At locations such as in the vicinity of Bé Aço on the south coast which are regularly flooded by the tides, broad-crowned *Avicennia marina* trees, seldom higher than 10 m, occur in pure stands. At low tide the pneumataphores of these trees stick out of the mostly sandy soils.

Approaching the accreting muddy shores and shelving banks but still well below high water mark we find *Rhizophora conjugata*, *Sonneratia alba*, *Ceriops* sp., *Lumnitzera racemosa*, *Bruguiera* sp. and palms of *Nypa fruticans*. At places which have been subject to anthropogenous influence, thickets of the tall ferns *Acrostichum aureum* and *Acanthus ilicifolius* appear. In areas of brackish or fresh water tidal inundation the swamp vegetation consists of *Excoecaria agallocha*, *Melaleuca leucadendra*, *Aegiceras corniculatum*, *Lumnitzera racemosa*, *Xylocarpus granatum*, *Acanthus ilicifolius*, *Caesalpina* sp., *Dolichandrome spathacea*, *Kleinhovia* sp., *Macaranga* sp., *Hibiscus tiliaceus* and *Premna* sp. Inland this latter forest is fringed by *Corypha utan* and *Melaleuca leucadendra* from where it grades into slightly deciduous forest owing to drier edaphic conditions - i.e. on sandy soils.

12. Swamp forest

The occurrence of swamp forest in the Area is confined to a few isolated patches on the south coast behind mangroves where fresh water from smaller creeks tends to stagnate e.g. at the plain of Uato Lari. This represents the tallest type of evergreen forest in the Area, reaching 30-40 m. Emergent trees sometimes reach even higher. With its lianas, epiphytes and buttressed trees it strongly reminds one of a mature rainforest, characterized by the following trees: *Canarium asperum*, *Ficus callosa*, *Ficus fistulosa*, *Ficus pisocarpa*, *Metroxylon sagu*, *Garcinia dulcis*, *Pongamia pinnata*, *Ficus retusa* var. *nitida*, *Barringtonia* sp., *Sterculia foetida*, and so forth.

As seen on Plate 15 which shows the swamp forest in the plain of Narequici near the coilão of Bé Sain, this vegetation type has to give way locally to new rice fields.

13. Riparian forest

Because larger rivers are absent from the Area, riparian forests, even those near river mouths, are too small to be

mapped at the scale of Fig. 23. Still, they certainly form a conspicuous element in the vegetational pattern of the Area and therefore need to be briefly analysed. The composition of these forests varies considerably with soil and altitude. Along rivers up to 1000 m (e.g. Larigutu) we find *Pandanus tectorius* (the fruits of which are eaten by the Timorese) (heda)[69] and the virtually omnipresent *Casuarina junghuhniana* trees (ai caqueu) which usually occupy banks and levees of the larger rivers throughout the Area. *Casuarina junghuhniana* seems to be a type of pioneer plant in the constantly shifting rubble beds of these rivers. Other species arranged according to altitude include:

1. lowland and lower hills up to 300 m: *Buchania arborescens, Saccopetalum horsfieldii, Terminalia edulis, Xylosma amara, Erythrina variegata* var. *orientalis, Toona sureni, Ficus ampelos, Eugenia littoralis, Parinarium corymbosum, n, Neonauclea calycina, Psychotria* sp.
2. medium altitude up to 1000 m: *Polyscias rumphiana, Bischoffia javanica, Dysoxylum acutangulum, Dysoxylum speciosum, Arenga saccharifera, Pittosporum timorense, Timonius timon, Wendlandia burkillii* var. *timorensis, Planchonella obovata.*
3. above 1000 m: *Olea paniculata, Eleocarpus petiolatus.*

The preceeding analysis of the vegetation has repeatedly underscored the transitory position of Timor between humid Southeast Asia and dry central Australia. To obtain a more precise idea of the quantitative relationship of both elements in Timor's flora, it is necessary to look into this matter more deeply. According to van Steenis (see Kalkman 1955: 200), Timor belongs to the so-called 'South Malaysian floristic zone' comprising Java and the Lesser Sunda Islands. Within this zone we find the largest continuous belt of deciduous forests in Indonesia adjoining the northern Australian monsoon forest. Despite Australia's proximity the flora of the row of islands extending to the east of Java is for the greater part of distinctly Southeast Asian - not Australian - origin. This thesis originally advanced by van Steenis has been convincingly substantiated in an article by Kalkman (1955:201). On the basis of genera a distribution was made as shown in Table 20.

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[69] The role of pandanus in a Melanesian ecosystem has been analysed for the highlands of Eastern New Guinea by Schweinfurth (1970).

Table 20

Distribution of genera in the Lesser Sunda Islands and 'Malaysia' (= Island Southeast Asia)

	Lesser Sunda Islands		Malaysia
	Number	%	%
Type 1 - Genera occurring in continental Asia, Malaysia and Australia without showing a special centre of development in this area	439	58.8	27.7
Type 2 - Centre of distribution in Asia: not or hardly occurring in Australia	176	23.5	26.3
Type 3 - Centre of distribution in Malaysia, eventually with some outposts in continental Asia or Australia (autochthonous)	109	14.6	26.6
Type 3A - Local-endemic genera, from one island or group of islands (i.e. the Lesser Sunda Islands) only (endemics)	2	0.3	13.8
Type 4 - Centre of distribution in Australia and/or the Pacific or Subantarctic regions, not or scarcely represented in Asia	21	2.8	5.6
	747	100.0	100.0

Source: Kalkman (1955:202).

The results of this analysis show clearly that the Lesser Sunda Islands possess an exceptionally high percentage (58.8 per cent) of genera with a wide distribution occurring in continental Asia, 'Malaysia' and Australia. The group of western-centred Asian genera (type 2) is represented with less than a quarter of all genera recognized (23.5 per cent), while typical Malaysian (14.6 per cent) and local-endemic genera from one part of the Lesser Sunda Islands (0.3 per cent) are comparatively poorly represented as compared with the average for the whole of the Malaysian region, but still significantly higher than the eastern-centred genera (2.8 per cent).

A largely similar picture emerges when the species are taken as a criterion for consideration. Thus, in spite of the proximity of the Australian continent, the Australian elements play a very unimportant role in the general distribution of the vegetation in the Lesser Sunda Islands. Distinctly Australian-centred species include: *Eucalyptus alba*, *Eucalyptus urophylla*,[70] *Casuarina junghuhniana*, *Santalum album* and *Melaleuca leucadendra*, while many others are palaeotropic. In our Area the juxtaposition of Australian and Southeast Asian floristic elements is, of course, particularly striking in the drier northern section in the Area. Edaphic differences offering different habitats under similar overall climatic conditions have led to an interesting pattern of both elements. For instance, Mt Ossoala (Plates 1 and 25) is covered with Australian *Eucalyptus alba* because of its dry volcanic soils. However, in the ravines in which surface runoff tends to concentrate, slightly deciduous forest as well as riparian forest of Southeast Asian origin are to be found.

In conclusion, the present stage of the vegetative mosaic of the Area is chiefly due to human interference. In conjunction with the monsoon character of Timor's climate which inhibits the fast regrowth of once-felled trees, a rapid degradation from forest cover to open grasslands and in places even to badlands (without any vegetation cover) seems to have taken place in the Area. As will be shown by a number of indicators, such as erosion and disappearance of forests even in the hitherto preserved lulik groves in the upper reaches of mountains, the pace at which this land

[70] This species, however, does not occur on the Australian continent.

degradation takes place has increased in the past forty to fifty years, particularly since World War II. The problems of preserving at least the present vegetation cover and thus the necessity of avoiding dramatic losses will be dealt with in Chapter 5.

Chapter 3

TYPES OF LAND USE AND LAND OWNERSHIP

Types of land use

The Timorese economy is based mainly on subsistence agriculture in which the cultivators depend on the produce of their fields. The special character of Timor as an area of transition is also reflected in the pattern of land use. Here in Timor both the growing of root crops in dryland cultivation, as practised to a greater extent in the eastern part of the Malaysian Archipelago (i.e. primarily in New Guinea), and irrigated wet rice cultivation, practised chiefly in Java and Mainland Southeast Asia, are closely interwoven. According to Lekkerkerker (1927), before European contact the Timorese were mainly cultivators of root crops who supplemented their diet by food gathering in the forests. Taro (*Colocasia schot, Alocasia* sp.) (talas or keladi)[1] was the chief crop in those days. The introduction of rice and maize, Timor's two staple grain crops, is believed to have been of more recent origin. There is, however, no agreement among anthropologists as to the exact time of introduction of these two cereals into Timor. Middelkoop (1938) maintains that according to Atoni[2] oral tradition the invading Belu[3] brought rice and maize with them. In the course of time the Timorese have adapted themselves to the natural environment to such an extent that the distribution of these two basic types of land utilization (and their local variations) clearly reflects differences in environmental

[1] Still today the hill people in the vicinity of Dili are called keladi in Tetum (Dores 1907).

[2] Atonis form the majority of West Timor's population. Their language is Dawan.

[3] Belu (Tetum word for 'friend') is that portion of West Timor's population that lives near the border with Portuguese Timor. They are believed to have come from the west. Their language is Tetum.

conditions. As such, the present land use pattern, in conjunction with the vegetation, is helpful in elaborating a regional differentiation of our Area on an ecological basis. For comparison see Schweinfurth (1972) and Robertson (1964).

Before we are in a position, however, to analyse the regional pattern and the interaction of man in this unique Timorese environment, we first need a thorough understanding of the various forms of land utilization and their dependence upon environmental conditions. I begin the description of the various forms of land usage with the analysis of that type that is of major significance in Timor, that is bush fallowing,[4] of which two varieties will be distinguished, fila rai and lere rai. Next I talk about paddy cultivation; again two specific variations will be of interest. The chapter concludes by focusing attention on permanent gardening and livestock grazing.

Bush fallowing

The most widespread type of agricultural activity of the Timorese is bush fallowing. It is thus surprising that there is no proper term in Tetum to describe this type of agriculture. Instead the Tetum-speaking Timorese simply say halo to'os which means 'to work the garden', a term that refers to the cultivation of permanent gardens as well as of shifting plots.

At first sight, subsistence farming in the forest or in the savanna presents an appearance of bewildering confusion to the visitor who is only familiar with well-arrayed fields characteristic of mid-latitudes. Aside from the fields which are laid out in a seemingly haphazard fashion, there is a mixture of more than 30 different kinds of crops. From this confusion, however, a certain pattern does emerge.

The peasant has first to clear a piece of land allotted to him by his tribal chief by cutting out small and medium-sized trees with a catana (a sort of machete) and often

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[4] I have preferred this term to the general term 'shifting cultivation'. In my view the latter does not convey an exact idea of the type of fallow vegetation involved in the land rotation. Since chiefly bushes are allowed to regrow on the fallowed plots,'bush fallowing' seems to be a more appropriate term.

killing the bigger trees by girdling.[5] During the dry season the debris is dried for one to two months and subsequently burned (sunu rai). A second burning (by pushing forward the glowing charcoal) aimed at destroying all grasses is usually done at the first thunder at the beginning of the rainy season. Depending on a number of environmental conditions to which we shall return later, the Timorese recognize essentially two different forms of land preparation. When, after burning, they simply dibble holes into the soft ash-covered earth with a planting stick (ai suak), the Timorese refer to the whole process up to this point as lere rai (lit. 'to slash the earth'). On the other hand they speak of fila rai when the land, before it is planted, is tilled by a team of persons, each equipped with two 2.5-3 m long digging sticks (ai suak boot).

To reduce the risk caused by long dry spells the Timorese tend to plant a number of crops with different water requirements and different durations of the vegetative period. Little weeding is generally done in the first years. Each year lere rai or fila rai is repeated, in the course of which old vegetable remains from last year's crop, grasses and small bushes are burned. After a few years when the fertilizing effect of the ashes wears off and weeds become a plague, the plot is abandoned and reverts to some sort of forest or degrades back to grassland. However, shifting cultivation in a dry place like Timor, which has a rainless period of up to seven months, is not without hazard. In contrast to humid regions where the effects of anthropogenous influence are widely offset by a rapid regeneration of the vegetation, it takes much longer for the vegetation and the soil to recover in semi-arid regions. Still, even in dry parts like Timor the balance between man and his environment can be achieved under a bush fallowing system provided the

[5] In the Area a number of trees are usually spared such as: ai besi (*Intsia bijuga*), ai nitas (*Sterculia foetida*), ai na (*Pterocarpus indicus*), ai tali (*Corypha utan*), akadirun (*Borassus flabellifer*) and others, which are either valued for their wood (*Pterocarpus indicus* and *Casuarina junghuhniana*), their fruits (*Sterculia foetida*), as a universal source of construction material, as food (starchy stem of *Corypha*) or as beverages (known as tuak, derived from *Corypha* and *Borassus* palms). Some trees are also spared as they help to check the growth of grass; weeding would thus be reduced.

fallow period is long enough, i.e. if the population density remains low.

With population figures increasing, however, the land must carry a heavier load. Increased pressure on the land leads Timorese peasants to prolong the cropping period by simultaneously shortening the fallow period. As a consequence soil fertility is gradually reduced, and regrowth of large woody plants is rendered impossible. Owing to periodic, often even annual burning the seedlings or sprouts of most woody plants are killed and replaced by coarse perennial grasses. The latter, while dying above ground during the dry period, store up enough nutrients below ground to resume growth during the rainy period. Thus 'derived savannas' are the result of this development.

Moreover, in contrast to forest fallows the nutrient level is replenished only very slowly on savannas because the amount of litter as a potential source of humus is reduced as a result of fire. Unless the soil is replenished with nutrients through the agency of man, environmental conditions deteriorate, enabling an increasingly small number of people to make a living.

These preliminary remarks are essential for an understanding of how the islanders avail themselves of their environment in a dryland climate like that of Timor.

Lere rai. The chief type of agricultural activity in Timor from olden times is that which is commonly termed lere rai or ai leren. This system of cultivation is probably best described today as land rotation, combined with fallow periods of varying length. The house of the shifting cultivator is usually not moved along with the to'os. For this type of cultivation no particular scheme is discernible in terms of the outlay and the number of years under cultivation and under fallow. Ideally lere rai dominates in forested areas where loose forest soil requires no tillage (fila) after clearing. In forests the topsoil is usually thicker, containing more nutrients while minerals are more easily dissolved through the agency of water and humid acids. Also the invasion of weeds is believed to commence later than on savanna plots.

It is impossible to give exact figures as to how much time a Timorese requires to prepare one hectare of land by applying lere, since this is contingent upon the type of

vegetation to be cleared. Except for a few isolated spots primary and tall secondary forests are virtually non-existent in the Area. Therefore the Timorese are most frequently compelled today to resort to scrub and low or medium-sized tree vegetation for the preparation of lere fields. On the other hand, they do show a distinct preference for plots covered with scrub and low trees because of the tremendous work involved in felling the huge buttressed trees. The lere preparation of a quarter of a hectare of scrub/low tree land by one person takes about six days, while fila rai of the same field would take 18 to 20 times as long. Following the way of least resistance, lere has in the past been the dominant form of cultivation. Even today lere is still, though to a lesser degree, the prevailing form of cultivation in the Area. The Timorese resort to it in case they are late with the preparation of fila fields or should the necessary manpower be unavailable for fila rai, as in the case of a small family.[6]

A number of other factors seems to govern the decision of the Timorese cultivator as to whether he practises lere or fila. Paramount for this decision seems to be the type of topography. If the fields are too steep, fila is rendered impossible. No exact critical slope gradient could, however, be established for all parts of the Area, since fila and lere practices again hinge upon population pressure on the land. In Siralari (suco of Caraubalo, Viqueque) for instance, the critical angle above which lere was practised on greyish marly soils from Viqueque Formation (CMC) was estimated to be 20 degrees, while in Quelicai it seems to be much lower. Here population pressure led the people to terrace their fields in order to practise fila rai. Fields that are freshly cut from the forest are usually worked lere for a number of years until the roots have rotted away to allow for fila. Moreover, a sandy or stony soil renders fila impossible, and the cultivator has to resort to lere. Also, if subsistence field crops are planted on the same plot[7] under valuable tree crops, burning for lere is prohibited, and fila rai has to be done. Finally, as fila is a highly labour intensive type of cultivation, lere is resorted to unless sufficient manpower

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[6] For fila rai the Timorese rely on the help of either family members or on contracted labour.

[7] The owner of the trees may be different from the owner of the subsistence field crops.

can be made available. At least six persons are required for fila. For this peasants usually descend upon relatives for reciprocal help, commonly referred to in Tetum as serviço hamutuc (= 'joint service').[8] Otherwise the peasant has to contract labour for 6$00 per day with, or 8$00 per day without meals (see Hicks 1967:13).

Fila rai. Owing to population pressure an increasing number of shifting cultivators has given up lere rai and resorted to tillage of the soil, i.e. fila rai. While Timorese peasants unanimously agreed that fila rai fields usually yield far higher results than lere fields, the labour input of the former is tremendous. Six to eight persons stand shoulder to shoulder facing the same direction, each equipped with two pointed sticks (ai suak boot) about 2.5-3 m long, and made of hard casuarina wood (see Plate 29).[9] Each person, men and women, jams his sticks with successive thrusts into the soil until a row of holes, each about 20 cm deep, has been made. A large sod of about 50-80 cm in length and 30 cm in width is turned over. This laborious procedure, which usually takes place from July to October depending on the locality, is very time consuming. I estimated that in Maluro (Viqueque) and other places on light savanna soil six persons have to work two days to till 1000 sq m which is roughly tantamount to 80 sq m per day per person. This figure is in line with Leendertz's estimates of the Aroki Plain in western Timor[10] and with those by H. Lains e Silva (1956:100) who mentions that 100 man-days are needed to till one hectare of savanna soil, that is 100 sq. m per person per day. In no case, however, could I observe that more than 1500 sq m of new savanna grassland had been opened up

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[8] There is no Tetum equivalent for 'work' or 'service' etc. The institution of serviço hamutuc is in many ways reminiscent of the Javanese gotong rojong.

[9] As these digging sticks (often also used as planting sticks: Plate 30) are usually made solely of wood, I will refer to them as ai suak in contrast to ai suak besi which has one or two metal points like the ai suak kiik (small digging stick). The latter is utilized in stony areas and mostly in permanent gardening which does not need deep tilling (Plate 39).

[10] Cited by Ormeling (1955:105). On the Aroki Plain 50-100 sq. m per man and per day were the rule against 20 sq. m on heavily grassed land.

per annum by each family.[11] Thus while each year a portion of new garden land is added as the fertility of the soil of the cultivated to'os declines certain sections of the plot are gradually abandoned. At this stage it can already be said that fila rai allows for longer periods under cultivation than lere.

Lere rai usually has to be repeated each year as weeds and old vegetable refuse have to be burned. Fila rai, in contrast, is often done every other year during the first few years. Thereafter it also has to be done annually. When yields decrease significantly and weeding becomes too burdensome and arduous (particularly if the farmer is unable to combat the rhizomatous grass, duut manu lain (*Imperata cylindrica*) the plot is abandoned. If the plot is on savanna land, it is quickly covered by grasses after abandonment. In the southern coastal lowland the tall perennial *Saccharum spontaneum* appears after a few years replacing the *Imperata*. This is often taken as a sign by the farmer, at least on the south coast, that the land is again ready for cultivation. In other parts of the Area, such as in the central highland and the region north of it, where no *Saccharum spontaneum* and only little imperata occurs, other plants serve as similar indicators, such as the small perennial woody herb, ai açu ain (*Stachytarpheta indica*) or the leguminous plant dagarassa (*Cassia tora*) and ai café (*Leucaena leucocephala* - erroneously classified as *L. glauca*).

From the description of the fila rai technique it follows that this type of cultivation is only feasible on deep, non-sandy soils. It seems to me that complete tillage is more effective in retaining soil moisture during dry spells than lere fields. As such it resembles in certain respects the

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[11] In addition to fila rai and lere rai the following labour input has to be taken into account for a one hectare to'os (H. Lains e Silva 1956:100-1):
a) 10-20 woman-days for sowing of batar, hare to'os and other subsidiary crops;
b) 30-40 woman-days for weeding which is indispensable where dryland rice has been planted;
c) 20 woman-days for the harvest.
Thus, a total of 100 man-days (for fila rai) and in between 60 to 80 woman-days are required for the whole operation till the crop is harvested. This does not include the time spent for the processing of the cereals like threshing and winnowing (a process that is very labour intensive), not to speak of the transport of the surplus products to the market.

'dry farming' method, by which evaporation of the soil is reduced as capillary evaporation channels in the soil are regularly destroyed through tilling. Concomitantly thanks to the crumbly texture of the soil surface, precipitation enters the soil more easily. Likewise owing to tilling the growth of weeds, which are detrimental to the soil moisture storage through their transpiration, is impaired during the non-vegetative period.

In spite of these advantages Timorese peasants only practise fila rai when they feel compelled to do so because of the great labour input. Thus the occurrence of fila rai in the Area can be taken as a clear indicator of population pressure.

To'os crops. The Timorese's staple crop is maize (Zea mays) (batar) which, being a typical to'os crop, is grown throughout the Area. A number of different varieties are grown which are distinguished by colour - e.g. batar mean (red maize), batar mutin (white maize) - and size. I observed as many as four maize varieties in a single plot. Thus, for example, the Timorese speak of batar boot (big maize) and batar kiik (small maize) (also called batar labarik) when they refer to the size and indirectly to the length of the growing period of the particular maize variety. Batar boot requires three months compared to two months for batar kiik, both when grown at sea level. The short time variety, also called batar lalais (= 'fast maize'), serves to provide food as soon as possible after the beginning of the cultivation period since reserves in storages are commonly depleted long before the first crop of maize is harvested. The vegetative periods of both maize varieties increase significantly with altitude, becoming three and four months respectively at Uai Oli (600 m) and a maximum of four and seven months respectively at Larigutu (1000 m) and Dara Hoba (1200 m) (Ossu, slope of Mt Mundo Perdido).

Maize is easy to grow: at the beginning of the rainy season after three consecutive days of rain, holes about 10 to 15 cm deep and about 50 cm apart are dug in a haphazard manner in the moist soil by means of the long ai suak boot. Then usually women place three kernels of maize and one or two of climbing beans (foré tali) (*Dolichos lablab*) in each hole. The purpose of this system of planting is to spread the risk by planting crops that have different soil moisture requirements. Batar, having a lower moisture requirement, usually succeeds even in drier years while foré tali which

climbs up the maize stalk grows only if the rain falls continuously from the time of the sowing of the seed to the harvest. Success or failure of the crop is, above all, contingent upon whether the first rain showers at the beginning of the rainy season are followed by heavier rains. If the latter fail to occur, the peasant has to resow when heavier rains appear.

In the autumn of 1969, for instance, peasants around Baucau/Venilale (i.e. in the northern portion of our Area) had to resow twice. After each of the first two sowings dry spells of several weeks occurred. Only after the third sowing did the rains fall continuously. The impact of such instances for the Timorese can only be gauged by someone who is familiar with Timorese agricultural practices and knows that the grain reserved for sowing hardly suffices for even a single sowing, let alone for private consumption.

In certain parts of the Area dryland rice (hare to'os)[12] is a concomitant of maize. Hare to'os is highly valued by the Timorese for its taste which is considered to be superior to that of hare natar (wet rice). It requires more moisture evenly distributed over the vegetative period than batar. Hare to'os, moreover, requires fertile soil. Hence it is usually only grown on flat land that is relatively free from weeds. In the Area it is thus only grown on freshly opened up land during the first few years. Apart from weeding, harvesting of dryland rice requires far more labour than maize. Thus, the area under dryland rice is usually smaller than that under maize.

Along with these cereals, the cultivation of which is highly seasonal, a number of subsidiary crops, chiefly tubers, are grown. Lekkerkerker and other authors (e.g. Gomes 1964: 5) have pointed out that in their opinion, long before the arrival of the Europeans, the Timorese were chiefly tuber-eaters, similar to the New Guineans. If it is correct that the introduction of maize into Timor is due to the Portuguese, it is remarkable how fast this cereal replaced the traditional tuberous crops as the mainstay of Timorese food. When Dampier (cited by Ormeling 1955:107) visited Timor in 1699 maize was already firmly rooted as the number one crop of the island.

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[12] In Tetum the following names are used for rice at different stages of preparation: hare - unmilled rice, fos - milled rice, etu - cooked rice.

In contrast to grain crops like maize and rice, tubers require less care in weeding and have wider sowing and harvesting tolerances. In the more humid central and southern parts of our Area root crops can be harvested virtually throughout the year and usually remain unpicked in the soil until they are consumed. Thus no storage problem occurs with root crops.

Among the root crops that are interplanted in conjunction with maize or rice are cassava (*Manihot utilissima*) (ai farinha); many varieties of yams like *Dioscorea alata* (uhi), *Dioscorea aculeata*, *Dioscorea esculenta* (kumbili), *Dioscorea hispida* (kuan); yam bean (*Pachyrrhizus angulatus*) (cincomas); taro (*Colocasia esculenta* and *Alocasia* sp.) (talas or keladi); and sweet potatoes (*Ipomea batatas*) (fehuk midar).

While cassava and sweet potatoes are customarily planted by burying the vines in the soil, taro and the many varieties of yams are grown by replanting the upper portion of the tuber while the lower one is consumed. The maturation period for the various tubers is greatly influenced by the soil, e.g. at sea level cassava grown on light loamy or calcareous soil (CR) from sandstone and coral reef limestone takes five months against nine months on heavy clay soil (CN). But altitude and thus temperature also have a bearing upon the maturation period, e.g. more than 18 months are needed at Dara Hoba (1000 m) for the plant to mature. To avoid seasonal shortages root crops are kept at several stages of development.[13]

In association with the aforementioned root crops a number of subsidiary plants are cultivated, the majority of which were introduced since European contact. Of the latter the most popular are various types of pulses:

Peanut	*Arachis hypogaea*	fore rai
Cow pea	*Vigna sinensis*	fore sikoti
Bonavist bean) Kidney bean)	*Dolichos lablab*	fore tali
Broad bean	*Vicia faba*	fava
Mung bean) Green gram)	*Phaseolus mungo* var. *max.*	fore mungo
Black gram	*Phaseolus mungo* var. *radiatus*	mungo metan
Lima bean	*Phaseolus lunatus*	koto fuik

[13] Similar to the highlands of Eastern New Guinea (pers. comm. Prof. U. Schweinfurth).

French bean	*Phaseolus vulgaris*	koto dian
Pigeon pea	*Cajanus indicus*	tunis
	Cajanus cajan	
Soy bean	*Glycine hispida* max. *(soja)*	soja

Besides pulses other vegetables introduced by Europeans include onions (lis), cucumbers (caban), squash, pumpkins (lakeru), potatoes (fehuk Europa), cashew nuts, sesame (lena), castor-oil plant, sugar-cane and pepper (cf. Gomes 1964: 179-80).

Enclosure. All cultivated land in the Area is enclosed to keep freely grazing livestock, particularly domesticated pigs, as well as wild animals from marauding in the to'os and natar. The fence, called lutun in Tetum, is made of various types of material depending upon local vegetation. In the palm savanna of the Southern Foothill Zone leaf stalks of the corypha palm and bamboo poles of the spiny bamboo are commonly used (Plate 31), while fences in the central mountains consist chiefly of *Eucalyptus urophylla* and *Eucalyptus alba* branches which are wedged between upright posts. On the Baucau Plateau and in parts of Quelicai which are heavily deforested, people resort to blocks of limestone for fencing (Plate 40). Because of their pitted surface, these form a solid wall. Finally, throughout the Area living fences are commonly made of *Jatropha curcas* (ahi oan mutin), *Hibiscus tiliaceus* (ai feu), *Gossypium hirsutum* (ai kabas), *Agave sisalana* (tali belanda), cordyline shrubs and castor-oil plant (*Ricinus communis*) (ahi oan).

Moreover, for fencing purposes the Timorese avail themselves of natural boundaries like steep river beds and precipitous escarpments. Since to'os are often laid across old paths, stiles are constructed to provide crossing places over the fences. In contrast to fences made of branches and stones which usually decay after abandonment of the field, living fences continue to exist for many years after the cultivator has moved somewhere else. Thus the old layout of the fields often remains visible.

Fence construction is by no means an easy task; it is one to which the shifting cultivator has to devote considerable time. Field observations have shown that, for example, in the palm savanna of the Southern Foothill Zone the construction of a fence of about 100 m made of palm leaf stalks

(bebak) of the corypha palm takes one person two weeks.[14] Thus the fencing of one hectare would then take a person roughly eight weeks. In the absence of a detailed analysis of labour input in Timorese to'os cultivation, this example provides only an approximate idea of the considerable effort and amount of time required for fence construction. Studies by Leendertz and Lobach (Ormeling 1955:199) in Indonesian Timor revealed that fence-building in grasslands and in forests took about one-third to one-fourth of the total labour input. Moreover, for the upkeep of the fences the peasants have to spend additional time.

Wet rice cultivation

As outlined above, Timor's present land use pattern bears witness to the island's transitory role between the migratory type of land occupation dominant in the eastern half of the archipelago - particularly the root crop eaters of the Moluccas and New Guinea (Melanesia) and permanent rice land cultivation prevailing in the western half of the archipelago - particularly in Java, Bali and Lombok. Elements of both types of land use are intricately interwoven in Timor in accordance with local environmental conditions. Thus, wherever sufficient water supplies are available in flood plains, in the vicinity of springs or locally even in coastal swamp land, permanent wet rice cultivation is practised. The amount of land suitable for wet rice cultivation (natar) is thus limited.

While almost every Timorese has a to'os, only a fraction of the cultivators has a natar. On account of the highly erratic rainfall rice production varies greatly. Given the present level of agricultural technology, only a single crop of rice per year is harvested throughout our Area. Moreover, compared to classical rice growing areas like Java and Bali, agricultural practices on Timor have to be considered archaic. Rice yields are extremely low. Generally speaking in recent years rice (mostly of the non-glutinous indica variety) has been in short supply so that it has had to be imported on an increasing scale.[15]

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[14] The construction of eucalyptus fences involves, of course, considerably more time.

[15] Rice is not an everyday food in Timor and hence is mostly served on festive occasions.

The methods of paddy cultivation on Timor vary according to the water regime, the availability or lack of supplementary water, topography, the nature of the soil, and the labour obtainable. The methods can be described as consisting chiefly of either broadcasting (kare hare) of the rice seed or transplanting of nursery-grown rice seedlings. These two systems of cultivation are practised on inundated as well as on irrigated paddy fields. The former are either solely dependent upon rainfall or upon rainfall supplemented by surface runoff from surrounding land of higher elevation.

It seems mandatory at this point to outline briefly the chief characteristics and implications of the various forms of wet rice cultivation.

Broadcasting method (kare hare). Traditionally, the most widespread method of paddy cultivation in Timor has been broadcasting. Generally, paddy fields are prepared for planting soon after the first rains or, water conditions permitting, even earlier. The water is allowed to stand in the field for several weeks to soften the ground and to drown out the weeds. With the help of buffaloes (karau), and occasionally also horses (kuda), the soft muddy soil is thoroughly trampled (sama natar).[16] This natar treading consists of driving a herd of water buffalo over the natar till the mud assumes a certain consistency (Plate 32). Depending upon the type of soil sama natar is repeated once or twice. This technique is, of course, very laborious, for at least three men or boys are needed to drive the herd of buffaloes across the field and to prevent the animals from destroying the bunds. Thus it is not surprising that the time needed for a first natar treading of one hectare (according to my own observations) amounts to 2-2.5 days if 30 to 40 buffaloes are utilized.[17] The time needed for

[16] This method of preparing the paddy field is apparently also known in other parts of the Lesser Sunda Islands, like Flores and Sumbawa (see Fiedler 1929:65ff). In Indonesia this technique is called merantjah sawah. No ploughs or other machinery are used in this process.

[17] These figures are considerably lower than those provided by Ormeling (1955:190) who reports that for the preparation of a one hectare rice field 2000 animal hours are needed. Ormeling also cites Hoekstra who reports that 500 buffalo hours and 100 man hours are necessary per hectare on Sumba Island. H. Lains e Silva (1956:105) estimates that for the

treading, moreover, varies with the amount of water in the field. If plenty of water is available in the field only two days are required for the first 'ploughing'. The second treading usually only takes 1.5 days and is done briefly before sowing to kill the weeds that have emerged since the first treading.[18]

In a few places where buffaloes are scarce, for example, in Venilale, parts of Baucau, and Quelicai, horses are occasionally also used for sama natar. Because of the smaller hoofs this method is less efficient, and it is generally only the poor man who has to resort to horses. At Uato Uai (suco of Gari Uai, Baucau) the author observed that a field of 1584 sq m was prepared for planting by four horses in four days (first treading) plus two additional days (second treading).

Once sama natar is completed and kabubos (small dikes surrounding the rice fields) repaired (Plate 33) the field is ready for sowing, before which the water on the field is drained. The sowing of a one-hectare field is done by one man in a single day (see also H.L. Silva 1956:105). The amount of seed required varies greatly with the type of soil. While 5-6 latas[19] corresponding to 60-72 kg of rice seed are needed for broadcasting a one hectare paddy field with clayey soil (e.g. around Baucau village) about 8-10 latas (100-125 kg) are required on more sandy soils for the same size of paddy field (e.g. along the estuary of the Seiçal River).

Water is again let into the field five days after sowing. During the following period when 4-5 rice leaves have appeared, the natar is drained and irrigated on alternate days. Thereafter the Timorese tend their paddy fields very little. They seldom weed them more than once. At the grain

17 (continued)
complete preparation of a one-hectare natar (probably with at least two treadings) 20 buffaloes for twelve days are required. Our figure roughly corresponds to that estimated by the MEAU which gives a figure of 25 to 30 buffaloes required for two days for a one-hectare natar (Bizarro 1967b).

18 Rice fields that show decreasing returns are often 'ploughed' three times.

19 The Timorese customarily use bulk measures rather than weight measures. A lata is a 20-litre oil tin equivalent to 12.8 kg of unmilled rice.

maturing stage the peasants go to their fields and spend nights in a small hut (uma natar) in the paddy field scaring away marauding birds.

Harvesting of the rice is usually done by women who cut the rice stalk about 20-30 cm below the panicles with a small curved knife. Subsequently, the panicles are bundled and laid on the top of the kabubo to dry. According to H. Lains e Silva's estimates (1956:105) it would take 20 woman-days to harvest one hectare of paddy land. After 4-5 days in the sun[20] the rice is bundled and carried to a central threshing ground. The place is cleared, levelled, hardened and finally covered with a mat (biti). At times a small bamboo shade made of leaves is built over the threshing area. A loose loop hanging from the roof serves as a support for the thresher. The threshing method varies but is usually done by men trampling (Plate 34). For this, small bundles of rice panicles are rolled back and forth on the mat on the ground before the thresher jumps on the bundle to dislodge the grain from the panicles. When enough grain has piled up on the mat it is picked up on woven palm trays and winnowed by tossing the grains into the air several times to let the chaff and empty hulls blow away. Instead of tossing, the grain may also be poured out on the mat (Plate 35). The rice is then heaved into a temporary storage basket. Infrequently threshing may also be done by means of horses which are driven over the stalks to separate the grain from the panicles. The winnowing of the rice may sometimes be associated with a feast to which the owner of the rice crop invites relatives and friends who, after consumption of considerable quantities of tuak,[21] dance and trample on the rice all night through till the harvest is completely threshed. H.L. Silva

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[20] It often occurs that unexpected heavy rains lasting several days may cause serious damage or even complete destruction of the rice stalks on the kabubo, as occurred in November/December 1970 in Narequici (Uato Lari). Moreover, should the rice be stacked on the threshing spot while still moist, it would mildew or ferment inside the stack and pick up moisture.

[21] Tuak is a common beverage derived from the sugar palm *(Arenga saccharifera)* (ai tua metan). The word tuak or tuaka is also applied to similar beverages obtained from either *Corypha utan* or *Borassus flabellifer* palms.

(1956:105) assumes that, on the average, the threshing requires 50 man- or woman-days per hectare. The threshold rice is then brought home in carrying baskets (ganta) and stored in huge mat baskets called hokas in Tetum.[22]

The first requirement after harvesting is to select the best rice grains and to store them as seed. However hungry one may be and irrespective of when one runs out of rice, this seed rice is not to be touched. The amount of seed rice saved, however, seldom suffices, since reseeding is often necessary on account of the variable rainfall. Shortages of seed rice are liable to have serious effects on the food situation. The impact is, however, generally mitigated by inter-family gifts of seed rice. Only that portion of rice that is each time assigned for immediate consumption is milled in the traditional way by means of pestles and wooden mortar. Today, however, Timorese often have their rice milled for a nominal fee in government-run rice hullers - as in Baucau and Viqueque. A far smaller loss is incurred by this method than by the traditional method.

The hectare yields obtained by the broadcasting method are extremely low. Depending upon the rice variety and indirectly on the type of soil, they range between 500 kg and 1 ton.[23] However, in contrast to the transplanting method discussed in the following paragraph, the broadcasting method requires relatively little labour.

Transplanting method. Transplanting, though still practised only by a relatively small number of peasants in the Area (which I would estimate to be less than 20 per cent of all peasants), is becoming increasingly important in view of the rising population pressure, since it yields far better results than those obtained by broadcasting.

It differs from broadcasting only as far as the

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[22] These hokas measure 1.50 m in diameter and about 1.50 m in height.

[23] In exceptional cases three tons were reportedly obtained on deep clay soil in Manatuto (MEAU, Relatório 1965:3). The same yields were reported for Barique (Concelho of Manatuto) in 1968/69 as well as in Manatuto with IR-8 (pers. comm. by Administrator Geraldes Freire of Manatuto, 4.9.1969).

establishment of a nursery bed and the transplanting of the young seedlings are concerned. The rest of the methods involved corresponds to those described under the broadcasting method.

The establishment of a nursery bed[24] involves the selection of an irrigable site; thus usually one near a water source, either rivers or springs. The nursery bed, which is puddled in the same way as the paddy fields, receives two buffalo treadings 25 days apart. Then the water is drained off and the mud is levelled by a piece of wood. Following that, the field is allowed to dry for several hours to allow the mud to settle and thereby to prevent the seedlings from sinking too deep. The rice is sown into soft flat mud. Sowing of the nursery bed takes place 25 to 30 days before the chief paddy field is expected to be ready for transplanting. After that period seedlings are expected to be strong enough for transplanting. More often than not, however, transplanting is carried out no sooner than 30 to 40, in some instances even as much as 50 days after sowing. This is the result of a shortage of water for the preparation of the natar as well as of a shortage of personnel and buffaloes, which cannot all be made available at the right time. The owners of buffaloes and those of paddy fields are often not identical. Pooling of resources is therefore necessary before paddy cultivation can commence. Contrary to the practices in other parts of the archipelago, the seed is not sprouted before broadcasting. After sowing the nursery bed is left to dry for five to six days. When the seedling is well-rooted, water is let into the nursery bed, 5 cm high for 48 hours, then drained again and kept dry for five consecutive days. From then onwards the nursery bed is kept under a low film of water. During that time the natar is prepared in much the same way as was described for the broadcasting method. One day before transplanting, the seedlings which have attained 20 cm are uprooted several at a time and have the mud cleaned off.

Transplanting, which is done by a large group of people on the basis of mutual help, takes place in the drained paddy field. The seedlings are simply pushed into the soft mud at varying distances from one another, ranging between 20 and 30 cm. From three days after transplanting till flowering

[24] If one hectare of paddy land is to be planted with seedlings, the area of the nursery bed would be roughly one-tenth of a hectare.

the field is kept under 7 to 10 cm of preferably running water, while from then on till maturation stage the water cover is increased to between 15 and 20 cm. Owing to the shortage of water, however, the peasants often have to content themselves with less water, since the water cannot be kept running. In these cases only a limited amount of water is let into the natar at a time, and it is not replenished until the field is almost dry. After the rice has been transplanted, each peasant tends to his own weeding and watering until harvest time.

About two weeks before harvest time, the water is removed from the paddy field. Harvesting and threshing are done in much the same way as for broadcast rice.

The transplanting method, though demanding a great deal more work than the broadcasting of seed, yields far superior results, chiefly on account of wider spacing and cleaner cultivation due to weeding. Instead of over 100 kg (= about eight latas) needed for broadcasting, only 35-45 kg of seed (= about 3-4 latas) are required per hectare for transplanting. Conversely, for the transplanting of one hectare of paddy land, at least 100 man- or woman-days are required (as against 1-2 man-days for broadcasting) let alone the time needed to prepare the seedbed for which no exact figures could be ascertained. This high labour input is, however, the price for higher rice yields, which are almost twice those obtained by the ordinary broadcasting method; that is, yields normally range between 2 and 3 tons/per hectare without fertilizing[25] and up to 5.45 tons/per hectare if fertilizer is applied. (MEAU, Relatório Anual 1963:5).

Types of paddy fields. The discussion of wet rice cultivation in Timor would not be complete without a detailed account of the impact exerted by water as the overriding factor limiting agricultural activity and particularly that of paddy cultivation. According to the type of water source two sorts of paddy fields have to be differentiated.

Firstly, there are paddy fields entirely dependent upon the local rainfall stored in the bunded rice field. This type of rice field, which we shall term inundated paddy field, is thus completely rainfed and, at most, received supplementary runoff water from the surrounding land of higher

[25] Pers. comm., Tecn. Agr. Nhen Sui Siong, MEAU, 25.2.1970.

elevation. Proper water control in harmony with water requirements of the rice plant is not feasible. The risk involved in the cultivation of wet rice on these fields is considerable. Consequently, these fields are the first to fail in dry years, or in years with rainy periods interrupted by prolonged dry spells.[26]

The high degree of rainfall dependency starts with sama natar for which water is indispensable. After that, all water that has accumulated during the time has to be drained again. This means that shortly after planting rain must fall to ensure a steady growth. At that stage the plant is particularly vulnerable. Rice is merely broadcast on these fields because of the highly irregular supply of water. Here the farmer has little or no influence on the growth of the rice plant. As a rule, the longer the plant remains under water the longer the vegetative growth period and hence the higher the yields. An early cessation of the rainfall on the other hand, particularly at the time of panicle formation, leads to early ripening and to lower yields. While a shortage of water is the rule on rice fields with impounded water, an excess of water can apparently also cause a problem. This was the case in November 1970 in Gari Uai where the peasants had to dig irrigation channels to get rid of excess water on rainfed rice fields in the vicinity of the Baucau-Venilale road.

While inundated paddy fields are utterly rain-dependent and thus in some years not worked at all, the rainfall dependency is less pronounced in the second less common type of natar which is irrigated. These fields are fed by either a spring or by water from a river which is dammed by a simple brushwood dam built half-way across the river at an acute angle. This dam is made of wooden stakes, bamboo, rattan, stones, earth and grass. The water rises to the level of the height of the dam. While the surplus water overflows, the dammed up water flows into a water course which carries it to the paddy field. These canals often run for miles at almost the same elevation along the slope of a mountain. The rice land below this canal is then irrigated, while the rice land lying above it is rainfed. A number of cultivators, whose land will benefit from the water, join in the construction and maintenance of the dam as well as the opening

[26] When it does not rain for 10-15 days after the broadcasting or planting of the rice, reseeding is necessary, as happened in the fall of 1969 in Loilubo (southwest tip of the Baucau Plateau).

of the canal. The distribution of the normally scarce water is in the hands of a kabo bé who is assigned to this job by consensus of the peasants concerned. Nevertheless, disputes over water rights often lead to bloody quarrels. These brushwood dams are seldom able to withstand strong floods caused by torrential tropical rains. Therefore the canals have to be repaired almost annually,[27] and frequently even several times during the year when unexpected intermediate heavy rains, which are typical of Timor's highly erratic rainfall regime, lead to repeated destruction of the dam.

The Timorese usually wait to repair the dam till after the force of the water has decreased. As a consequence the entire cultivation cycle may often be upset or at least shortened. Under these circumstances it is extremely difficult for the Timorese peasant to arrange for buffaloes and for help of relatives and friends for transplanting, broadcasting, weeding, etc. Still, by comparison with inundated paddy fields, irrigated paddy fields imply a smaller risk for the Timorese peasant in terms of the availability of water. This is the reason why transplanted rice is preferably grown on irrigated fields, i.e. on land with good water control, provided sufficient labour is available for transplanting.

In places where fresh water is available throughout the year, as, for instance, near springs, double cropping on paddy fields is common: a rice crop in the first season from November to June and irrigated maize (batar bé), sweet potato (fehuk bé) or onion (lis) crop in the second, drier season (July to November) (Plate 38). This type of crop rotation is not feasible on heavy clays in spite of favourable water conditions at higher altitudes. These rice fields are irrigated with spring water which contains few nutrients. Therefore the rice yields are usually low. To ensure a good crop of batar bé, twigs, branches and leaves of lopped *Casuarina junghuhniana*, *Schleichera oleosa* and other trees are burnt (the ash serving as fertilizer) on the drained rice field. It is then thoroughly moistened before the maize is planted. After one week, when the small maize seedlings appear above the ground, the earth is loosened around the plants

[27] Although canals are commonly made of clay and earth, Duarte (1930:312) reported concrete dams already in the Baucau area before 1930. In 1969-70 I did not come across any concrete dams in the Area.

to allow the roots to spread in the otherwise compact soil. Thereupon every four to five days the field is irrigated by splashing with water that is conducted in low parallel furrows in between the maize plants. When the plants have attained about 40 cm in height the fields are irrigated only once every couple of weeks. Except for this special case of batar bé cultivation no manuring or fertilizing is carried out on either to'os or natar in the Area.

On the other hand, in view of the relatively simple agricultural techniques so far discussed, the visitor is bewildered by the ingenuity the Timorese display in the construction of their rice terraces. These may cover entire slopes and thus constitute an excellent way of controlling erosion (see Plates 2, 10 and 37). The impact of man in transforming the landscape is certainly most impressive in these terraced natar. At this point, it must be stressed that the construction of rice terraces on steep slopes of Bobonaro Scaly Clay may constitute an erosion hazard since continuous irrigation may render the entire hillside unstable. This was the case in Uato Iro (suco of Uma Ana Ulu 1) on the west slope of the Baucau Plateau at 600 m altitude where excess water led to waterlogging, transforming deep lying impermeable layers into greasy slipways (rai kois) over which a huge portion of water-soaked earth suddenly skidded downhill destroying natar and to'os alike.

Permanent gardening

This form of cultivation which is practised by every Timorese in the Area plays an important part as a source of food supply in the peasant economy. These to'os kiik (house gardens) are a conspicuous feature of native agriculture. The observer sees before him a diversity of plants in seeming disorder. A number of fruit trees, bamboos and bananas interwoven with climbing and winding plants, vegetables, tubers, etc. may give these gardens a look of the jungle. The term 'mixed garden' therefore seems to be very appropriate. In contrast to the shifting to'os these mixed gardens are cultivated permanently on individually owned house sites. Private ownership of the plot seems to be a necessary prerequisite for mixed gardening.[28]

[28] See also Terra (1954:34) who discussed this type of horticulture for Java.

The chief characteristic of these gardens - which are too small to be mapped as separate units on the land use map (Fig. 25) - is their ability to produce fruits, vegetables and tubers throughout the year for private consumption as well as for barter and sale on the local market. The produce of these gardens thereby affords some income at all times. Moreover this system of interplanting annual crops with perennial fruit trees offers the advantage of bridging the nonproductive years of the trees.

Since market orientation is a young phenomenon in the Area, mixed house gardens primarily serve to furnish food for private consumption of the peasants. Without attempting to go into any great detail, some of the more prominent plants cultivated in these house gardens should be mentioned (see Gomes 1964).

Among the fruit trees the following are particularly common: bread-fruit (*Artocarpus altilis*) (kulu), jak-fruit (*Artocarpus integer*) (jaca), mangoes (*Mangifera indica* and *Mangifera caesia*) (has), various species of jambus (*Eugenia* spp.), lemon trees (*Citrus medica*, C. *hystrix*, C. *aurantifolia*, C. *sinensis*), grapefruit (*Citrus grandis*), pawpaw (*Carica papaya*) (ai dila), cantaloupe (*Cucumis melo*), soursop (*Annona muricata*), bullocks heart (=sugar apple) (*Annona reticulata*), Bael fruit (*Aegle marmelos*), almond (*Canarium indicum*), kapok tree (*Ceiba pentandra*) (ai lele), cashew nut (*Anarcardium occidentale*) (caju), candlenut tree (*Aleurites moluccana*) (ai kamii), and coconut tree (*Cocos nucifera*) (nu). Underneath these trees bananas (*Musa paradisiaca*) (hudi), plantains, sugar-cane (*Saccharum officinarum*), cassava (*Manihot esculenta*) (ai farinha) and yams (*Dioscorea* spp.) (kumbili, kuân, uhi) are planted.

The ground cover on the other hand contains a large number of vegetables, tubers, cereals, and spices. Apart from those plants also cultivated on the shifting to'os, the house garden usually contains plants which are needed for the daily menu or for use at home. To name a few: pepper vines (*Piper betle*) (malus),[29] cotton plant (*Gossypium* sp.) (ai kabas),[30] pepper (*Pimenta officinalis*) (piri-piri), sesame

[29] These are needed for the common betel chewing, a stimulant for which also Areca nuts (bua), lime (ahu) and fruits and leaves of the pepper vine are required.

[30] This is used for the manufacture of the handwoven cloth (tais) which is commonly worn around the hip.

(*Sesamum indicum*) (lena), turis (*Sesbania grandiflora*) (turis),[31] castor-oil plant (*Ricinus communis*) (ahi oan or luhul),[32] tobacco (*Nicotiana tabacum*), *Capsicum annum*, pumpkins (*Cucurbita maxima*, *Cucurbita mosdata*, *Mormordica charantia*) (lakeru), cucumbers (*Cucumis sativus* var.), various pulses, and some sorghum (*Andropogon sorghum*) (batar ai naruc).[33]

Whereas most annual crops grown in mixed gardens are generally the same throughout the Area - most of these annuals only differ in terms of length of the vegetative period - there are considerable regional differences as to the assortment of perennials such as trees grown in such gardens. While most useful trees listed above occur in the moist zone south of the central uplands, there is only a small assortment of them to be found in the dry region of the north. In the latter particularly *Aleurites moluccana*, *Artocarpus integra*, *Morinda citrifolia*, *Anona squamosa*, *Aegle marmelos*, *Citrus reticulata* and *Mangifera indica* seem to flourish.

In the central mountainous section above 800 m the assortment of useful trees is even smaller on account of the lower temperature. A conspicuous feature of house gardens above this altitude is the absence of coconut trees, areca and candlenut trees, as well as mangoes (above 1000 m) - the four chief types of useful fruit trees in Timor. At this altitude lemon, lime and orange trees dominate instead.

The Area's chief cash crops which are either sold to the local cantina (Chinese shop) or to the weekly market, are copra, candlenut, areca, maize, rice and tobacco, depending upon the locality. Fruits like bananas, pineapples, oranges and mangoes as well as vegetables rank second as cash crops in the native economy.

The list of cultivated plants in Timor is considered to be one of the shortest of the eastern islands (cf. FAO 1960: 159). This phenomenon may be attributed to the long duration of the dry period which reduces the number of species in

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[31] The large petals as well as the leaves of this plant are relished as vegetables.

[32] Castor oil is used for torches.

[33] Sorghum is very rare in our Area. The only place where I found sorghum was on a field behind the Baucau hospital.

general, as well as to the fact that the Timorese still rely considerably on the resources of wild plants. When crops fail they return to wild plants from which they derive not only food but also medicines,[34] dye-stuff, fibres, glue, insecticides, oil for illumination, poisons for fishing, etc.

Useful trees and bushes that in other parts of the Indonesian Archipelago are often grown in house gardens but which grow wild in Timor include *Tamarindus indicus* (ai sukair), *Psidium guajava* (guajaha), *Metroxylon sagu* (rombia)[35] *Cordyline fructicosa*, *Bauhinia tomentosa*, *Leucaena leucocephala*, *Arenga saccharifera*,[36] *Zizyphus mauritiana*.[37]

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[34] Meneses (1968:65 ff) gives a good account of native medicines and their alleged therapeutic effects. (See also Cardoso 1902.)

[35] In some places, for instance in Luca, this tree is also planted in swamps.

[36] The Arenga palm (ai tua metan) is the chief source of tuak, the Timorese palm wine. The juice is derived from 9- to 12-year old trees. As soon as the male inflorescence (cyme) is formed the stem of the palm at this spot is beaten (the reason for this is not entirely clear) for seven days before the cyme is cut off. The juice is collected in a bamboo receptacle which is hung underneath the cut-off inflorescence. Daily production is between 4-5 litres and may be maintained for up to five months. At times several fruit stems may supply juice simultaneously. Upon collection of the juice the acid bark of several trees - particularly *Schleichera oleosa* (ai dak) - is added to retard fermentation. The unfermented beverage has to be consumed immediately. Alcoholism does certainly constitute a serious problem, as tuak is also derived from *Corypha utan* (ai tali) and *Borassus flabellifer* (akadirun). Moreover, fermented and distilled beverages known as tuak sabo in Tetum, are very popular. The trunk of the Arenga palm also yields starchy sago while the leaf sheaths are covered by a rough black fibrous material (gamuti) that is considered as a fine thatching material as well as being used for the manufacture of ropes (tali).

[37] Forestry as a type of land use practised by the local population is not known in the Area. The so-called village forester, in Tetum called makleat, simply makes sure that villagers respect ownership rights of each others' fruit trees. No afforestation is carried out by the local population.

Livestock grazing

Besides to'os and natar cultivation livestock keeping is an intrinsic part of the life of the Timorese. Livestock is kept on an extensive basis in a seemingly uncontrolled way. Free ranging livestock, either big livestock like buffaloes, horses and Bali cattle or small livestock like pigs, goats and sheep are conspicuous. Hence, we cannot speak of animal husbandry, as the larger livestock is usually turned out on grazing grounds to fend for itself. As a rule the animals receive very little care. At most, an attempt is made by the holders to keep the herds together in order to prevent straying. Likewise the animals are not regularly corralled or penned, except at the time of harvest in order not to jeopardize the crop.

Livestock owners seem to be more concerned with numbers than with the condition of their animals (see also FAO 1960:163), which have to rely on whatever food they can find on ranges, cropped to'os and natar. As a consequence, while stands of grasses remain ungrazed, a shortage of feed occurs during, and particularly at the end of the long dry season. At this time of the year especially big livestock, emaciated to the bones, offer a pitiful appearance.

Still, livestock keeping is of great social significance. In this context, water buffalo rank first. They are assumed to have been introduced into Timor from the west (probably from Java along with the technique of wet rice cultivation) before the advent of the Europeans in the Malayan Archipelago (Ormeling 1955:112-3). In Timor buffalo are kept for prestige and sacrificial purposes. As such, the wealth and social ranking of a Timorese is directly correlated with the number of buffalo he owns as well as with the length of the animals' horns. The longer these are the more prestige they bring to the owner. The horns are measured by pardau, roughly equivalent to 22 cm - the length of the palm of a hand. This measurement is still customary today among Timorese. It is natural that the seller usually tries to measure the pardaus on the outer (= longer) side of the horns while the buyer, of course, tries to take the inside for measuring. Conflicts have arisen between the traditional concept of the value and usefulness of a buffalo and the modern westernized ideas of livestock management. As the price of buffalo meat sold in the municipal abattoirs is fixed by weight rather than by the length of the horns, the problem arose in Dili

before 1958,[38] when the official price was below that obtained on the basis of pardaus. Eventually the buffalo owners had to be forced to sell their buffaloes at the official price and, moreover, to sell young animals (R.P.S.V., Rel. An. 1968:6-7). As a rule the Timorese do not keep buffaloes primarily for commercial purposes, but rather for ceremonial occasions like weddings (barlaque) as a bride price (see Jorge Duarte 1964), for funerals, as well as for sacrifices. They are therefore generally reluctant to sell.

Another aspect of the keeping of buffaloes which has already been touched upon earlier is its use for 'ploughing' or rather treading of the natar. For one thing, the labour input which is required to keep buffaloes on the rice field during treading (sama natar) is disproportionate to the returns. It is astonishing that this archaic way of wet rice cultivation, which is still existent in the eastern parts of the Malay Archipelago, has not been replaced by trained yokes of buffaloes which plough rather than trample the rice field. It has been estimated that in order to prepare a one hectare paddy field only three days are required for a ploughing with a yoke of trained buffaloes and one person. This contrasts with 10-12 days with 20 buffaloes and 3-4 boys for sama natar (H. Lains e Silva 1956:105). Although ploughs were already introduced under the Administration of Governor Filomeno da Câmara (1911-17) (Duarte 1930:311), these and subsequent efforts have not been met with any positive response on the part of the Timorese. They have no tradition with metal tools and were therefore not able to repair the ploughs which were easily damaged in the rocky fields. Since spare parts were not available in this island, and since European ploughs from Portugal seemed too heavy for the relatively slender Timorese, the idea of using ploughs for paddy cultivation was soon discarded.

Besides the high labour and buffalo input sama natar has, however, another serious drawback which should not be underestimated. As a result of constant trampling by buffalo hoofs at a depth of about 0.5 m an impervious clay layer builds up which impedes percolation. Aeriation so essential to a fertile paddy field is interrupted, water tends to stagnate and sulfides are formed which harm root development. Productivity of the natar is thereby considerably reduced.

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[38] Until that time buffalo meat was the only type of meat sold on the public market in Dili.

The current low rice yields are to no small degree likely be due to the particular consequences of this type of cultivation.

In contrast to the water buffalo which is not as efficiently used in Timor as in similar environments in other parts of Southeast Asia, the horse (kuda) is intensively utilized as mount and pack animal (see Valdez 1926). For transport purposes it is simply indispensable on the small paths in the interior where wheeled traffic is ruled out owing to lack of roads. In some instances, e g. in Venilale because of the shortage of buffaloes, horses are often used for sama natar, although it takes far longer than with buffaloes. The Timorese horse has an average size of about 118 cm[39] (FAO 1960:225). It is small but strong and sure-footed, perfectly adapted to the diverse relief of the island. Fiedler (1929:68) attributes the strong bony structure of the Timorese horse to the limestone soils and their particular vegetation on Timor. On the other hand horses are more particular about their feed than buffaloes.

In contrast to buffaloes and horses, cattle were introduced in Timor much more recently. The first attempts in this direction were undertaken by the Administration of former Dutch Timor which as early as 1912 (Ormeling 1955:155) began to import Australian, Madura and Bali cattle. An increasing preference was shown for the latter strain (*Bos sundaicus*) which proved very satisfactory in the Timor environment (Table 26). Although statistics show a total of over 600 head of cattle (1913) in eastern Timor[40] surprisingly enough no effort was made by the Portuguese administration to introduce cattle into the native economy on the eastern half of the island. The lack of initiative of the Portuguese administration in this matter may be partly accounted for by the fact that in eastern Timor coffee had become firmly rooted as a cash crop around the middle of the nineteenth century. Coffee was probably considered as providing enough incentive for the commercialization of the economy while in western Timor this role was exclusively taken over by cattle which henceforth became the export item no. 1.

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[39] Ormeling reports 115-120 cm (1950:115), while for the Belu horse he quotes 130 cm.

[40] Presumably concentrated in areas along the border with west Timor from where the cattle has probably been imported.

Be it as it may, in 1956 (R.P.S.V. Rel. An. 1967:5) a system of raising Balinese cattle on government farms was initiated. The cattle were subsequently distributed (each time ten cows and one bull) free of charge to applicants under the condition that they had to replace the same number of cattle in a period of 4-5 years. This policy, laid down later in *Portaria* no.3 271 of 8 February 1964, which was similar to that practised far earlier in western Timor, proved very successful as evidenced by the development of the cattle population illustrated in Table 26 (p.194). It shows that before 1955 the cattle population was well under 10,000, but within a period of five years jumped to over 24,000. This upward trend has continued since so that at the end of 1969 67,039 head of cattle were reported for the whole of the Province.

However, in contrast to what happened in western Timor (Ormeling 1955:159) the increase of the cattle population was not accompanied by a decrease of the buffalo population. The economic advantage of cattle has certainly not yet been widely recognized by the population in Timor's eastern half. Until now the cattle had been distributed preferably to evoluidos - i.e. to those who can read and write - thus mainly to chiefs, Europeans and Chinese who are believed to provide better care for their animals than others. In giving preference to the local chiefs the Portuguese government attempted by way of the former authority (i.e. chefe de suco) to introduce cattle more rapidly to the masses. Until today, however, no real bandwagon-effect has been observed. On the contrary, in the village of Lospala (near the administrative centre of Lospalos) and in Lautem the author made the observation that common Timorese (ema; not aristocrats or chiefs) felt that cattle were considered as a status symbol of the liurai (today meaning chefe de suco).

To make such a distribution policy work two cattle centres (Centro Pecuário) were created at Lospalos (Concelho of Lautem) in the east in 1961 and Same (south coast) in 1962.[41] Although it is a declared objective of this new livestock policy gradually to replace buffaloes with Balinese cattle, a number of factors has inhibited the rapid success of the

[41] In 1954 such a Centro Pecuário was opened in Ossu (called Estação Zooténica de Ossu) which proved a failure, allegedly because of the poor quality of the surrounding pastures on mostly heavy clay soils (CN). The station was discontinued in 1960 when the Portuguese Army took over the facilities.

cattle policy. To name a few, probably the strongest factor has been the lack of incentive on the part of the majority of the Timorese to improve their lot. Lack of initiative is not easily overcome. Moreover, the cattle do not fulfil the same function as buffaloes - in contrast to western Timor cattle have not been accepted as a bride price in Eastern Timor; neither can they be used for ceremonial purposes nor, at least in the eyes of the Timorese, for natar treading. Also, cattle need more care than buffaloes for they have to be corralled daily lest they turn wild. Herding and corralling are particularly necessary in the high grass plains (*Saccharum spontaneum* and *Imperata cylindrica*) of the south coast (Plate 23). Less care is required for instance in the short grass areas on heavy clay soils (CN) in the Ossu region.

On the other hand, cattle raising has clear advantages, for the animals are less susceptible to the effect of the dry season than are buffaloes. The gestation period is 9 versus 11.5 months; cattle have thus a higher rate of reproduction (see R.P.S.V., Rel. An. 1968:7). Finally, young cattle are said to be more resistant to diseases than buffalo.

Despite these advantages and the fact that the meat of Balinese cattle finds a ready market in Timor (Chinese, Army personnel, European residents) the Timorese of Eastern Timor on the whole are still reluctant to accept this new type of livestock. It will probably take a while (as it did in western Timor) before cattle become fully accepted and before people recognize the economic advantages.

In order of importance pigs (fahi), which are black and usually smaller than European pigs, ought to be mentioned next. The social significance of pig-keeping is only second to that of buffaloes, as both animals play an important role in traditional sacrifices as well as at ceremonial feasts, such as marriages and particularly funerals. On such occasions large amounts of buffalo meat and pork are consumed, which makes it necessary for the average Timorese who lives at subsistance level to aggregate - besides rice[42] - as many pigs as possible. Frequently such feasts demand economically ruinous efforts on the part of the feast givers who often starve to be able to accumulate enough food. At such a feast the guests eat till they become sick, and the more buffalo

[42] Rice, pigs and buffaloes are the most prestigious commodities of the Timorese (see also Ormeling 1955:88).

meat and pork served, the higher the host's social prestige. These feasts are not held regularly as is the case in New Guinea where pigs are the most prestigious animals and where so-called pig cycles from one feast to another can be observed (for instance described by Brookfield and Brown (1967:57).

Pigs are useful scavengers as they feed on garbage and hence help to keep the village compound clean. In order to prevent the pigs from rummaging in the to'os or natar, particularly at harvest time, pigs are either kept in sties or are tethered. Frequently, three bamboo sticks are fastened as a triangle around the pig's neck so that it cannot slip through small holes in the fences. When tethered or kept in sties pigs are fed often on marrow of *Metroxylon sagu* (rombia), *Corypha utan* (misnamed sagu) or on a fleshy plant called maik, usually spared out on freshly cut to'os. Other than that very little care is given. No systematic breeding is practised, although castration is common.

Of the small livestock, goats (bibi) and sheep (bibi malai) rate a mention. Apart from their use as meat producers, goats particularly are used for sacrificial purposes. Milking of goats, although sometimes practised, is rare.

Land ownership

The present land use pattern in the Area is determined to no small degree by the type of land ownership. Therefore it seems mandatory to outline briefly this aspect of rural life. Although very scarce the ideas expressed in the literature on this subject are in no way uniform. Meneses (1968: 70), L.da C.Gonçalves (1936:19), and Kohler (1905:337) allege that since time immemorial the land belonged to the community, be it the suco or the reino. Other authors like Françillon (1967:154) advanced a different viewpoint by saying that in South Belu the land was owned by one person, the nai boot. Every member of the respective suco had the right to occupy and cultivate those patches of land which were obviously uncultivated. The granting of these usufruct rights for a particular piece of land was done by the dato rai, to whom the liurai (king) had delegated his power of the allocation of tribal land to individual families. The occupants of the land who were quasi-tenants, in turn, had to pay an annual rent, so-called rai teen (lit. 'excrement of the land') to the chief of the kingdom or princedom. While the latter as

well as the office of the dato rai have meanwhile disappeared, the principle of usufruct rights of occupation of the land remains. This was also guaranteed by the Portuguese government in 1915 (B.C.A.F. 5, 1915:544). Since house gardens and paddy fields are worked permanently, these tracts of land are considered individual 'property'. Should a natar remain unworked, the 'owner' does not forfeit his usufruct rights on that paddy field. In case another suco member is interested in cultivating that particular paddy field, he has to ask permission first from the 'owner' of the natar, who, in turn, will usually demand a share of the crop as rent.

A special case of establishing 'ownership' rights on a natar occurred in Uma Quic on the natar Hare Bé Oan, on the west bank of the River Cuha, south of Viqueque. For more than ten years (since the mid-1950s) the old natar had remained unused as the water level of the River Cuha had fallen so low that no more water could be led through the old irrigation channel to the rice fields. Thus, the old owners from the sucos of Caraubalo, Uma Uain de Baixo and Balara Uain stopped cultivating the fields. In 1965 the chief of the suco of Uma Quic had a new canal built whereby he made the old natar irrigable and thus became the new 'owner' of the paddy fields. Those who helped dig the canal were given a small portion of the newly irrigated natar. As a rule, however, 'ownership' of house gardens and natar is never forfeited and thus the usufruct right is individually inheritable.

In the case of shifting fields, to'os, individual 'ownership' of the plots is also established by actual cultivation. Upon abandonment of the to'os, however, any other person of the suco may occupy the plot after a certain number of years[43] provided no boundary marking plants or plants designating property rights (kero) have been planted by the former occupant. In that case the planter of these perennials - such as coconut, areca, candlenut, banana, cordyline, etc. - has clearly shown his intention to retain his property rights - or rather his usufruct rights. The to'os is thus not relinquished for good by the original owner. When fertility is restored after a number of years, he returns

[43] The number of years varies from place to place. In Viqueque the chiefs alleged that tilled to'os could be occupied five years after abandonment, whereas a field which was slashed after three years.

to his old site. This does not, however, necessarily mean that cultivation of the land beneath these trees is not feasible by somebody else, provided he has been granted permission to do so by the owner of the trees. The latter may, however, be reluctant because of fear of fire which might ruin his plantação.[44]

From the above it is clear that nothing but usufruct rights of the land are known in Timor. Land thus is not alienable. In recent years, however, with land becoming increasingly scarce because of population pressure in certain parts of the Area such as in Quelicai, permanent cultivation of even the to'os has resulted in a common feeling of land ownership. A few more advanced Timorese[45] have established firm titles by having their pieces of land surveyed and registered in Dili. Official registration of land is, however, the exception. Traditional usufruct rights are still the rule. Natar, house gardens, and any to'os currently under cultivation can be subject to inheritance. Customarily, these and other tangible property rights are inherited by the sons of the deceased in equal portions. Should there be no son, the brother of the deceased or his sons become inheritors. The wife of the deceased or his daughters normally do not inherit anything save in the absence of sons or brothers, when the wife acts as proforma heir to the land, usually asking help from other family members. Apart from a few things of family use handed down from mother to daughter, all property descends patrilineally.

Equal sharing of the bequest of the deceased among the sons seems to prevail in the Area. Normally the inherited natar is worked jointly by all sons. If one of the brothers refuses to co-operate while still maintaining his 'property' rights on that natar, he does not get any share of the yield. In case of quarrels the natar is simply divided. Quarrels over natar are by no means uncommon and take much debating to be settled. Quarrels do also occur quite often when seemingly abandoned paddy fields[46] are reoccupied by some person other than the original owner.

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[44] A term, commonly used by Timorese for groves with a handful of fruit trees.

[45] E.g. Don Cristovão Guterres, the chief of the suco of Uato Haco and son of the former liurai of the kingdom of Venilale.

[46] As a visible sign the kabubos (small dikes surrounding the rice field) have disintegrated.

Far fewer quarrels happen over rights concerning to'os. Fruit trees and other perennials bear witness that the owner has not given up his usufruct rights. After inheritance has taken place, the to'os are seldom worked jointly by all sons. They are usually divided according to the quality of the land or on the basis of fruit trees. As a consequence of traditional land ownership and rules of inheritance, land holdings are largely fragmented and scattered, thus causing waste of land in constructing lutun (fences) and waste of time to the peasant who has to go from one plot to another. In the Area I often accompanied peasants to their individual plots, which were frequently hours apart. It seemed to me that the degree of fragmentation was highest in Baucau and Quelicai where population pressure is greatest, while on the thinly populated south coast fields are more contiguous.

Apart from individually 'owned' land the greater portion of all land is communally owned (port.: baldio). On this all suco members freely graze their livestock, or they may cut timber. Some rare resources, such as sandalwood and trees housing hives of wild bees are individually owned (see also Fiedler 1929:63).

In reviewing the traditional Timorese form of land-ownership it becomes evident that such a system of usufruct rights, while working reasonably well when population pressure is relatively low in a migratory farming system, has serious drawbacks in a technically more advanced type of permanent cultivation. Rising population pressure has led to an increasing number of quarrels over land, as reported by administrators. Hence, it has to be considered as a clear sign of the obsolescence of the system of usufruct rights. More and more cases are reported where buffaloes and other livestock have marauded to'os and natar or, as a result of uncontrolled fire, valuable fruit trees have been destroyed. To maintain a certain degree of order on the village compound and to safeguard the ownership of land, particularly that of trees, the Timorese have a kind of village forester, the makleat[47] (in Tetum) or maksaba (in Macassai). He is charged with the supervision of fruit trees, village orchards and sacred groves. If he detects someone stealing fruit, he either tries to solve the case himself or brings the subject to the attention of the major (another official in the

[47] Derived from the Malay word of melihati (= to inspect). The makleat is thus the person who inspects.

village). In difficult cases the quarrel is brought before the chefe de povo or chefe de suco, and finally to the administrator.

Indigenous non-written legislation is very strict with respect to property rights of tangible and intangible property. Thus, from time to time the suco members assemble at a certain spot where they raise a bando, a bamboo pole in front of which they sacrifice a pig, a goat, a buffalo, chicken, coconut, etc. These sacrifices are to remind the suco members to respect each other's property (see Plate 28). Usually, the suco chief names the offences and the respective punishments which can be expected in the case of violation of these laws.

Customarily only suco members have the right to cultivate land in their respective sucos. Therefore before *Pax-Lusitana* suco boundaries were arduously defended. Quarrels over suco boundaries (balizas) give rise to fierce tribal wars. Because of these boundaries the degree of land use intensity and population pressure varies greatly between sucos. Only in exceptional cases (usually because of family ties) are members of one suco allowed to cultivate fields or to graze their livestock in another suco. As mentioned above, suco chiefs are in general reluctant to grant this permission to foreigners for fear of quarrels caused by trespassing buffaloes, horses, etc. Once these foreigners have settled in a suco of which they are not members, the respective suco chiefs have no power to settle the quarrel since the foreigners fall under some other suco chief's jurisdiction. However, the suco chief can request the foreign peasant to quit if he is not wanted or if the land is needed by a local resident. Moreover, foreigners usually pay their annual head tax (imposto domiciliario) in the village of their native suco where they remain registered. As the chiefs (chefe de suco as well as chefe de povoação) get an annual fixed salary[48] instead of the former rai teen they have no particular interest in foreigners. Changing of sucos is only practised in exceptional cases. Even if someone works outside the suco, traditional ties to his family and agnates are so strong that he remains registered in his suco, and he returns to his village at least for the annual tax census (arrolamento).

[48] In 1970 the salary of the suco chiefs amounted to 3 per cent of the total imposto domiciliario levied in the suco plus an extra amount according to rank while the chefe de povoação received 3 per cent of the imposto domiciliario of the village.

The issue of land ownership in Timor is certainly a tricky one. Traditional concepts of land ownership are in no way conducive to land use planning. Moreover, as Ormeling (1955:84) correctly pointed out, the weak ties between the peasant and his land have to be considered disadvantageous because they provide no motivation to apply soil conservation measures. It is suggested that only permanent farming on individually owned land with firm land titles may induce the Timorese to feel more responsible for his land in conserving fertility and in preventing erosion.

In the 1930s the Portuguese government had already begun to survey land on a very moderate scale and to acquaint the population with the idea of firm property titles (Duarte 1930:312). As mentioned earlier, however, advances in this direction remained marginal in the Area and were restricted to the property of a few Timorese (mostly chiefs) as well as, of course, to that of the Chinese merchants in the administrative centres.

Chapter 4

AN ANALYSIS OF THE ENVIRONMENT IN ITS ECOLOGICAL CONTEXT

Regional distribution of land use types

The preceding chapters have acquainted us with the major ecological factors determining the ecosystem of the Baucau-Viqueque area. In order to analyse the interrelationship of these factors in regional perspective, a map of the major land use types has been compiled (Fig. 25). Because of the small scale at which it had to be reproduced. This map constitutes a generalized version of the original 1:50,000 land use map which I drew with the help of airphotos and extensive field investigation. Before analysing the regional distribution of the various types of land utilization, however, it is necessary to make several qualifications concerning the definitions of the various types of land use.

The map distinguishes ten types of land usage. Of these rice cultivation is the easiest to delineate and to present on such a map because most paddy fields are cultivated annually. Thus, they are comparatively easy to detect on airphotos. Still, there is some reason for arbitration with respect to those paddy fields which have been fallowed for a great number of years and on which terraces and dikes (kabubo) have consequently disappeared. In such cases these fields have been assigned as grazing areas, thus representing their present use.

On the other hand, to'os cultivation and livestock grazing are not as unambiguous to define. Both types of land use are intricately interwoven. The area assigned as being under to'os cultivation does not preclude the existence of some grazing. Conversely, the areas mapped out as grazing grounds, although predominantly used as pastures, do include some to'os cultivation.

Finally, owing to the small size of the permanently cultivated gardens surrounding the houses, this type of land



Fig. 25 Land use pattern of the Area

Legend to Fig. 25

I. Natar cultivation

1. Single cropping natar:

   a. Single cropping natar (yield uncertain)
   b. Single cropping natar (yield certain)

2. Double cropping natar: wet rice in rotation with maize, sweet potatoes or onions

II. To'os cultivation

1. Bush fallowing
2. Permanent cultivation

——— On to'os within this area double cropping of maize (batar boot and batar kiik) is common.

····· On to'os within this area double cropping (dryland rice: Nov.-Apr. and maize: May-July/Aug.) is common.

----- To'os south of this line double cropping (maize: Dec.-March/Apr. and dryland rice: May-Aug./Sept.) is common.

III. Predominantly livestock grazing with scattered to'os cultivation

IV. Forest and savanna woodland with scattered to'os cultivation

Note: No exact delineation could be ascertained between permanent to'os cultivation and bush fallowing.

Explanation: I Cai Cassa Hoo
Agricultural Experimental Station, C.M.B.

II Laliu
Agricultural Experimental Station, C.M.V.

III Ra Tahu
Coconut Plantation (SOTA)

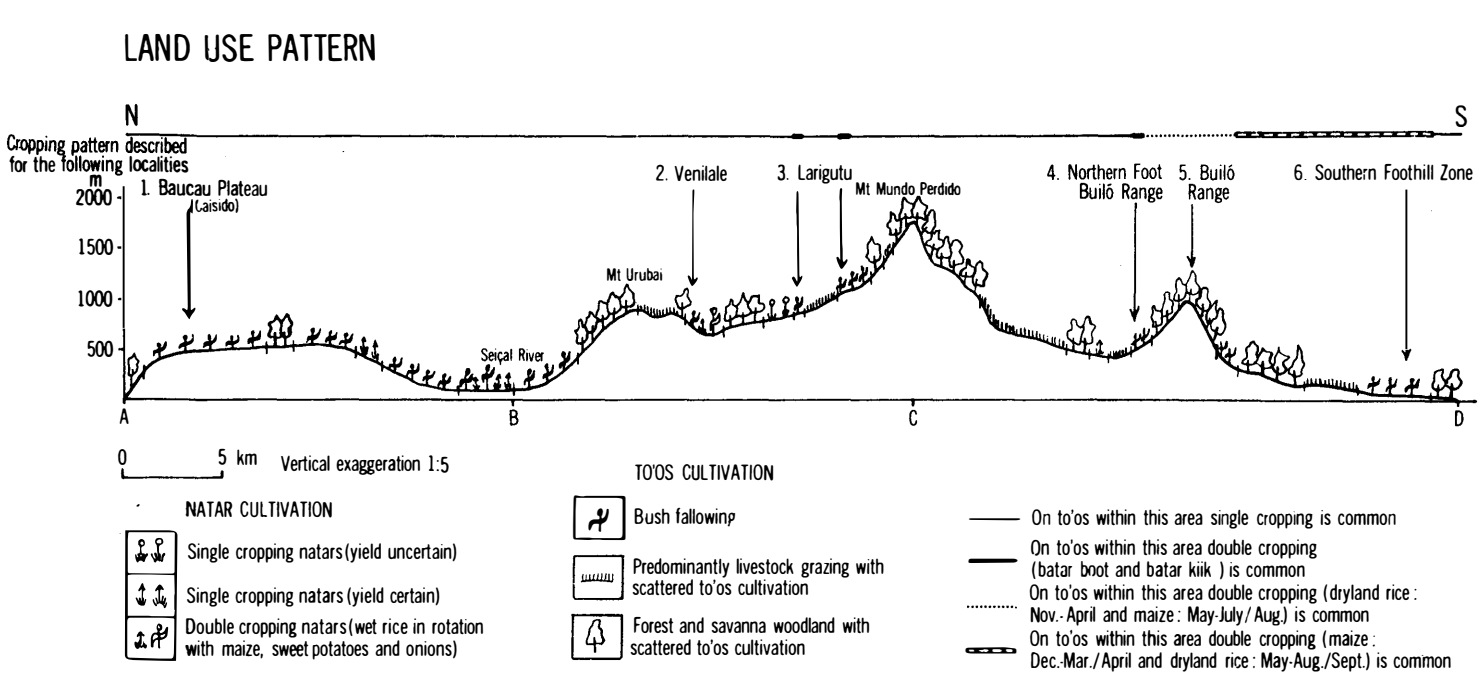


Fig. 26 Land use pattern along profile

usage necessarily had to be omitted from the map. With these reservations in mind we can now embark upon our analysis of the regional distribution of land use types.

Wet rice cultivation

As clearly outlined in Fig. 25 the centre of wet rice cultivation lies - surprisingly enough - north of the central divide, thus in that portion of the study zone which has a prolonged dry season. Wet rice fields are predominantly located in the floodplain of the River Seiçal and along the western and eastern escarpment of the Baucau Plateau (Baucau-Sede), as well as in the foothill zone of Mt Mata Bian in Quelicai. A number of paddy fields are also to be found in Ossu; at Larigutu; south of Mt Mundo Perdido at Liaruca and Loihuno; and north of Mt Builó (Ossoroa), along the Bicaliu River.

The concentration of natar in the north as well as in the central upland contrasts sharply with the almost complete absence of paddy fields in Viqueque (except for the two small rice fields of Bé Laco[1] and Hare Bé Oan[2]) and Uato Lari (apart from the few natar along the river Bé Bui, and the recently (1965) opened up rice fields in the plain of Uato Lari (Narequici)). The uneven distribution of the paddy fields in our Area is all the more striking as from the knowledge of the rainfall regime we would expect a concentration of rice fields in the south of the central upland. Thus it is obviously not rainfall which accounts for the lack of wet rice fields here. It seems that other factors are more likely to be responsible for the distribution pattern.

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[1] The paddy field of Bé Laco receives water from the River Bé Tuco. That part of the rice field near the Viqueque-Luca road was opened in 1962 while the rest was older.

[2] This rice field was reopened in 1968 by the chefe de suco of Uma Quic who had a new irrigation canal built. For over 20 years this paddy field was unsuitable as the riverbed lay too deep for irrigation. According to information provided by both the chief of Uma Quic and the guarda pecuário of Viqueque (Sr António Pereira Soares) the pace at which the River Cuha silts up has increased during the past 10 to 15 years. This has presumably resulted from intensified, though careless land utilization in the upland.

In the first place, it appears that hydrological conditions are less favourable on the south coast: the only river with a year-round flow of water, the Cuha, has a bouldery and very narrow floodplain which is deeply incised by the river because of the comparatively high gradient from the source to the coastal plain. Hence the greater part of its floodplain is not irrigable by traditional Timorese methods. Likewise the Bé Tuco and to a lesser extent the Bé Bui, being ephemeral rivers, do not permit large tracts of land to be irrigated for wet rice cultivation.

Secondly, and this appears to me to be the chief reason for the absence of paddy fields on the south coast, the southern coast is malaria-infested and hence is adamantly avoided by the Timorese even today, as is reflected by the low population density. The Narequici paddy fields (Uato Lari) were opened up in 1965 upon the initiative of the local administrator. However, the project only started to become a success after the government established a dispensary (posto sanitário) on the west bank of the River Bé Bui. Since then, persons infected in the rice fields by malaria can receive immediate medical treatment. Formerly they were dependent on the waters of the Bé Bui which sometimes rendered any crossing to the dispensary of the administrative centre of Uato Lari impossible for days.

Thirdly, the scarcity of paddy fields on the south coast around Viqueque seems to be linked with the social organization of the Tetum-speaking people of Viqueque. According to Hicks (pers. comm. 18.2.71) they are family-oriented, rather than clan-oriented.[3] As a consequence natar cultivation seems to be beyond the scope of the eastern Tetum,[4] since the labour input for wet rice cultivation exceeds that of a simple family (ema uma laran).

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[3] Dr James J. Fox, Professor of Anthropology, Research School of Pacific Studies, Australian National University, questions the relevance of Hicks' proposition since for example the Javanese who have no clan system have nevertheless developed elaborate wet rice cultivation. Fox notes that it is of particular interest that such agricultural developments as terracing have been most elaborated by the Macassai, one of the non-Austronesian groups on Timor (pers.comm. 10.11.1976).

[4] Consequently the Tetum buy rice from the Naueti- or Macassai-speaking people, i.e. from Uato Lari and north of Viqueque (see also Hicks, Field Report 1967:7).

I want now to describe the regional pattern of the various types of natar cultivation.

Single cropping natar (yield uncertain). The overwhelming majority of all wet rice fields[5] in the Area are dependent on impounded rainfall only. As the rainfall dependency and the length of the rainy period vary greatly in the Area, cultivation periods of these natar can be expected to have been adjusted accordingly. This is demonstrated in Fig. 27 in which the cultivation periods on natar have been plotted against the mean monthly rainfall curves of seven of the Area's rainfall stations. These rainfall curves, though they can be considered representative of only the area around the recording stations, convey a rough idea of the rainfall regime of the natar having similar rainfall conditions to those of the rainfall stations. On these charts rainfed natar are marked with a cross (+). From these diagrams the following regional pattern emerges.

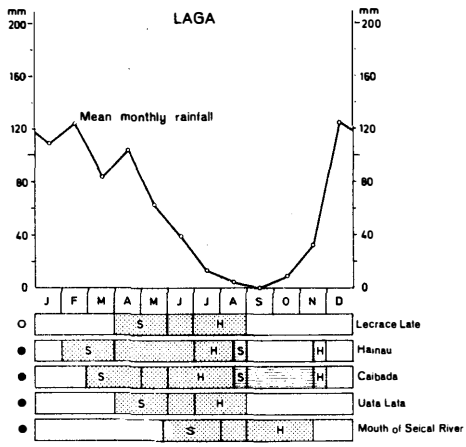
a. Rainfed natar north of the central upland. Since rainfall is generally limited to a few months of the year, wet rice has to be sown in January/February and harvested in May/June, e.g. at Uainoe, Uai Behe Ana (Fig. 27b and Plate 36) and most natar in Quelicai (Fig. 27c).

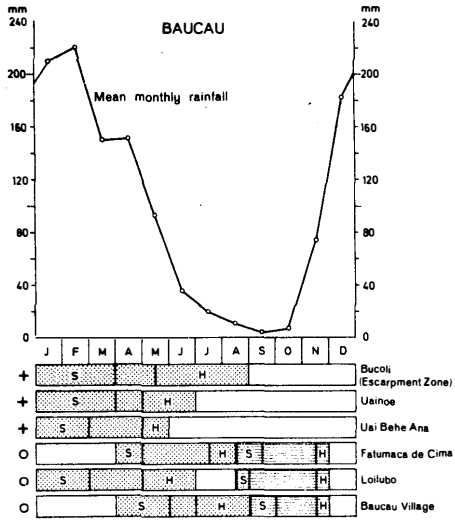
In exceptional cases harvesting may be performed as late as August, e.g. at Bucoli (Fig. 27b), on natar above the irrigation canal of the Assa Lai Tula River (Fig. 27d and Plate 41) and above the spring of Uai Oli (Fig. 27d).

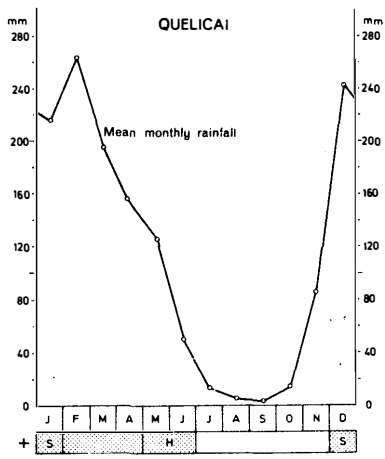
b. Rainfed natar of the central upland. As can be seen in Fig. 25, despite more favourable moisture conditions, most natar in the central upland are rain-dependent. Here, however, it is not water scarcity but rather excess of water (particularly in January and February) that determines the time of cultivation. According to altitude and exposure I have observed the following differentiation (Fig. 27c):

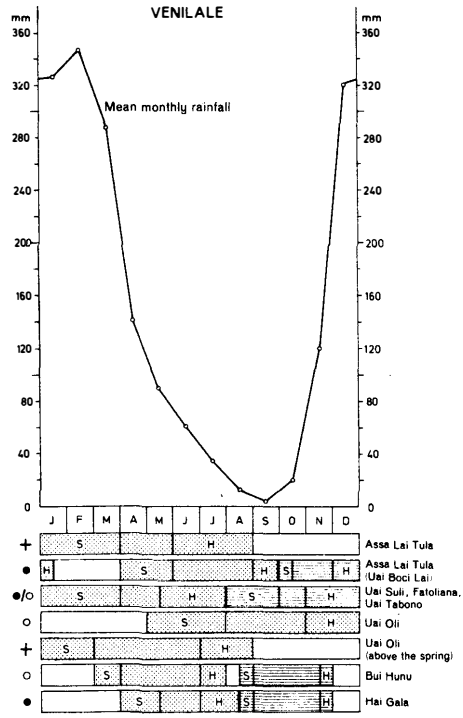
	sowing	harvesting
Nahareca (300-400 m)	February/April	July/August
Lianida (800 m)	April/May	October/November
Larigutu (1000-1100 m)	June/July	December/January

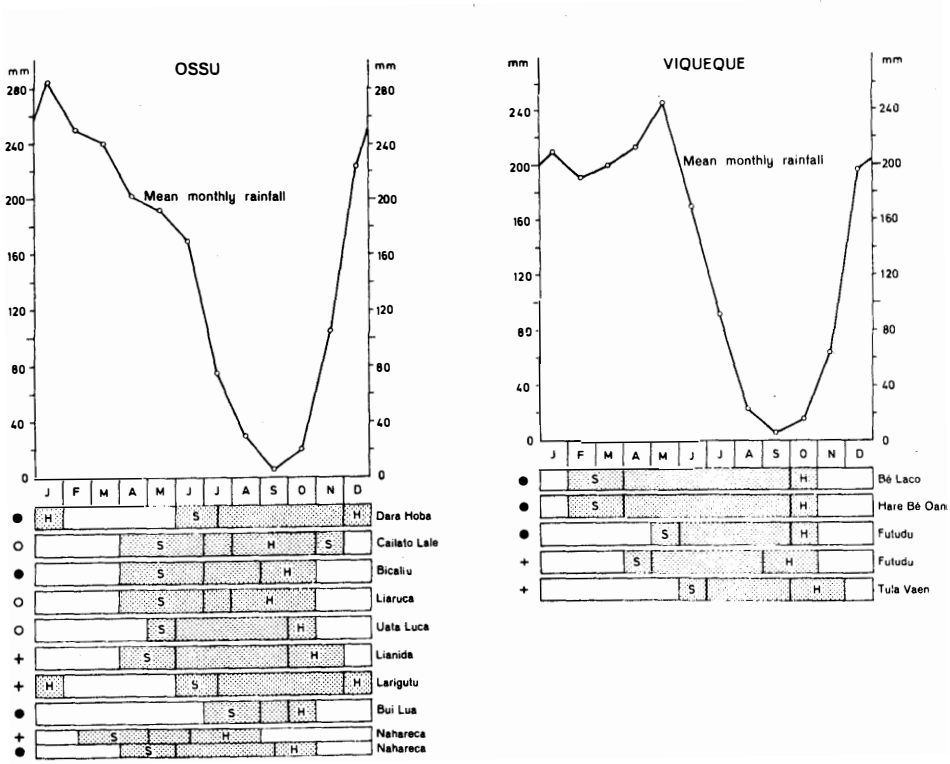
[5] Estimated by the author at over 90 per cent of all natar in the Area.


LAGA
mm
Mean monthly rainfall
J F M A M J J A S O N D
Lecrace Late
Hainau
Caibada
Uata Lata
Mouth of Seical River


BAUCAU
mm
Mean monthly rainfall
J F M A M J J A S O N D
Bucoli (Escarpment Zone)
Uainoe
Uai Behe Ana
Fatumaca de Cima
Loilubo
Baucau Village


QUELICAI
mm
Mean monthly rainfall
J F M A M J J A S O N D


VENILALE
mm
Mean monthly rainfall
J F M A M J J A S O N D
Assa Lai Tula
Assa Lai Tula (Uai Boci Lai)
Uai Suli, Fatoliana, Uai Tabono
Uai Oli
Uai Oli (above the spring)
Bui Hunu
Hai Gala



Legend (for fig. 27)

- \+ Rainfed Paddy Fields depending on impounded rainfall only
- ○ Springfed Paddy Fields
- ● Riverfed Paddy Fields
- S Sowing
- H Harvesting
- Rice
- Irrigated maize, sweet potatoes, onions

Fig. 27 Cultivation periods on natar: Laga, Baucau, Quelicai, Venilale, Ossu, Viqueque and Uato Lari

c. Rainfed natar south of the central upland. Owing to the bimodal rainfall pattern of the south, rainfed natar at about 100 m are planted not earlier than May, e.g. Futudo, or even July, e.g. Tula Vaen (both Fig. 27f). It is feared that if rice were planted earlier, say in January/February, the rainy season would interfere with the flowering of the rice plant. The harvesting of the rice is therefore performed as late as September/October in Futudu and October/November further inland at Tula Vaen.

Single cropping natar (yield certain). Wet rice fields of this group are fed by springs or rivers. Although they too are not completely independent of rainfall, they yield fairly regularly every year. As demonstrated in Fig. 27 these natar, which are marked by a black dot (riverfed natar), or by a circle (springfed natar), are generally planted later in the year than the rainfed paddy fields.

This lag is conditioned to no small degree by the comparatively simple technique of irrigation. As explained above the common practice is to build an earthen dam, reinforced with branches and rubble, diagonally halfway across the river. This is clearly inadequate during much of the rainy season, and hence irrigated rice can only be planted once the floods have abated.

An example showing the dependency of the beginning of the rice planting on the flow of water is given along the Seiçal River (Fig. 27a). In the upper course of the Seiçal, at Hainau, planting takes place in February/March; at Caibada and the lower terrace of Gailata, further downstream, in March/April; at Uata Lata, in the middle course of the Seiçal River, April/May; and near the mouth of the river in the suco of Seiçal planting is performed as late as June or even the end of July.[6]

Single cropping natar with regular yields are found

[6]This late planting in June or even later has the disadvantage that the water may not suffice to bring the rice crop to full maturity. The administrator of Baucau, Salgado, therefore intended to induce the Timorese to plant their rice in March/April instead of June in 1971. Dams and irrigation canals would have to be permanently kept in order; this additional effort would be compensated by higher yields (pers. comm. Administrator Salgado, 8.11.1970).

mainly in the central upland (see Fig. 27e for Ossu) where the 'growing period' is longest. Because of lower temperatures and the predominance of heavy clay soils, however, plant growth is slowed down considerably, allowing only for a single rice crop.

Double cropping natar. The source of water is similar to that of the regularly yielding single cropping paddy field - i.e. fed either by a spring or a river. In contrast to the latter type of rice fields, however, the double cropping natar are, as a rule, located at lower or medium elevation. Growing periods of the crops are thus shorter. In addition, double cropping paddy fields are characterized by light textured soil, be it calcareous (e.g. CMC-soil) or alluvial soil (e.g. AMC-soil).

All three conditions are encountered at a few places in our Area,[7] for instance at:

1. Above all, along the escarpment zone of the Baucau plateau near water seepages, e.g. at Fatumaca de Cima; Loilubo; below the village of Baucau (see Fig. 27b);
2. At a few paddy fields in the floodplain of the River Seiçal, e.g. Hainau and Caibada (see Fig. 27a);
3. In the floodplain of the River Assa Lai Tula; Uai Boci Lai and Hai Gala (see Fig. 27d);
4. In the floodplain of the River Uai Suli (suco Fatolia) (see Fig. 27d).

At these few localities double cropping on natar is common: a crop of rice in the first half of the year (January-July/August) and a crop of irrigated maize (batar bé), sweet potatoes (fehuk bé) or onions (lis) in the second (August/September-December). These latter crops, but particularly maize, require light textured soil. Since water conditions

[7] Surprisingly enough, the southern seaboard of Viqueque and Uato Lari, where these conditions may also be found locally, is devoid of double cropping natar. It seems to me that since dryland rice (hare to'os) is commonly planted here there does not appear to be any need on the part of the lowland people (ema tasi) to intensify natar cultivation further.

apparently do not permit a second crop of rice per year, the local population grows maize instead. This demands far less moisture than wet rice. Even so, in years when water from rivers or springs is particularly scarce during the rainless season, sweet potatoes, which require less moisture than maize, are grown instead of maize. Likewise, a zonation of the cropping pattern usually occurs on double cropping springfed rice fields along the rim of the Baucau Plateau: here in the immediate vicinity of springs where more water is available batar bé is usually grown. Further away from the spring a few canteiros (Port.: compartments of a rice field) of fehuk bé are planted. Seldom does the water suffice to plant the entire natar with a second crop and not infrequently spring water has even to be collected in a pond to make proper irrigation possible at all.

From the preceding paragraphs we can see that climate is the main factor conditioning the temporal differentiation of the rice cultivation in the Area. The impact of climate has been attenuated only at those places where springs and rivers have permitted a prolongation of the growing period well into the dry season.

The beginning and length of the growing period of rice is contingent upon a number of other factors besides climate, like the availability of water buffaloes for sama natar, the availability of manpower and seed at the beginning of the planting season, and on the type of rice used.

Rice varieties

A large number of local rice varieties are known. However, since they change their names from place to place and from tribe to tribe, it is impossible to ascertain the exact number of different varieties. These rice varieties, the origin of which is usually unknown, are considered to belong to *Oryza sativa* of the indica sub-species (Bizarro 1967b). They may be roughly distinguished according to their maturation periods (i.e. the total number of days from planting to maturity) as early, medium, and late varieties (see Table 21).

In Tetum the early rice varieties are called hare lalais (fast rice). They have a growing period of 3 to 4 months[8]

[8]Most common of this group are: Ceilão, Java, Maubesi, Equero Lotuc. The variety with the shortest growth cycle

and are grown on rice fields of lower elevations (below 500 m) which are likely to be short of water - such as most rainfed rice fields in the north as well as saline rice fields (e.g. at the mouth of the Seiçal River) which can only be used for short periods before capillarity sets in and salts are brought near the topsoil. In addition, early varieties are customarily planted by most Timorese on a portion of their paddy fields to enable them to have some early rice after the long dry season which is usually accompanied by a complete exhaustion of their food stocks. Early varieties, finally, are planted on double cropping natar: an early rice variety as a first crop and batar bé or fehuk bé as a second.

Medium rice varieties have a growing period from 4 to 5 months and are mainly found at medium altitudes (200-700 m), e.g. at Uai Oli, Uato Haco, Fatumaca.

Late rice varieties have a growth cycle of over five months (like Mahertala, Cai Dau Reça) which fits best to high altitude rice fields, e.g. at Larigutu, Ossu, Dara Hoba, where the rainy season lasts longer.

Table 21 conveys an idea of the wide range in the length of the growing periods of the same rice variety. For this altitude, or rather temperature, soil type and water supply are responsible.[9] The longer the plant is under water the longer the growth period, but usually also the higher the yield: for instance, Mahertala at Uai Oli (Venilale), 500 m, grown on a natar well watered by a perennial spring takes more than six months to mature compared to only little over five months in a less intensively watered natar at Uato Luca (Ossoroa) at about the same elevation.

Likewise, the length of the growing period increases with altitude: for instance, Mahertala grown at Futudu (Viqueque), 100 m, takes 4 to 5 months, as opposed to over seven at Dara Hoba (southern escarpment of Mt Mundo Perdido),

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8 (continued)
seems to be India which is truly hare lalais as it matures within 75 days. Yields are, however, meagre.

9 Only where a second crop of irrigated maize is grown is some fertilizing done. This is in the form of the burning of branches and twigs of casuarina and other trees. Lopping is very popular.

Table 21

Native rice varieties in the Baucau-Viqueque Area

Variety	Locality	Altitude (m)	Reported length of growing period (months)
I.Early varieties			
Ceilão	Narequici (Uato Lari)	s.l.	3
	Fatumaca	50-300	3
	Roliu (Uato Lari)	200	3
	Loilubo	750	4
	Lecrace Lele	s.l.	3.5
	Seiçal	0-50	4.5
	River Umi Toqui (Nahareca)	200	3.5
	Vemasse	250-350	4
	Hainau (Seiçal)	150	3.5
	Maubu	100	3.5
	Gailate		3.5
	Lui Nau		4.5
	Lia Kura		4.5
	Caibada (Venilale)	100	4.5
	Tula Vaen	100	4.5
Equero Lotuc	Liaruca	500-600	4.5
	Laga	s.l.	85 days
Hare Lotuc	Uato Luca (Ossoroa)	550	3-3.5
India	Uato Haco	700-800	75 days
I R-8	Narequici (Uato Lari)	s.l.	4
	Seiçal	s.l.	4-4.5
Java (one of the best native varieties)	Seiçal		4
	Lecrace Lale	s.l.	5-6
	Loilubo	750	4
	Ossoroa	450	5
	Tula Vaen	100	4.5
Kaubesi	Assa Lai Tula	700	4
	Liaruca	500-600	3.5
II.Medium varieties			
Au Lau	Uai Oli	500	4.5
Cai Naha	Uai Oli	500	4.5
Equero Java	Seiçal	100	4.5
Equero	Roliu (Uato Lari)	200	5
Ita Ana	Liaruca	500-600	4.5
Lalu Rua	Uai Oli	500	4.5-5
Leço Reça	Seiçal	10	4
Lehe Meta	Uai Oli	500	4-5.5
Plimplim	Seiçal, Uata Lata	50	4.5
Singapura	Fatumaca	50-300	4
	Uato Haco	750	5
	Venilale	600-700	4.0

Table 21 (continued)

Variety	Locality	Altitude (m)	Reported length of growing period (months)
	Mt Builó (Ossoroa)	800	4.5
	Uata Lata	50	4.5
Su Lai	Uai Oli	500	4-5.5
Timor	Fatumaca	50-300	5
III.Late varieties			
Cai Dau Reça	Seiçal	0-100	4
	Assu Lai Tula	600	5
	Uai Oli	500	4.5
	Dara Hoba	800-1000	7-8
	Larigutu	1000	7-8
Cai Dila	Dara Hoba	800-1000	6-7
	Uai Oli	500	4
	Assa Lai Tula	600	4
	Seiçal	s.l.	4.5
	Larigutu	1000	7-8
	Lecrace Lale	s.l.	3-4
Mahertala	Dara Hoba	800-1000	7-8
	Ossoroa	450	4-4.5
	Dauboro Baha	750	4.5-5
	Liaruca	500-600	5.5
	Seiçal	100	5
	Uai Oli	500	6-7
	Uato Luca (Ossoroa)	550	5
	Tula Vaen	100	5-6
	Futudu	150	4-5
	Larigutu	1000	7-8
	Lecrace Lale	s.l.	3-4
Nippon (=Japão)	Narequici	s.l.	4-5
	Uato Haco	700-800	5
	Fatumaca	50-300	6-7
	Seiçal	100	5
	Seiçal	s.l.	4
	Uata Lata (Buibau)	s.l.	5
	Lecrace Lale	s.l.	6

s.l. = sea level

800-1000 m.[10] Finally, the compactness of the soil influences the length of the growing period, heavy clay soils lengthening the growing cycle.

Rice yields

Although, in general, the Timorese peasant has an excellent knowledge of these ecological relationships as evidenced by the careful selection of rice varieties grown in the various parts of the Area, most of the native rice varieties, with the exception of Java and Nippon (probably introduced), are very low yielding varieties. The poorest yields are obtained on heavy clay soils (CN) as, for instance, in Loihuno, Ossu de Cima, Quelicai, Baucau and Vemasse[11] where yields of five, at best ten latas[12] per each lata broadcast are common. This corresponds roughly to 240 to 480 kg per hectare.

Far better yielding rice fields are those with soils containing clay mixed with calcareous material as, for instance, at Fatumaca de Cima (eastern escarpment), of Buboraga (Baucau Plateau), and Bucoli (western escarpment) where yields of 20 latas per each lata broadcast are common. More than this is obtained only on alluvial ground: for example, on rice fields in the floodplains of the Seiçal (at Uata Lata, in the suco of Seiçal) and of the Vemasse River or in fields on the lower terraces of the Assa Lae Tula.

The little rice that is actually harvested is processed in a highly wasteful way. The rice is reaped by women with a small knife. Subsequently the rice panicles and culms are dried on the kabubo (bunds surrounding the paddy fields). Heavy rains may occur during the so-called dry period and

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[10] The Timorese use the Tetum term 'rai malirin' (lit. 'cold soil') to indicate that the maturation period lasts longer on land at higher elevations.

[11] Loihuno: Lia Loi Oli (800 m); Ossu de Cima: Lianida (850 m), Uato Ita (700 m), Larigutu (800-1000 m); Quelicai: near Posto (600 m); Baucau: Lecrace Lale (near sea level).

[12] A lata is a 20-litre oil container serving as the common measurement in Timor and equivalent to: 12.8 kg unmilled rice (nele); 16.3 kg milled rice (fos); 8.0 kg coffee cherry; 16.3 kg maize; 18.0 kg beans.

inflict heavy losses through damp grain. Losses may also be caused by plagues like stem borers, mice (Raimundo 1965), birds, monkeys and plant diseases,[13] and by domestic animals like water buffaloes, pigs, dogs etc. rummaging in the rice fields. Threshing (by foot and by horses' hoofs) (Plate 34) and winnowing (Plate 35) is very wasteful. Moreover, the bulk of the crop is retained in households and hand pounded by pestel and mortar. This traditional technique yields only some 40 per cent in milled rice and even this is not safe from mildew and rats.

In view of these appallingly low rice yields from 1961 the Department of Agriculture (RPSAF) of Portuguese Timor made increased efforts to introduce high-yielding rice varieties (see Mourão 1961; Sousa 1967; Bizarro 1967b). Around 1968 IR-8 and IR-5 were brought to Portuguese Timor from the International Rice Research Institute (IRRI) at Los Baños, Philippines (see also Carvalho 1968). The introduction of these new varieties was linked with the hitherto rarely practised technique of transplanting. Though still today only a few progressive farmers[14] have sufficient money,[15] labour and irrigable natar[16] at their disposal to practise transplanting, it appears that this new technique is becoming increasingly popular. The rising population pressure upon the land seems to be the decisive factor in this.[17]

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[13] Among the most common plant diseases of rice in Portuguese Timor are bacterial leaf blight and particularly rice blast; for the latter see Noronha (1967, 1969).

[14] Mostly chefes de suco, as for instance Srs João and Cipriano Correia of Seiçal and Sr Manuel Belo of Tirilolo.

[15] By comparison to western Timor the degree of commercialization and monetization seems to be far lower in Portuguese Timor. Thus for instance small Japanese transistor radios, often considered an indicator for the degree of commercialization elsewhere, are not yet popular with the people of eastern Timor.

[16] Transplanting requires proper, well-timed dosages of water.

[17] The people from Quelicai are considered the most efficient rice growers in the Area. They have - again a symptom of population pressure - the longest tradition in the transplanting of rice. Many of them who do not have natar in Quelicai make regularly socio contracts with people from Baucau or work for money. For 5 latas transplanted (this equals about 1.5 hectares) at suco of Seiçal they earned

Because far less seed is needed for transplanting, more Timorese resort to this type of planting whenever the amount of seed reserved is not sufficient for broadcasting.

Rice yields obtained by transplanting IR-8, IR-5 and even Java, the best native variety, are over ten times higher than those obtained by traditional kare hare of most local varieties. Thus, one lata transplanted yields about 100 latas as experience shows at the following locations: at Lecrace Lale (at sea level, Baucau), in the suco of Seiçal (sea level), at Uato Lata (suco Buibau, near the Seiçal River, 50 m) or at Bucoli (western escarpment, 400-500 m).

The relatively slow pace at which these new varieties are becoming accepted[18] is to no small degree due to a number of drawbacks associated by the Timorese with the cultivation of these new varieties. They argue that IR-8 does not grow as high as Nippon (also called Japão) and therefore requires weeding (extra work). Likewise, and this for the Timorese seems to be a strong argument against IR-8, its taste is generally considered inferior to a number of local varieties, let alone hare to'os which of all rice varieties is generally preferred for its taste. Thus, whenever possible, IR-8 is sold by the Timorese at the Chinese cantina in exchange for local rice varieties. It is, however, generally accepted that IR-8 outyields all other varieties, and Uato Lari peasants agree that, in contrast to Japão which often has empty grains, IR-8 always yields. Because of its relatively small plant stature, it is less prone to lodge than most local varieties.

The ecological analysis of wet rice cultivation has elucidated a number of closely interrelated problems with which the Area's natar cultivation is presently faced. These problems stem partly from the low level of technology of the local population, partly from eastern Timor's unique environment, and above all from the erratic and highly seasonal character of the island's climate.

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17 (continued)
500$00 plus food. For this work the Quelicai farmers usually come with their families and even other relatives.

18 In 1970 only 8 taxpayers (contribuintes) of suco of Seiçal and 3 of Tirilolo were said to have planted IR-8 in the whole of Baucau-Sede.

To'os cultivation

The most widespread type of land use in our Area is to'os cultivation which, in contrast to natar cultivation, is practised by virtually everybody. It is a collective term that comprises extensive and intensive types of dryland farming. To the visitor, in fact, one of the most fascinating features of Timor's land usage is the way in which extensive and intensive forms of cultivation coexist in a relatively small area. These various forms could be considered as stages along a hypothetical chain of development from extensive to intensive shifting cultivation which leads in the end to sedentary agriculture (see also Clarke 1966). The merging of these forms of cultivation can even be observed within the same community, where farmers often combine intensive tilling techniques (permanent to'os cultivation) on one field with extensive slash and burn practices (shifting to'os cultivation) on the adjacent one. This phenomenon is contingent upon soils, climate, topography, and population pressure. The juxtapostiion of various forms of dryland cultivation precludes their presentation on such a small-scale map as Fig. 25. Instead, I have attempted to show the impact of these factors upon the degree of intensity of to'os cultivation at a number of selected spots.

Fig. 25 shows that in fact by far the largest portion (over 75 per cent) of the Area is being used for to'os cultivation. Excluded from this type of land use are the irrigable floodplains and terraces and areas near springs, which are reserved for wet rice cultivation; the few remnants of primary forests on top of fatus and crests of smaller hills and mountains; swampy patches along the south coast, and areas with severe rock outcrops such as west of Bucoli to the sea or at Bé Ro (near Bé Aço). All other areas, even those which have been singled out as predominantly grazing grounds, are used in one way or another for to'os cultivation.

Types of intensity of to'os cultivation. Two types of to'os cultivation are shown on Fig. 25. Firstly, there is to'os cultivation as a form of land rotation, for which the term bush fallowing has been chosen. This denotes that the fallow period is so short that only scrub and small secondary tree vegetation is allowed to grow during the brief fallow period. And secondly, there is to'os cultivation as practised permanently. This excludes house gardens.

Permanent to'os cultivation is chiefly practised on volcanic soils (CD) mixed with eluvial soil from adjacent fatu rock (PF) of Mt Mata Bian. This soil is among the most fertile in the Area. The high fertility and the healthier upland climate (above 700 m) has here led to high population densities of locally over 300 persons per sq. km (Laisoralai de Baixo (2), Abo). On account of the ever-increasing population pressure on the land, farmers have by sheer necessity resorted to sedentary to'os cultivation. For this terracing of the comparatively steep hillside (mostly 14-22° slope gradient) was necessary. Drainage channels have frequently been built across the to'os to drain off some of the surplus water during the heavy monsoonal rains. On permanently cultivated to'os tilling, that is a mere scraping or slight hoeing of the soil surface, 5-10 cm deep only is imperative (Plate 39). This is done by means of a small digging stick called ai suak kiik which is about 1 m long and equipped with a metal point on one side (for rocky soil) and a slightly flattened piece of iron on the other end (for loose soil). Usually only one person, either man or woman, tills the family's garden in Quelicai.

The overwhelming majority of all to'os in the Area is, however, cultivated on the basis of bush fallowing. A clearer idea of the degree of agricultural intensity of this type of to'os cultivation is obtained by means of quotients indicating the number of years under cultivation alternating with the number of years under fallow at a particular place. An additional indicator of agricultural intensity is provided if we further specify the type of dryland farming: i.e. either fila rai or merely lere rai (see Fig. 28).

The land that is least intensively cultivated by this form of land rotation in our Area is undoubtedly that on heavy clay soils (CN). The peasants consider this the least valuable type of land, in Tetum designated as rai tahu manu tem (literally 'clay chicken excrement'), on which one, at most two years of cultivation are followed by 15-20 years, or often more, of fallowing. Farmers maintain that these soils are too heavy and compact for root crops, cereals (like maize) and pulses. They are low in organic matter and nitrogen. These soils can thus be termed marginal for farming. Thus wherever farmers have made their fields on these clay soils it is usually because all other soils of superior quality have been occupied. The occupation of heavy clay soils alone could therefore be considered as a measure of population pressure upon the land. Clay areas

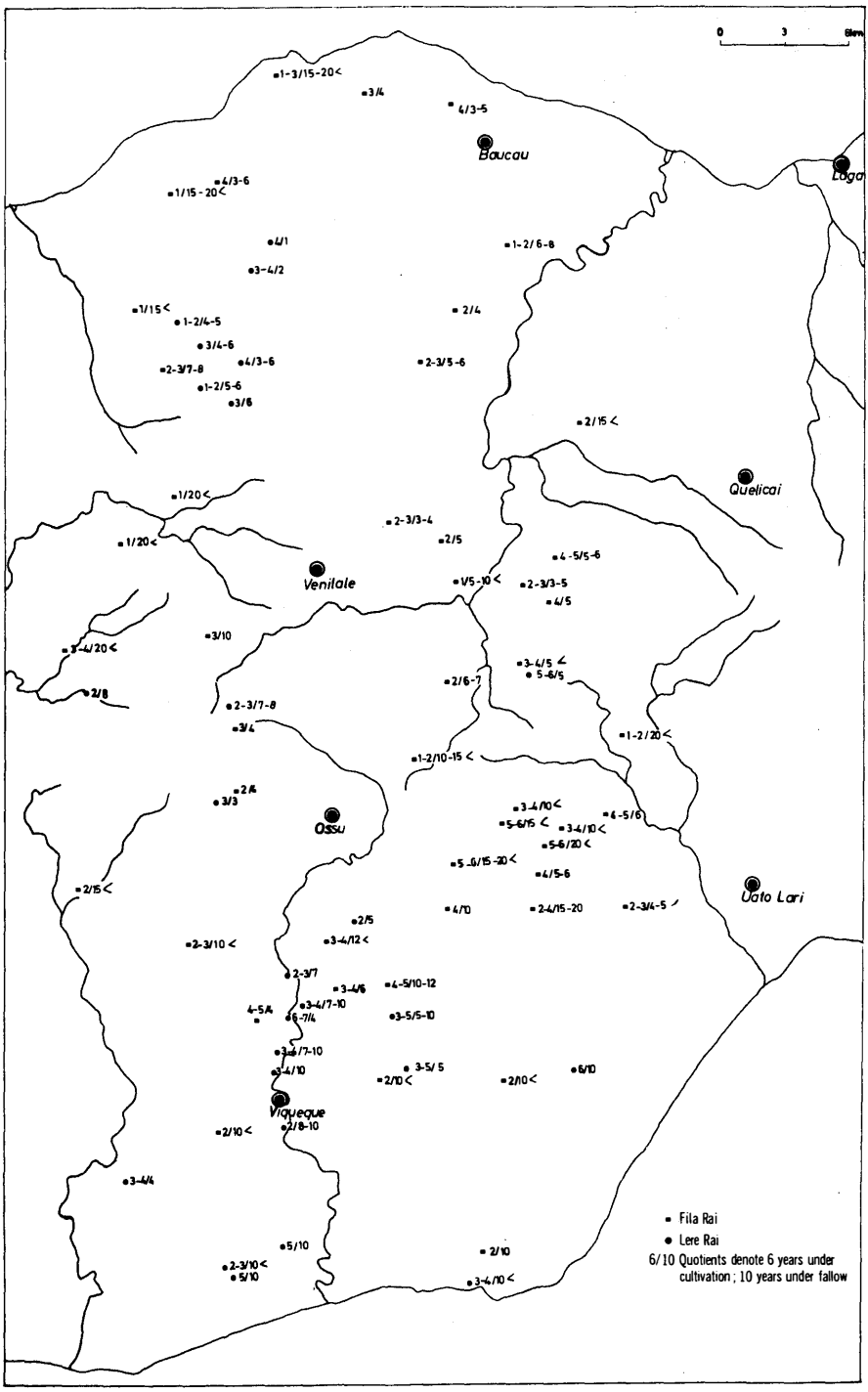


Fig. 28 Rotation periods on to'os

with to'os cultivation are found on both escarpments east and west of the Baucau Plateau, in the sucos of Bucoli, Ostico, Uato Lari, Loilubo (all belonging to Vemasse); Fatolia, Uma Ana Ulo, Baha Mori (all belonging to Venilale); Gari Uai and Seiçal (belonging to Baucau). In the north also the entire suco of Samalari (Baucau), Tequinamata (Laga), and parts of Uai Tame, Guruça, Baguia, Macalaco and Lelalei (Quelicai) belong to this group of to'os land. In the central upland the clay areas with long cultivation cycles are those of Ossu de Cima, parts of Uabubo, Nahareca, Uaguia and Uaibobo.

Because of greater population pressure, it appears that the clay soils in the upland, particularly in Ossu de Cima, are used more intensively than heavy clay soils at lower elevations. At higher elevations the disadvantages of the soil texture are partly overcome by the fila rai practice, however laborious this may be. In the first year after tilling only sweet potatoes and cassava are planted as they are said to loosen the soil. In the second and final year maize and pumpkins can be cultivated.[19]

Of equally low agricultural intensity are skeletal soils of the Northern Marine Terrace Zone (lere: 1 - 3/15 - 20<) and of the Barique Formation (e.g. Mt Ossoala) with slope gradients exceeding 22° (lere: 1/20<) as well as, finally, many parts of the fertile Southern Littoral Plains Zone (coastal lowland soils; Plc-soils), e.g. Uma Uain de Baixo (2), Uma Quic (1) and Maluro (lere: 2 - 3/10) which owing to high malaria incidence is only very thinly populated.

Between this highly extensive form of shifting cultivation on the one hand and permanent agriculture around Quelicai on the other we find a wide range of different stages of intensity. Broadly speaking, the more fertile and the better drained the soil, the more favourable the topography for agriculture and the moister the climate, the shorter is the cultivation cycle (i.e. the longer are the number of years under cultivation and the shorter the number of years under fallow).

To demonstrate the impact of the soil type upon agricultural intensity, an example is given from the Escarpment Zone of the Baucau Plateau. On top of the Plateau, e.g. in the west at Aubaca and Lequi Leuato (both belonging to

[19] Pers. comm. Chefe de Posto of Ossu, Senhor Pires, 10.5.1970.

Bucoli) reddish calcareous soil (VR) of crumbly texture (rai mean) predominates which in the eyes of the Timorese farmers is next to rai metan one of the most fertile soils one can find in the Area. Because it is easy to work[20] this soil is tilled (fila rai) and continuously cropped for four years and subsequently fallowed for one to two years[21] (at Lequi Leuato and Aubaca where population density is relatively high), or three to six years (at Ostico, Loilubo and Gari Uai (Buboraga)). Although rai mean is found all over the Plateau, the greater part of it is considerably less suitable because of pitted limestone outcrops that force the farmer, e.g. at Caissido near Bani Uaga (Tirilolo) and Caibada, to cultivate only very small patches, often only as small as a few square metres of to'os land in between the solution cavities. Flat, stone-free, deeply weathered rai mean is scarce and is restricted to the eastern and western rim of the Plateau as well as to its southern end. Since the population has settled permanently near the springs and water seepages along the escarpments of the Plateau, the highly valued flat and stone-free rai mean soils at the rim of the Plateau are among the Area's most intensively cultivated to'os - apart from those in Quelicai.

Right at the rim of the escarpment, predominantly in swales, rai mean is fringed by rai metan, black calcareous soil which is considered even more fertile than rai mean because of a greater water holding capacity. On the other hand rai metan requires more care and more labour for tilling. The extent of rai metan is very small and rotation cycles are almost identical with those of rai mean (e.g. Loilubo 1-2/5-6, Ostico 1-2/4-5). An exception is Fatumaca de Cima where a few plots are cultivated permanently east of the Baucau-Venilale road. [22]

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[20] Although rai mean tends to dry out easily because of underlying porous coral limestone.

[21] The fact that very short fallowing has been practised for at least 20 years without the fertility level of the soil declining noticeably (according to the chief of Tirilolo Manuel Belo) is at least partly due to crop rotation. This is the only place in the Area known to me where crop rotation is practised.

[22] Pers. comm. Chefe de Jurisdição de Fatumaca de Cima, João Tomé Boavida.

Further down-slope below the rai metan belt we find a layer of white calcareous soil (rai mutin) derived from the Viqueque Formation (CMC) and which underlies the Baucau Limestone. Rai mutin, though still considered to be of good quality for halo to'os, is significantly inferior in quality to rai mean and rai metan. Thus usually not only longer fallow periods of 2-3/7-8 (Loilubo, 400 m), 1-2/6-8 (Buibau at Loibua, 250 m), 4/3-5 (Caibada (1) at Uai Hura, 250 m), 4/3-6 (Macadai de Baixo, 350 m), but also lere rai instead of fila rai are conspicuous on rai mutin.

Below rai mutin further down-slope the aforementioned rai tahu manu tem is found, having one of the longest rotation cycles of 1-3/15-20 years.

As we move south across our Area and come to the central upland, we find that wherever patches of rai mutin[23] are encountered, rotation cycles - though under lere rai practice - are significantly shorter than on the surrounding heavy clay soils (CN). They hover around 2-3/3-5 at Uanisse (450 m) and Leo (325 m), and 4/5 at Uitau. In Nahareca, which is located on a small plateau (about 400 m) of Viqueque Formation, owing to the level rather fertile ground, people have resorted to fila rai with rotation cycles of 5-6/5 years.

Further south in less densely populated Ossoroa, in spite of relatively favourable edaphic and hydrological conditions only lere rai is practised with relatively long rotation cycles having quotients of 3-6/15 and more years. These rotation cycles are common at Buareça, Ossocoqui, Samaliurai (a village belonging to the suco of Uaibobo), Uaibobo (south slope of Mt Builó belonging to the suco of Ossoroa); i.e. mostly along the foot of the fatu block where fertile rai metan soil and water seepages occur as well as locally on level spots of the range (e.g. Samaliurai).

On the top of the Builó range at Lai Sore Lé (275 m), Bia Issi (600 m) and Cai Daua Lari (850 m) rotation periods on lere fields are much shorter and range between 4-5/6-10 years. The reason for this is that these fields benefit more from the southeast monsoon rains on account of the high elevation. Regrowth is consequently faster.

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[23] Not indicated on either geological or soil maps for reasons of scale.

The area south of the central upland, from about 350 m down to sea level consisting of gray calcareous soils derived from Viqueque Formation (CMC), is thinly populated. As a consequence the to'os in hilly parts are worked lere rai with rotation cycles of 3-5/6-10< years, e.g. at Siralari (200 m), Buanurac (250 m), Fatun (250 m), Lacobi (250 m) as well as Mt Burluli at Lua (150 m).

Still more fertile than the aforementioned calcareous soils on the hills of the Southern Foothill Zone are the alluvial soils in between these hills, particularly those of the River Cuha. These soils are therefore more intensively cultivated. Fila rai and rotation cycles of 3-5/5-10 years are common, as at Uala Uau (Loi Huno, 125 m), Futudo (Loihuno, 125 m), Uato Muni (Uma Uain de Baixo, 125 m), Mane Hat (Caraubalo, 50 m), Lama Claran (Caraubalo, 50 m), Bé Laco (Balara Uain, 50 m) and the plain of Luca.

Agricultural intensity finally drops again to 3-5/10-15 as we come to the Southern Littoral Plains Zone.

Cropping pattern. The level of agricultural intensity of to'os cultivation is also reflected in the Area's cropping pattern which is characterized by the many ways in which the Timorese have adapted themselves to the variable rainfall. In order to spread and thus to minimize the risk, they practise interculture whereby several plants with different moisture requirements are grown on the same to'os. The crop combination on a particular field is thereby contingent upon the degree of rainfall variability, upon altitude (i.e. temperature), soil and topography.

The crop with the widest ecological tolerances is maize (batar) which occurs throughout the Area from sea level at Rai Hun (Uma Quic) and Seiçal to the Area's highest to'os at Tu Nihan (hamlet belonging to the village of Uairio in the suco of Ossu de Cima (see Plate 18), north slope of Mt Mundo Perdido at roughly 1300 m.[24] To adjust to the particular rainfall regime short and long growing maize varieties are grown. Thus the Timorese speak of batar kiik and batar boot. Depending upon local conditions, maize is customarily grown together with other crops. As the composition of these additional crops varies from place to place I will attempt

[24] Maize even occurs at an elevation of 1700 m near Ossoliro (Lelalei), a village on the west slope of Mt Mata Bian (2223 m). This village is, however, not included in our Area.

to depict the striking regional differences in the cropping pattern as dependent upon the availability of water at the following six localities along a north-south cross-section of the Area (see Fig. 26):

1. Northern tip of Baucau Plateau: 400-500 m.
2. Upland around Venilale: 600-800 m.
3. Larigutu: 900-1200 m.
4. Northern foot of Builó Range: 500 m.
5. Builó Range (600-800 m) and south-exposed slopes (down to 300 m).
6. Southern foothill zone: sea-level to 300 m.

1. Northern tip of Baucau Plateau: 400-500 m. Type of to'os cultivation: single cropping to'os (bush fallowing) at lower elevation.

We begin our analysis of the cropping pattern at the northern tip of the Baucau Plateau (e.g. Caisido, suco Tirilolo) where batar is planted in late November/beginning December at the onset of the rainy season. Three or four grains of maize and one or two kidney beans (foré tali)[25] are sown into the same hole. After four months batar boot is harvested, followed shortly by the harvest of the climbing kidney beans which use the maize stalk for twining and ranking. Foré tali, having lower water requirements then maize, succeeds in most years while batar boot sometimes fails. In this portion of the Baucau Plateau, where small patches of fertile reddish calcareous soil (VR) are cultivated in between coral limestone outcrops, crop rotation is a common phenomenon. In the first year after lere rai oan[26] maize, peanuts, some cassava along the stone fence, pigeon pea, European potato, pumpkin, and mung bean are planted.

In the second year after tilling chiefly sweet potatoes and peanuts are grown on the field.[27] These two crops, which

[25] For identification and food value of various Timorese agricultural products reference is made to Carvalho (1953).

[26] At lere rai oan (or lere rai kiik) only tall grasses and bushes are slashed and burned while at lere rai boot big trees are felled. On the Baucau Plateau fallowed gardens are mainly invaded by *Tecoma stans* (ai funan modoc), a bush up to 4 m high with big yellow flowers.

[27] In our Area sweet potatoes are seldom and peanuts usually never planted in interculture, but rather in monoculture on a separate field.

besides tobacco and candlenut (*Aleurites moluccana*) have become a sort of cash crop for the Baucau people, are harvested by means of ai suak kiik with which the farmers merely loosen the soil in order to extract the fruits. The leaves are mulched. Thus for the subsequent third year the soil is loose and crumbly and ready to be planted anew with maize. After a period of three years the field rests for three to four years before the crop rotation is renewed. In general, the Plateau farmers have at least three (often more) widely separated to'os, fenced in with stone walls made of piled-up coral limestone. These protect their plots from marauding goats, sheep and pigs (see Plate 40). As the various plots are kept in different stages along the crop rotation cycle, the farmer attempts always to have sufficient maize and other subsidiary crops for private consumption.

The Plateau farmers are the only ones in the Area who practise crop rotation. What is no less striking, they frequently keep their goats or sheep in one of their fallowed gardens, using it as a corral. Thus they are the only farmers in the Area who make use of animal manure as fertilizer for their fields. To'os cultivation is particularly intensive in the northern part of the Baucau Plateau. This is all the more remarkable since limestone outcrops leave only small islands of soil for cultivation.

2. Upland around Venilale: 600-800 m. Type of to'os cultivation: single cropping to'os (bush fallowing) on medium altitude.

As we gain in altitude approaching the southern tip of the Baucau Plateau (which belongs to Venilale) the cropping pattern changes slightly. With altitude the growing periods become longer. Batar bo'ot takes about five months instead of four to mature (e.g. at Fatuliana, 800 m). Cassava also does not ripen in nine months, but is usually left in the soil for 18 months to two years (e.g. Loilubo, 700 m).[28] Coconuts are seldom encountered at elevations over 500-600 m, where they take 10-12 years instead of 7-8 at sea level to mature. At these high elevations coconut trees yield only

[28] On account of its long growing period and its shadowing effect at higher elevations, cassava is often planted only along the fence. While it matures over a period of two years, the field can be planted and harvested twice.

very small nuts.[29]

Above 600 m foré tali is gradually replaced by French beans (koto)[30] which had been observed at Nunoti (Loilubo, 700 m), Fatuliana (Fatulia, 800 m) as well as at Liaró (Builale, 1100 m). Like foré tali at lower elevations, koto is here planted in association with maize which serves as a pole for the climbing pulse. At Fatuliana (800 m) where rainfall is considerably heavier and lasts longer than in the northern part of the Baucau Plateau (450 m) cassava and maize were planted in rows. Thus, as soon as batar and foré tali are harvested in late April/mid May, the rows in between cassava are again interplanted by koto and foré mungo (*Phaseolus mungo* var. *radiatus*) as a dryland crop. These two types of beans require only three months to mature and are thus harvested in August. As such, the little moisture stored up in the soil at the end of May usually suffices for these two bean varieties.

At Uato Haco, around the administrative centre of Venilale, 800 m, an attempt has recently been made by the administration to revive the cultivation of two crops from temperate zones: wheat (*Triticum vulgare* or *Triticum saticum*) and chick pea (*Cicer arietinum*). The cultivation of wheat has apparently played an important role in Venilale before World War II, during which time the local flour mill was destroyed. As a consequence wheat cultivation was soon discontinued. Several efforts by various administrators aimed at reviving wheat cultivation together with that of chick pea did not meet with any positive response on the part of the Timorese. In 1970 wheat was only grown by the suco chief of Uato Haco, Cristovão Guterres. In 1970 the local administrator ordered all sucos to plant chick pea, at least, on communally-owned fields. For that purpose seed was distributed. The success of this measure is, however, doubtful. Not only do the local farmers lack skill in the cultivation of this crop, but also they do not seem to have a great liking for its taste. As chick pea does not tolerate a lot of water, in Venilale it is planted in July and

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[29] It is estimated that at Ossu (600-700 m) 24 coconuts yield one litre of coconut oil as compared to six nuts required for the same amount of oil at Viqueque.

[30] Also called koto dian (*Phaseolus vulgaris*) in contradistinction to koto fuik (*Phaseolus lunatus*), a less important crop than the former.

harvested five months later in November. Wheat, in contrast, is planted in March/April and harvested in September. The combination of low temperature, a monomodal rainfall regime and good soil conditions (calcareous soil around the administrative centre) seems to favour the cultivation of these crops at Venilale instead of in the central upland which is characterized by a far longer rainy season with two peaks (e.g. Ossu).

3. Larigutu: 900-1200 m. Type of to'os cultivation: double cropping to'os with maize (batar boot and batar kiik) at high elevation.

The cropping pattern at Venilale - although restricted to a few fields with calcareous soils - seems to indicate that rainfall conditions are likely to permit the cultivation of a second dry crop with very moderate moisture requirements like foré mungo and koto. Still more favourable moisture conditions are encountered at Larigutu (900-1200 m)[31] where two maize crops per year are rendered possible along the contact zone of Larigutu Limestone and heavy clay (CN) - e.g. at Cai Uai Hoo (1100 m), Uairio (1000 m), Nunobate (900 m) and Uma Ana Ico (900 m) (suco of Ossu de Cima). At Cai Uai Hoo batar boot is planted in November and harvested in May/June the following year. Thus it takes 6-7 months to mature instead of four at lower elevations. At Larigutu this first crop is followed by a second maize crop of batar kiik which requires 4-5 months instead of three months to ripen. Therefore, it is not harvested before October/November. On account of the prolonged growing periods no batar boot can be planted as a second dry season crop.

On the other hand, local farmers maintain that the cultivation of hare to'os, which replaces batar kiik on double cropping dry fields at lower elevations of the Southern Foothill Zone, is not feasible up here because of the low temperature (rai malirin). This, however, does not seem to be the real reason, for even at higher elevations dryland rice is cultivated in parts of Indonesia (e.g. Java). It rather seems that since almost everybody in Ossu grows hare natar, there is no need of cultivating additional hare to'os.

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[31] The saddle of Larigutu between Mt Mundo Perdido and Mt Laritame intercepts moisture of the northwest and the southeast monsoon. Only 5 km away in the northwest direction at Mt Ossoala the southeast monsoon is no longer felt.

Along with the staple garden crop of maize, French beans, potatoes, yams and cassava are also grown.[32] The number of different crops grown at this elevation is considerably reduced. Tobacco, coconuts, and areca do not grow well. Candlenut is the only cash crop that seems to grow at the foot of fatus on loose black calcareous soil (PF) (rai metan).

The Larigutu area is in several respects unique. Firstly, it benefits from a prolonged but not too long rainy season. It thus stands in contra-distinction to Dara Hoba (1000 m) on the southern slope of Mt Mundo Perdido. There it is too wet during the second season (May to September), according to local farmers, for a second crop of either hare to'os or batar kiik, because of heavy convectional rains. Secondly, calcareous soils at Larigutu are decidedly better suited for agricultural purposes than the heavy clay soils further south in between Larigutu and Builó Range at Lianida, Uato Ita and Uailia.

4. Northern foot of Builó Range: 500 m. Type of to'os cultivation: double cropping to'os with maize (batar boot and batar kiik) at lower elevation.

As one leaves the vast clay area of Ossu behind (see Plate 42) one comes to the foot of Mt Builó where at an average elevation of only 500 m a cropping pattern similar to that of Larigutu is encountered. At villages of Builó (650 m), Osso Coqui (650 m), Derulo (750 m), Buareça (500 m), Umabere (500 m) (all villages belonging to the suco of Ossoroa) black calcareous soil (PF) (rai metan) and water seepages from the adjacent fatu block make two crops of maize per year possible - in the first season: batar boot (4-5 months, November/December-April) and batar kiik (3-4 months, November/December-January/February); in the second season: merely batar kiik (3-4 months, May-August/September). The cultivation of the latter is, however, dependent upon whether it rains during bai loro kiik i.e. the interseasonal period on the south coast and in the central upland which is characterized by an abatement, but not a complete standstill of the rains. For should there be no rainfall in April, farmers would not venture to plant batar kiik. Kidney beans are only planted during the first season, as is tunis (*Cajanus indicus*) which

[32] Yams (kumbili) (*Dioscorea esculenta*) take 2-3 years at this elevation instead of nine months at sea level and cassava (ai farinha) requires two years till maturation at Larigutu.

needs seven and more months to mature (November/December-July). At this elevation the principal cash crop is bua (*Areca catechu*) besides some candlenut, while coconuts do not yield well at this elevation.

5. Builó Range (600-800 m) and south-exposed slopes (down to 300 m). Type of to'os cultivation: double cropping to'os with dryland rice (November-April) and maize (May-August/September).

As we come to the top of the Builó Range - to the villages of Baha Lata (700 m), Curacate (700 m), Lai Soro Lé (800 m), Uata Laua (500 m) including the southern escarpment Uata Cau Issi (350 m), Bia Issi (550 m), Manolari (300 m), Uaibobo (300 m), all within the suco of Ossoroa - moisture increases due to higher rainfall throughout the year and consequently gives rise to a new type of to'os cultivation.

Here moisture conditions seem to warrant the cultivation of dryland rice[33] in the first season (November/December - April), followed by a maize crop in the second (May-September). Since the second season (May to August) appears to be the moister one of the two rainy seasons, farmers seem to prefer planting dryland rice in November/December. They maintain that since hill rice has to be planted in a squatting position whereby a handful of rice grains is put into the planting hole each time, the second, moister season would render such an operation more laborious. Instead, in the second season farmers plant maize which can be planted in a standing position, from which the maize and bean grains are simply thrown into the holes.

Apart from the southern slope of Mt Mundo Perdido[34] the abovementioned effect of convectional rain is, however, apparently limited to the Builó Range and its southern escarpment.

6. Southern Foothill Zone: sea level to 300 m. Type of to'os cultivation: double cropping to'os with maize

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[33] Depending upon the quality of the soil, maize is sometimes planted in the first season on less fertile plots too.

[34] In contradistinction to the villages on top of the Builó Range, which are well below 800 m, Dara Hoba at Mt Mundo Perdido at 1000 m is apparently too wet and cold (rai malirin) for a second crop per year.

(December-March/April) and dryland rice (May-August/September).

Another type of to'os cultivation is encountered at the Southern Foothill Zone.[35] This type is found on calcareous soil derived from the Viqueque Formation (CMC) and thus starts south of a line that runs roughly from Manolari (suco of Uma Quic on the east bank of the River Bé Tuco) to Uala Uai (125 m, Loi Huno). East of the Cuha the line runs north of Lacobi (200 m), Gomi Lari (200 m) and Uato Dere (125 m). Here, in contrast to the aforementioned type of cultivation, maize is planted in the first season (December-April) (called batar udan) and dryland rice usually in the second (April/May-August).

The local farmers of the Southern Foothill Zone maintain that the second season usually brings more rainfall and is more reliable in terms of actual rainfall incidence. This explains why dryland rice, which requires more water than maize, is usually planted in the second season. This, however, also depends on a number of other factors: dryland rice is preferably grown on fila rai fields which yield more than lere fields. In addition, because the soil is rapidly exhausted dryland rice can often only be grown in the second season of the first year after clearing (e.g. at Siralari, 200 m, Caraubalo). In the following years only two maize crops are grown annually. Maize is sometimes also grown instead of dryland rice even in the first year if a dry second season is expected because of very dry conditions during bai loro kiik (March/April).

The main crops, dryland rice and maize also determine the crop combination with other subsidiary crops. Usually dryland rice is planted with little interculture - except for various forms of yams like uhi and kumbili (grown throughout the year) and some taro (December-September) and pigeon pea, while cassava, pumpkins and kidney beans are interplanted with maize. Sweet potatoes and peanuts are customarily planted unmixed on separate fields. Foré mungo may be planted up to three times per year because of its short growing period of 8-12 weeks. At Uata Muni (Uma Uain de Baixó, 150 m) the last foré mungo crop is planted in September. Since mung bean is fairly drought resistant, it still yields that late in the dry season.

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[35] Exempted are only the few clay areas near Viqueque village, parts of Maluro and Uma Uain de Cima.

The chief cash crop in this zone is coconut. It has become increasingly popular since 1960. Farmers are eager to plant coconut on fila rai fields in interculture with other crops for the first 3-4 years. Thereafter no more food crops will be cultivated on these plots. Since the trees are not properly spaced, their shade impedes the successful growing of other plants. Therefore the coconut plantação is merely weeded to reduce the fire hazard and to boost coconut production. Some areca is also grown in association with coconuts, for instance at Balara Uain and Luca. The west bank of the Bé Tuco flood plain is, moreover, a centre of tobacco production. Candlenut is not popular in the Southern Foothill Zone since it requires far more labour than coconut. The hot humid climate precludes hard work, as has been evidenced by a number of abortive attempts aimed at introducing labour-intensive cash crops into the native economy.

In the course of the discussion of to'os cultivation a close relationship between cropping pattern and rainfall has been evident. The humidity gradient from the drier north to the moister south has been recognized as the overriding factor determining the cropping pattern. This chief determinant is locally enhanced only by differences in soil type. Throughout the Area, interplanting of crops with different moisture requirements is the rule, in order to minimize the risk caused by a highly variable rainfall.

Livestock grazing

It is no easy matter to assess the number of livestock in the Area. In the absence of an official livestock census the livestock population can only be estimated from data obtained at the annual tax assessment (Port.: arrolamento). On that occasion livestock owners are simply questioned by the tax committee as to the number of head of animals they own. It is obvious that these figures can only be considered as approximations of the truth.[36] Thus, whether willingly or not, figures are likely to be distorted. Moreover, according to the chief veterinary officer (Dr Gabrier da Silva, who was chief of the Veterinary Service (RPSV) until autumn 1969), before the introduction of the livestock tax in 1966,[37] the Timorese declared more livestock than they

[36] On account of the extremely low literacy rate counting above ten constitutes a problem for the average person.

[37] Buffalo, Bali cattle and horses are taxed, at 10$00 per head.

actually had. Since buffaloes and also horses are used as a bride price, it seemed that before the actual transfer of the animals had been effected the animals were declared as property by both the wife giver and the wife taker, and thus counted twice.

After 1966 tax evasion became the rule. Spot checks in a number of villages by the RPSV revealed that actual numbers of large livestock (horses, buffaloes and Bali cattle) by far exceeded those declared for tax purposes. It is therefore obvious that nobody has an exact idea of how much livestock there is in Portuguese Timor.[38]

As a consequence the local veterinary service has established its own coefficients to bring these figures nearer to reality. Table 22 shows that these coefficients range between 1.02 and 1.30.[39] Although these coefficients have been made as realistic as possible, they cannot disguise the fact that the estimated livestock figures might still differ considerably from the truth. For planning purposes a thorough and comprehensive livestock census seems imperative. Yet, in the absence of more reliable figures the data received from the tax statistics were used for computing the animal densities. Thus these data are highly conservative and should represent nothing more than the lowest estimate.

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[38] According to the guarda pecuario of Viqueque, Sr Antonio Pereira Soares, even on the occasion of mass vaccination, when people corral their livestock in order to benefit from the free treatment, he is not in a position to determine the owners of all livestock. Often the Timorese do not know how many buffalo were born.

[39] Similar spot checks in Indonesian Timor revealed that actual livestock figures had to be estimated as at least twice those shown in the tax registers. In the case of small livestock (goats, pigs) the conversion ratio was as high as five times. By comparison to the multiplication factors used in Indonesian Timor the coefficients for Portuguese Timor seem to be very moderate. Ormeling (1955:156) reports a multiplication factor of two in 1952, while in 1958 the Djawatan Kehewanan (Indonesian Veterinary Service) used the following coefficients: horses 1; cattle 2.75; buffaloes 2.5; goats and sheep 5; and pigs 4 (FAO 1960:222).

Table 22 gives an idea of the livestock population of the whole of Portuguese Timor for 1969. Livestock densities have been computed on the basis of the corrected figures for which official multiplication factors have been used. These figures already point to a relatively high livestock density for the tropics. More revealing for our purpose seems to be the regional distribution on the basis of 'Standard Head of Livestock' (SHL) as indicated on Table 23. This table shows that in 1969 the concelhos of Viqueque and Baucau had one of the highest livestock densities in Portuguese Timor both with 28 SHL/sq. km). Only Suai (on the south coast adjacent to the Indonesian border) and Oécussi have higher densities (35 and 31 SHL sq. km respectively). The relation SHL per person, on the other hand, demonstrates that in Viqueque for each person there is one SHL (exceeded only by the figures for Suai and Oécussi with 1.14 and 1.06 SHL per person) while there is far less livestock in relation to population in Baucau.

While Table 23 already draws attention to the disproportionately high ranking of the Baucau-Viqueque area as one of the major livestock centres in Portuguese Timor, Table 24 gives the Area's absolute livestock figures on a posto basis. From the same table it becomes evident that although the Baucau-Viqueque area constitutes no more than 9.3 per cent (= 1783.4 sq. km) of the total area of Portuguese Timor (18.989 sq. km), its livestock population is proportionately far more important for buffalo (22.2 per cent of the total stock of the Province), horses (21.4 per cent), pigs (13.1 per cent), goats (15.5 per cent) and sheep (46.per cent). I want now to discuss the regional distribution of the individual species within the Area.

Buffalo. Figure 29 shows a high density of water buffaloes in the central upland, particularly in Quelicai (suco of Laisorolai de Baixo) and Ossu (suco of Uaguia) as well as in Vemasse (suco of Loilubo). Along the Southern Littoral Plains Zone as well as on the Baucau Plateau, densities are lowest. Since water buffalo (karau) seem to be quite sensitive to extremely dry and hot climates, it is no wonder that the central upland has the highest concentration of karau in our Area. Timorese claim that buffalo reproduce more rapidly in the cooler climate of the upland where there is a longer duration of pasture growth. A number of Timorese, e.g. the chefe de suco of Balara Uain (Viqueque), keep their buffaloes in the Southern Foothill Zone above 400 m in Loihuno, instead of in the hot coastal belt.

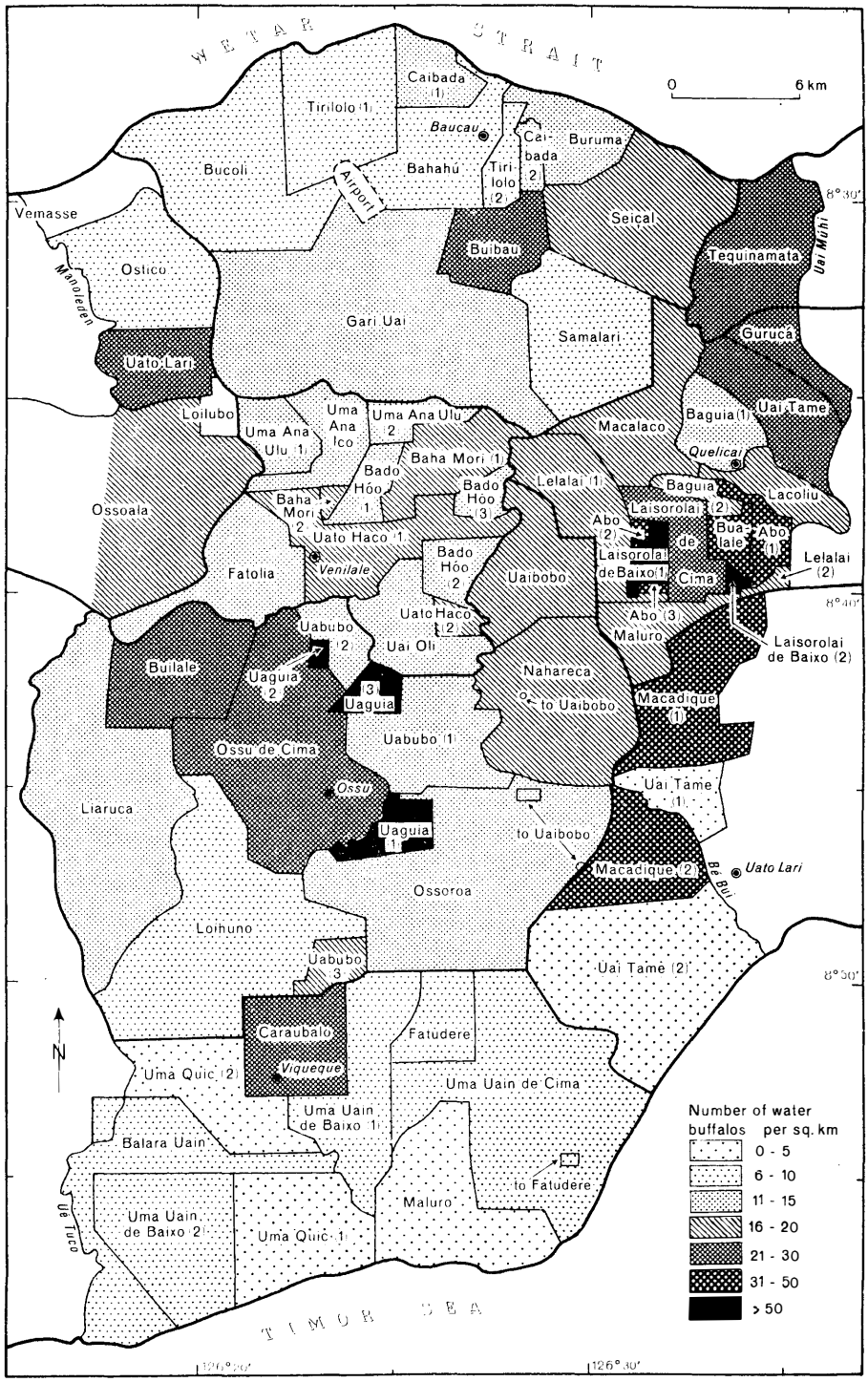


Fig. 29 Distribution of water buffaloes within the Area

Table 22

Livestock in Portuguese Timor, 1969

	Livestock figures obtained at tax census 1969	Official multiplication factor	Corrected figures for 1969	Livestock density per sq km
Buffaloes	123,900	1.3	161,079	8.29
Horses	106,772	1.2	138,803	7.15
Cattle	67,039	1.2	80,446	4.14
Pigs	202,510	1.2	236,731	12.19
Goats	201,404	1.2	241,687	12.44
Sheep	41,548	1.02	42,378	2.18

Source: RPSV, Rel. An., Dili 1969, p. 23.

Table 23

'Standard Head of Livestock' and population in Portuguese Timor, 1969*

Administrative Districts	Population (according to tax census 1969)	Livestock in SHL**	Area in sq. km	Population density per sq. km	Livestock density SHL** per sq. km	Number of SHL** per person
Lautem	37,196	30,954	3,281.0	11	9	0.83
Viqueque	57,814	58,834	2,065.0	28	28	1.00
Baucau	34,281	44,986	1,600.0	21	28	1.31
Manatuto	32,543	25,078	2,655.0	12	9	0.77
Dili	61,546	10,965	1,011.0	61	11	0.18
Liquiçá	46,918	15,332	965.0	49	16	0.31
Ermera	56,716	17,525	1,940.0	29	9	0.32
Same	34,616	25,163	1,295.0	27	19	0.73
Ainaro	46,710	16,327	682.0	68	24	0.35
Bononaro	68,314	47,071	1,865.0	36	25	0.69
Suai	38,817	44,258	1,255.0	31	35	1.14
Oécussi	23,815	25,372	808.5	29	31	1.06
Total	589.386	361,857	19,422.5	30	19	0.61

* Livestock figures were corrected according to official multiplication factors (see Table 22).
** 'Standard Head of Livestock' being defined by RPSV (Rel. An. 1969, p. 20) as:
1 head of cattle = 5 pigs
1 head of buffalo = 10 sheep
1 head of horse = 10 goats

Source: RPSV, Rel. An., Dili 1969, p. 20

In this context it is useful to bear in mind that since the data only refer to the livestock at the place of registration (i.e. native suco of the livestock holder), actual livestock distribution (particularly that of large livestock) may differ considerably from the picture given in Fig. 29. Thus, for example, a great portion of the buffalo herds belonging to Bualale, Abo, Laisorolai de Baixo (all sucos of Quelicai) are permanently kept on pastures of the sucos of Macalaco (Quelicai) and Uaibobo (Ossu).

In addition, transhumance is practised locally, as for instance between the eastern escarpment of the Baucau Plateau and the floodplain of the Seiçal, which during the dry period offers some water so essential to buffalo. In general, people are reluctant to transfer their buffalo from the upland to the lowland. Transhumance is therefore not widely practised. Quelicai and also Ossu people who have brought their buffaloes down to the plain of Uato Lari for paddy cultivation in 1965 claim to have lost a great number of their animals thereby. Following that experience they have discontinued the practice.

On the other hand it seems that buffalo are viable even in the lowlands of Timor, as for instance in the suco of Seiçal where sufficient water is available throughout the year providing some protection for the animals against the high insolation.

The large number of water buffalo in the whole of Portuguese Timor is, in general and in the study area in particular, surprising only when we consider the usefulness of these animals. Apart from a few weeks during the year when the paddy fields have to be worked, the buffalo are not utilized at all, either for dairy purposes or as draft animals. Thus, except during natar cultivation, the buffalo roam freely about, only to be tended casually by herdsmen. Grass consumption of these animals is considerable and by far exceeds that needed for Bali cattle. This problem deserves attention in view of the shortage of pastures in the Area.

Despite the comparatively high percentage of water buffalo in the Area, a shortage of karau makes itself felt each year when paddy fields have to be 'ploughed' (sama natar). Since most natar are as we have seen rainfed, buffalo are needed for trampling during a short time of the year only. At this time of the year a serious shortage of buffaloes occurs. This is aggravated by the unequal social distribution of buffaloes as shown on Table 25 for Ossu and

Table 24

Livestock in the Baucau-Viqueque Area by postos in 1969 (uncorrected figures)

	Buffaloes	Horses	Cattle	Pigs	Goats	Sheep
Uato Lari (2 sucos)*	2,848	1,608	-	2,592	2,309	38
Ossu	8,982	8,249	543	6.548	10,325	1,979
Quelicai (11 sucos)**	3,456	3,021	85	5,428	4,091	1,862
Viqueque#	2,628	3,526	1,082	4,230	2,640	159
Baucau	4,275	2,479	105	5,037	6,391	9,864
Vemasse (4 sucos)##	2,131	1,255	-	525	1,523	1,563
Venilale	2,358	2,630	11	1,917	3,585	2,826
Laga (1 suco)+	820	64	-	279	425	803
Total	27,498	22,832	1,826	26,556	31,289	19,094
In % of total of Portuguese Timor	22.2	21.4	2.7	13.1	15.5	46.0

* Only sucos of Macadique and Uai Tame Vessoro.
** All sucos except for Afaçá and Namanei.
# All sucos except for Bibileu, Uai Mori and Luca.
All sucos except for Cai Cua, Uai Gae and Vemasse.
\+ Only suco Tequinamata.

Source: Arrolamento 1969 for concelhos of Baucau and Viqueque.

Table 25

Social distribution of buffaloes in Ossu and Posto Sede of Viqueque in 1969 (uncorrected figures)

	Buffaloes*	Taxpayers	Buffalo owners	Buffalo owners in % of taxpayers	1-5 buffaloes				6-10 buffaloes				11-30 buffaloes				Over 30 buffaloes			
					Buffaloes		Buffalo owners		Buffaloes		Buffalo owners		Buffaloes		Buffalo owners		Buffaloes		Buffalo owners	
					Head	% of total	Persons	% of total	Head	% of total	Persons	% of total	Head	% of total	Persons	% of total	Head	% of total	Persons	% of total
Posto of Ossu																				
Builale	597	433	37	8.5	22	3.7	8	21.6	78	13.1	9	24.3	363	60.8	17	45.9	134	22.4	3	8.1
Liaruca	1074	279	22	7.9	3	0.3	1	4.5					156	14.5	7	31.8	915	85.2	14	63.6
Loi Huno	780	295	42	14.2	40	5.1	15	35.7	88	11.3	10	23.8	95	12.2	5	11.9	557	71.4	12	28.6
Uaguia	1241	355	31	8.7					18	14.5	2	6.5	358	28.8	15	48.4	865	69.7	14	45.2
Ossoroa	1254	771	82	10.6	82	6.5	30	36.6	93	7.4	11	13.4	614	49.0	31	37.8	465	37.1	10	12.2
Uabubo	602	461	28	6.1					21	3.5	3	10.7	422	70.1	21	75.0	159	26.4	4	14.3
Uaibobo	507	500	37	7.4	26	5.1	11	29.7	92	18.1	11	29.7	224	44.2	11	29.7	165	32.5	4	10.8
Nahareca	887	557	56	10.1	54	6.1	26	46.4	65	7.3	9	16.1	261	29.4	11	19.6	507	57.2	10	17.9
Ossu de Cima	1838	759	60	7.9	19	1.0	4	6.7	54	2.9	6	10.0	698	38.0	34	56.7	1067	58.1	16	26.7
Total Ossu	8780	4410	395	9.0	246	2.8	95	24.1	509	5.8	61	15.4	3191	36.3	152	38.5	4834	55.1	87	22.0
Posto of Viqueque																				
Caraubalo	527	585	74	12.6	125	23.7	48	64.9	63	12.0	9	12.2	224	42.5	14	18.9	115	21.8	3	4.0
U.U. de Cima	459	281	118	42.0	242	52.7	100	84.7	116	25.3	14	11.7	50	10.9	3	2.5	51	11.1	1	1.1
U.U. de Baixo	588	309	98	31.7	188	32.0	75	76.5	96	16.3	12	12.2	132	22.4	8	8.2	172	29.3	3	3.1
Balara-Uain	390	486	53	10.9	79	20.3	28	52.8	114	29.2	14	26.4	197	50.5	11	20.8				
Fatudere	53	94	18	19.2	34	64.2	15	83.3	19	35.8	3	16.7								
Maluro	65	97	26	26.8	58	89.2	25	96.2	7	10.8	1	3.8								
Uma Quic	343	515	76	14.8	156	45.5	57	75.0	141	41.1	17	22.4	46	13.4	2	2.6				
Total Viqueque	2425	2367	463	19.6	882	41.2	348	75.2	556	22.9	70	15.1	649	26.8	38	8.2	338	13.9	7	1.5

* Figures are slightly lower than those in Table 27 which were obtained from the concelho administration in Viqueque.

Source: Administação de posto de Ossu e Viqueque-Sede.

Viqueque.[40]

While 19.6 per cent of all taxpayers in Viqueque - where there are hardly any paddy fields - own buffalo, there are only 9 per cent in Ossu where natar abound. In contrast to Viqueque where 90 per cent of all owners have up to ten buffalo (75.2 per cent only own 1-5 head), in Ossu less than 40 per cent of all owners are in that category. Thus, since herds of at least 20 animals are required for natar cultivation, only a few taxpayers in Ossu have been able to accumulate such a big stock of animals. Buffalo owners and owners of paddy fields are often not identical. Thus pooling of resources is essential. This can either take the form of tau karau hamutuc (lit.: to put the buffaloes together) whereby several owners pool their buffaloes, thereby forming a herd big enough to carry out sama natar, or, what is also very common, halo socio (lit.: to make partner) which is a type of contract between the buffalo owner and the owner of a wet rice field. The stipulations of the latter type of contract vary from place to place and seem to be contingent upon the availability of buffalo, manpower and wet rice fields. Normally, if one side provides the buffaloes and the other the natar - while both sides provide the necessary manpower - the harvest is halved. In Uato Lari, however, the labourers do not normally provide the buffaloes, and yet receive 50 per cent of the yield while the rest is earmarked for the owners of the paddy field and the buffaloes. Thus on the mosquito and malaria infested south coast the conditions of these contracts seem to be more favourable for those who actually work in the natar.

Despite pooling of herds there is still a serious shortage of buffalo at harvest time. As a result, a great number of rice fields remains unworked, particularly those which depend entirely on impounded rain and which have to be 'ploughed' at a certain moment of the year. The farmer has very little flexibility in choosing the date of ploughing. He has, however, a little more leeway with river- or springfed paddy fields. The dependence of the paddy farmer on buffalo is, moreover, underscored by the fact that at the beginning

[40] Unfortunately this analysis could not be carried out for the entire Area as the respective data for Baucau, Quelicai and Venilale vanished in the mail; thus we have to be content with the presentation of the data for Viqueque and Ossu only, which nevertheless in my opinion serves well to illustrate the problem.

of the rainy season buffaloes usually suffer from diarrhoea owing to the fresh green grass which they are not used to after the long dry season. Four to six weeks are needed for the animals to adjust their metabolism to this new feed.

For planning purposes it is useful to watch the development of the buffalo population. Statistics using uncorrected figures reveal (Table 26) that for the entire Province buffalo numbers have held their own ever since about 1955 when severe losses incurred in the buffalo population during World War II were compensated. Since then the number has hovered around 123-124,000 with temporary setbacks in the late 1950s and early 1960s when the number dropped to 105,000. Concurrently the number of Bali cattle increased steadily from 881 (1946) to 67,039 (1969).

From this general picture the situation in our Area differs considerably, as evidenced in Table 27. It shows that the number of buffalo increased, in general, till 1964 in all parts of the Area. Then during the period 1964-69, a downward trend can be observed in all postos except in Laga and Uato Lari, with Ossu holding its own. Bearing in mind the aforementioned qualifications as to the reliability of the data, it seems too hazardous to make any definite deductions from the statistics. This is particularly so with respect to the lower figures for 1969 relative to those of 1964 which may be due in no small degree to the introduction of the livestock tax in 1966. On the other hand, since there are hardly any cattle in the Area, no analogy with the general situation in the Province as a whole can be drawn. Nevertheless, on the basis of the observations one deduction from the data seems permissible, namely, that the increase in the number of buffalo in Uato Lari has to be correlated with the opening up of the Uato Lari plain (Narequici, Fatún) where buffalo have been needed since 1965. The necessity to increase the buffalo population in that posto was reportedly due to the unwillingness of the socios (= mostly people from Quelicai) to bring their buffalo down to the plain.

The erratic character of the data, which becomes particularly evident when one considers annual figures, may also suggest that the number of buffalo killed or dying because of disease varies considerably from year to year. Although everybody in Portuguese Timor is required by law to report any slaughter of livestock to the Administration, only a minor proportion of all slaughters are actually registered.

Table 26

Livestock population in Portuguese Timor, 1913-69 (uncorrected figures)

	Cattle	Buffaloes	Horses	Pigs	Sheep	Goats
1913	646	47,579	26,339	43,059	13,207	44,093
1920	617	87,076	48,247	89,490	31,459	69,753
1927	1,477	126,356	73,028	121,225	47,171	146,122
1935	1,283	127,395	87,880	114,208	47,762	129,391
1946	881	64,073	38,487	73,371	21,051	52,708
1950	3,725	91,107	45,799	129,823	36,480	103,003
1955	10,242	97,585	56,433	188,498	44,039	197,610
1960	24,172	112,753	91,652	227,161	42,335	229,494
1965	51,434	124,301	105,845	325,633	57,271	250,925
1969	67,039	123,900	106,772	202,510	41,548	201,404

Source: 1913-65: RPSV, Rel. An. 1968, annex.
1969: RPSV, Rel. An. 1969, p. 18.

Table 27

Buffalo population by postos (uncorrected figures)

Postos	1959	1964	1969
Ossu	7,603	8,774	8,982
Viqueque*	3,053	3,772	2,628
Uato Lari**	936	1,763	2,848
Laga#	445	610	820
Baucau	3,545	5,543	4,275
Venilale	2,789	3,697	2,358
Quelicai##	3,115	3,653	3,456
Total	21,286	27,812	25,812

* Without sucos of Bibileo, Uai Mori, Luca.
** Only sucos of Macadique and Uai Tame (Vessoro).
# Only suco of Tequinamata.
Without sucos of Afaçá and Namanei.

Source: Annual tax census 1959, 1964, 1969.

It is an open secret that illegal home slaughter (which cannot be controlled because of lack of administrative personnel) is still the rule. Thus Table 28 gives but a fraction of all livestock slaughters.

Livestock diseases, at times, also ravage and cause serious damage to the buffalo stock. Septicaemia haemorrhagica - a common animal disease in the tropics - plays havoc with buffalo and Balinese cattle, especially in tropical regions like Timor having a well-marked dry season. According to Duarte (1930:168) Septicaemia haemorrhagica takes a heavy toll of the buffalo herds particularly in January. Until vaccination campaigns became the rule,[41] this and other animal diseases which we shall discuss later will constitute a natural bar to overstocking.

Horses. The horse has greater economic importance to the Timorese than the buffalo. The Area's horse population, which amounted in 1969 to 21.4 per cent of Timor's total stock of horses, has nevertheless remained the same since 1964. A glance at Fig. 30 reveals that the cooler climate of the central upland (Quelicai and Ossu) preferred by man is also the favoured place for horses. Horse density is highest in the suco of Loilubo (Vemasse), i.e. on the highest part of the Baucau Plateau (600-700 m) - with 70.6 head per sq. km, followed by Uaguia (Ossu) (60.6) and several sucos in Quelicai. The park-like landscape of Larigutu, Loihuno, Liaruca, and the 'intramontane valley' between Mt Builó, Mt Laritame and Mt Mundo Perdido is widely used for grazing.

Another reason why horses tend to be concentrated in the central upland is the disappearance of *Hippobosca* sp. above a certain elevation (see also Ormeling 1955:159). This horse fly is a great nuisance and at places occurs in such big swarms that horses are virtually covered and seriously handicapped in their efficiency by the insects.

But even in the upland pastures livestock, particularly horses, do not look well, and at the end of the dry season,

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[41] Twice a year buffalo, cattle and horses are vaccinated against Septicaemia haemorrhagica, Carbunculo simptomatico and Tripanosomiasis (= surra). Vaccination against other diseases is not compulsory. As there was no laboratory until 1971 the possibility of identifying more animal diseases in Timor is not ruled out.

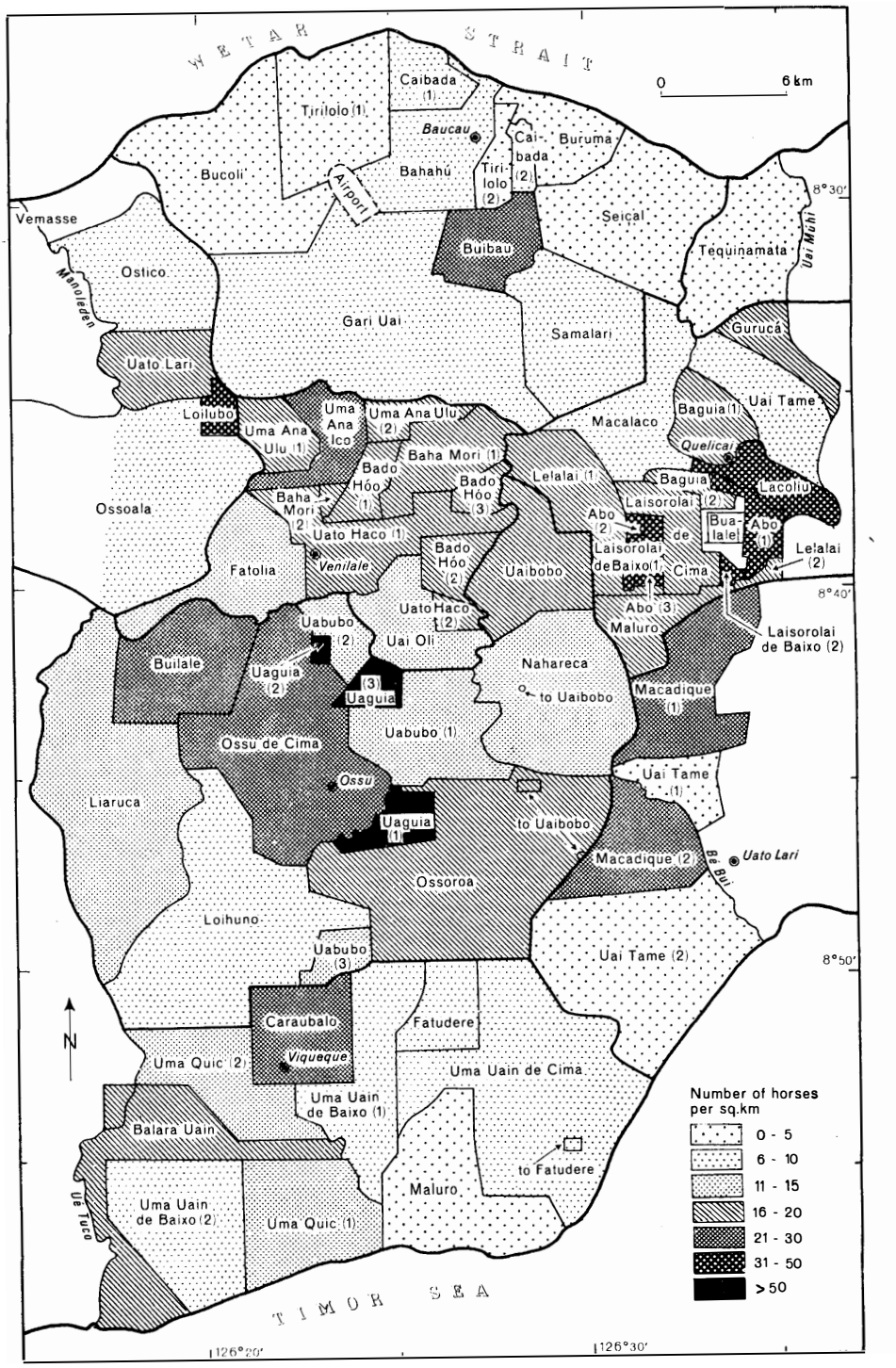


Fig. 30 Distribution of horses within the Area

Table 28

Livestock slaughtered or died from disease by postos, 1967-69

	Buffaloes						Bali cattle						Horses**			Sheep						Goats						Pigs					
	Slaughtered			Died from disease			Slaughtered			Died from disease			Died from disease			Slaughtered			Died from disease			Slaughtered			Died from disease			Slaughtered			Died from disease		
	1967	1968	1969	1967	1968	1969	1967	1968	1969	1967	1968	1969	1967	1968	1969	1967	1968	1969	1967	1968	1969	1967	1968	1969	1967	1968	1969	1967	1968	1969	1967	1968	1969
Baucau (Sede)	100	104	83	110	23*	1	44	53	118	4	-	-	75	-	-	139	78	47	-	-	-	46	28	36	-	-	-	258	248	317	-	-	-
Laga	68	52	55	67	243	140	-	-	-	-	-	-	9	11	23	9	-	-	-	5	-	69	58	57	-	15	-	90	82	75	-	2	-
Quelicai	29	60	56	178	257	399	-	-	-	11	13	15	124	126	250	10	4	1	2	4	3	99	131	205	2	4	1	98	166	314	6	2	13
Vemasse	30	34	37	352	226	205	-	-	-	-	-	1	65	67	39	34	26	28	87	18	84	30	24	23	131	43	122	19	20	16	37	28	55
Venilale	34	53	33	183	97	105	-	-	-	-	1	-	52	35	48	68	97	29	78	49	68	77	112	54	90	104	66	88	129	50	29	19	35
Viqueque		88	96		13	67		5	3		2	2		14	59	no sheep registered in this Area							2	3		-	3		104	123			
Ossu		59	67		160	9		3	1		-	-		56	8								262	59		1	-		169	98			
Uato Lari		61	43		83	43		-	-		5	-		42	16								16	12		3	-		86	61			
Total	261	511	470	890	1102	969	44	61	122	15	21	18	325	351	443	260	205	105	167	76	155	321	633	449	223	170	192	553	1004	1054	72	51	103

Blanks indicate no data available.

* No entries for July to December 1968.
** No slaughters reported for horses.

Source: Livestock statistics, administration of concelhos of Baucau and Viqueque, 1967-69.

especially in the northern part of the Area, the animals look skinny and pitiful. Only during the rainy season do they thrive.

As mentioned earlier, livestock is kept in free range conditions. As far as the horses are concerned the mares are left to themselves on the range while no planned cross-breeding is attempted. Thus it is no wonder that export of horses, which according to Duarte (1930:169) once reached the volume of 900 head per year, has completely come to a standstill. Horses of better quality can be obtained today from Sumba and Roti. Although horses are regularly vaccinated, surra is very frequent and causes great losses to the horse population.

Cattle. The Area's cattle population is insignificant. In 1969 it represented but 2.7 per cent (= 1826 head) of Portuguese Timor's total cattle population. The low density (Fig. 31) is all the more surprising in view of the massive efforts by the government to make cattle popular throughout Eastern Timor.

Fig. 31 reveals that what few cattle there were, were concentrated in most sucos of Ossu, in Bahahu (Baucau), Baguia (Quelicai) and Caraubalo (Viqueque). With the exception of Caraubalo where the SOTA keeps a herd of over 1000 head, the cattle density is below five head per sq. km.

Small livestock. Of all livestock figures those for small livestock (pigs, goats, sheep) seem least reliable. Hence no attempt has been made to map their regional distribution in terms of densities. However, the following observations can be made. Of the small livestock pigs rank highest as the chief source of animal protein (however small that may be - see below). Pigs as well as goats occur throughout the Area. Densities for both are strongly correlated with the population and average 0.3 pigs and 0.4 goats per person. Sheep, in contrast, show a distinct preference for the dry parts north of the central divide and are found primarily in the postos of Laga, Baucau and Venilale (sucos of the Baucau Plateau).

Livestock and landscape. The Area's natural pastures are, above all, the heavy clay soils (CN) of the central upland surrounding the fatus. Here moisture conditions permit a thin turf of grass for the greater part of the year. The high elevation also seems to be well suited to the temperature

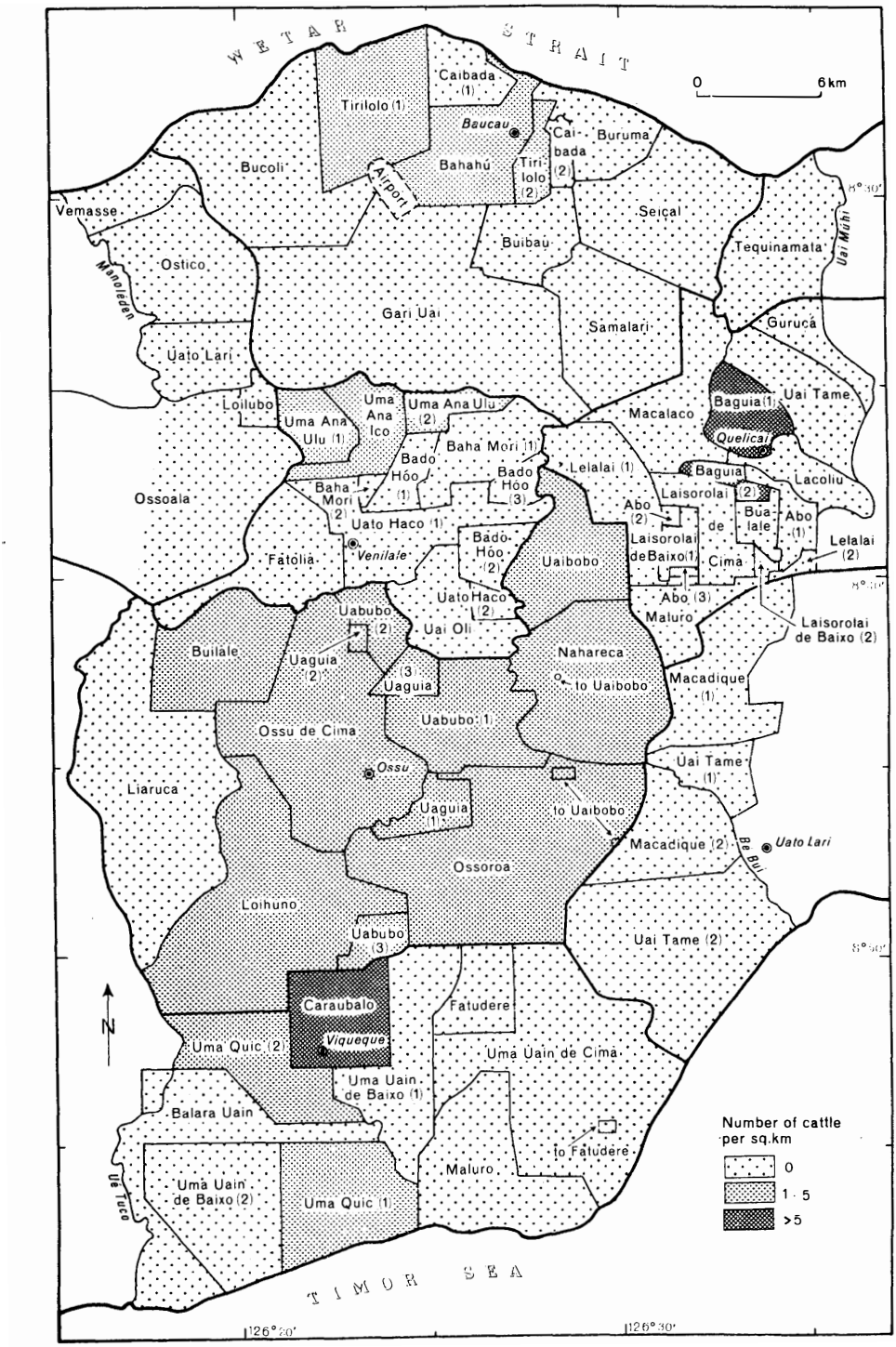


Fig. 31 Distribution of cattle within the Area

requirements of buffaloes, cattle and horses. Reproduction rates are said to be higher here than, for instance, in the hotter climate along the south coast.[42] Grazing on these heavy clay soils is, however, not without risk, for in summer when these soils dry up, deep cracks (see Plate 16) not only destroy part of the grass layer, but, what is more serious, invite erosion (see also Hamidjojo 1964). During the rainy period when the soils swell up, sliding and slumping of land is common. Livestock grazing on these soils may accelerate the process of erosion as the animals destroy the grass layer with their hoofs. Small paths along the slopes, for instance at Larigutu, having caused innumerable scars to the grassy surface, bear witness to this process. On the western part of Mt Mundo Perdido (near Liaruca at 1200 m), these paths, although on volcanic soils which are less susceptible to erosion, at places have become 80 cm deep; the soil is uncovered and erosion takes place (Plate 48). There is no doubt that, in the central upland, erosion has been caused to no small degree by livestock.

The problem is put into proper perspective when it is realized that, as land suitable for farming becomes scarcer,[43] the Timorese tend to concentrate their livestock grazing on the agriculturally least suitable clay soils. For the Timorese these clay areas with scattered casuarina are natural communally owned pastures. Every member of the _suco_ has the right to graze his livestock on these grounds. No individual property rights can be established except in the case of a man opening up a piece of land for _to'os_ and planting perennial trees. It appears, however, that _suco_ boundaries and _suco_ rights are not always strictly adhered to in the case of pastures. For instance, in Ossu members of most _sucos_ of that _posto_ graze their livestock at Larigutu which is part of Ossu de Cima and to a lesser part owned by Uaguia.

The grazing value of these savanna grasses is very low (cf. Soares 1963; M.M. Castro 1964a, 1964b). At lower

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[42] Pers. comm. _guarda pecuario_ Antonio Pereira Soares of Viqueque.

[43] The shortage of suitable grazing grounds in the Venilale area has already caused local farmers of Bado Hoo as well as farmers of various other _sucos_ of Venilale to use part of their wet rice fields at Caibada and at the River Cuha as pastures.

elevations in the northern dry parts of the Area (for instance at Laga, Quelicai and Baucau) pastures are particularly poor, because the growing period of the grasses is reduced to the short rainy season which is followed by a long dormant vegetative period. Here bunch grasses prevail which offer little protection against erosion.

In the annual report of the RPSV of 1968 (p.14), da Silva, chief of the Veterinary Service, considers a stocking density of no more than 1-2 head of livestock per hectare to be appropriate for the unimproved pastures. This limit has long since been surpassed.

Undergrazing can be as much of a problem as overgrazing, for instance, along the southern coastal zone. Here stocking density is far too low. As a consequence ungrazed grasses turn unpalatable. Therefore it is no wonder that local livestock holders favour burning of the ungrazed grasses during the dry period so that the young palatable shoots can be grazed by the livestock at the beginning of the rainy season.

Another problem caused by livestock grazing is that, as a result of the free roaming of the livestock, farmers have to protect their fields with strong fences. In fact, a great amount of time (up to one-third of the total time dispensed for to'os cultivation) has to be devoted to fence construction. Population pressure upon the agriculturally valuable land has become so great that farmers have introduced a sort of 'land use zoning' in Venilale, and to some extent also in Quelicai, whereby certain parts of land are reserved for grazing. In Venilale people guard their livestock permanently at certain indicated spots. Many wet rice fields are cultivated twice a year, rice in the first, irrigated maize in the second season. Laborious fencing on natar has thus become obsolete in Venilale. This is, however, a matter of discipline, and 'land use zoning' is apparently restricted only to these two places in our Area. If livestock were regularly kept on fenced-in pastures, or tethered at various points on the harvested paddy land during the dry period, more controlled use could be made of animals as a means of maintaining soil fertility. So far no integration of farming, particularly bush fallowing and livestock grazing, has occurred in the Area. Ploughing of either shifting plots or wet paddy fields is still largely unknown in Timor although recent attempts

in this direction have been made by the government.[44]

In concluding this section on livestock it should be mentioned that, although livestock keeping is an intrinsic part of Timorese life, it has contributed little to the diet of the Timorese. In its annual report of 1966 the RPSV (p.155) presents data of the per capita consumption of animal protein as calculated on the basis of slaughtered livestock reported to the postos. Since many head of small livestock (goats, sheep, pigs), on which no tax is levied, surely escape control, the figures only represent an estimate. The figures for large animals (buffaloes, horses, cattle) are likely to be closer to the true values. Keeping in mind this reservation the data imply that 3 g of animal protein per capita per day are consumed. From a nutritional standpoint, this is certainly much too low; the FAO (1957) recommends 1 g per each kg of body weight per day. Moreover,

Table 29

Meat consumption per head per year in Portuguese Timor, 1965

Cattle	200 g
Buffalo	453 g
Pigs	329 g
Sheep	20 g
Goats	33 g
Total	1035 g

[44] Despite repeated abortive attempts to introduce the plough between 1964 and 1969, only a total of 75 yokes of oxen were distributed to 52 beneficiaries by the RPSV during this period. These yokes were, however, largely used by the municipalities (Commissão Municipal) e.g. in Baucau and Viqueque:

Year	Yokes of oxen	Beneficiaries
1964	10	3
1965	9	4
1966	15	7
1967	24	22
1968	1	1
1969	16	15
Total	75	52

Source: RPSV, Rel. An. 1969, p. 16.

as we have seen, livestock owners seem to be more concerned with numbers than with the condition of their animals (FAO 1960:163). As a consequence livestock tend to be undernourished. They lack sufficient feed rich in nutrients to be able to carry out heavy work.[45] Their poor physical condition is due to the fact that they are wholly dependent upon unimproved rangeland grazing, i.e. upon pastures largely deficient in legumes, but rich in grasses of low nutritional value.[46] Supplementary feeding with silage, hay or maize straw is not practised. No selection of livestock - e.g. by castration - is ever practised. Thus a deterioration of the quality of the livestock is inevitable.

Agricultural calendar

The previous section has already suggested the intimate relationship between the agricultural pattern and some environmental factors, chiefly rainfall and soil. I want now to outline briefly the major temporal differentiation of the crop sequences at selected sites of our Area. The discussion of this temporal aspect will be essential for a more thorough understanding of the complicated timing of agricultural activities. For example, should any technical innovation such as the transplanting of rice replace the traditional method of broadcasting (kare hare), the entire work sequence might be disrupted, and serious repercussions on a whole series of other essential agricultural activities would

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[45] After a few hours of mountain climbing most horses are exhausted. Similarly, buffaloes cannot be used for a long time for sama natar. Buffalo owners maintain that their buffaloes are not capable of trampling rice fields for more than two weeks a year.

[46] Overgrazing has led to impoverishment of the pastures. An increasing proportion of annual, low nutritional grasses and erosion have been the consequences. Rotational pastures with far lower stocking rates as well as improvement in the quality of the pastures by introducing grasses with higher nutritional value are required. The RPSV in its annual report of 1966 (p. 6) recommended not to introduce new grasses to which livestock would first have to get accustomed, but rather to select those indigenous grasses that have a relatively high nutritional value (for instance *Eleusine indica*). At the same time it was recommended that poisonous grasses be eradicated.

result. These considerations will eventually have a bearing upon planning.

Important activities in the Timorese agricultural year are the planting and harvesting of maize and rice. These operations are accompanied by activities such as the construction of drainage channels and bund repairs, ploughing of rice fields (sama natar), weeding (hafaho rai), threshing (tuku), cutting trees and bushes to clear the to'os for cultivation (lere rai), burning of the cut branches and bushes (sunu rai), fencing (halo lutun) and tilling of the to'os (fila rai). The sequence of these decisive stages in the agrarian cycle will be demonstrated for the following five localities indicated in Fig. 26:

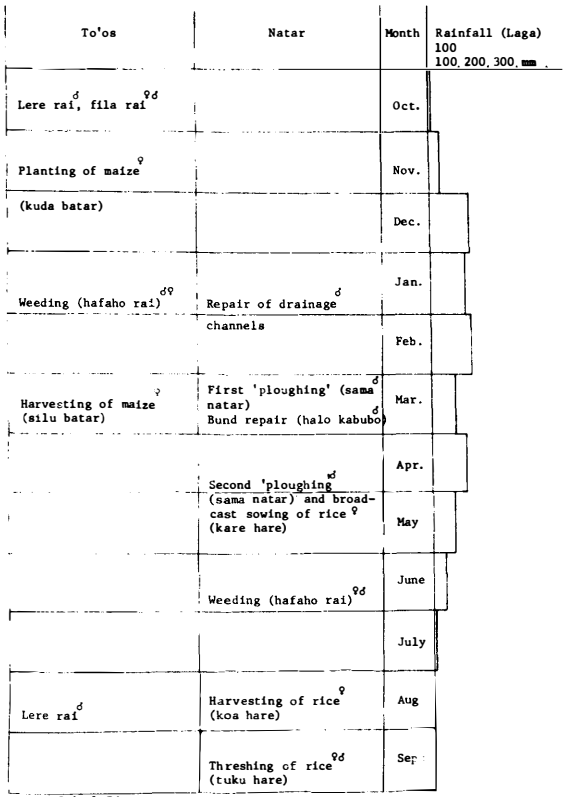
1. Seiçal River at mouth of river: sea-level
2. Baucau Plateau: 500 m
3. Larigutu: 1000-1200 m
4. Lower parts of Ossu: 450-800 m
5. Viqueque: 50 m

The agrarian calendars of these five localities contain all major activities on both to'os and natar. Although every Timorese in the Area tends his to'os, not all peasants are engaged in natar cultivation. Moreover, there are several different types of paddy field in some localities, each require labour input at different times of the year. Therefore, the agrarian calendars for these places convey the somewhat misleading impression that the peasant is permanently occupied with wet rice cultivation. This, however, is not usually the case, as peasants concentrate on only one or another type of natar at any given time.

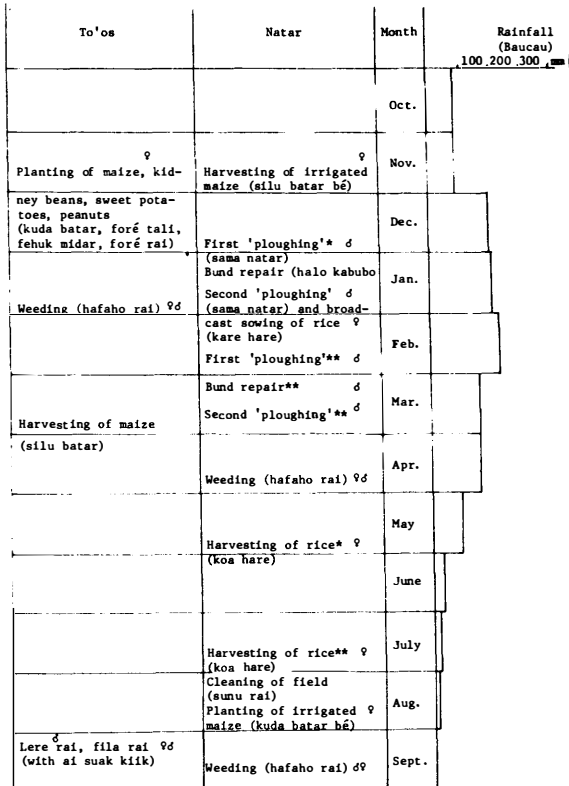
I intend to describe the agricultural calendar for the lower parts of Ossu (450-800 m) in the central upland in some detail. This will provide a basis from which the deviations in the agricultural year north and south of the central upland can be briefly alluded to.

The analysis starts with the commencement of the rainy season (rai udan) which is heralded by days of thunder and lightning about the end of October or beginning of November. After the first few days of continuous rain every peasant in the central upland, accompanied by his family, suddenly leaves his hamlet, heading for his to'os. There he stays in a temporary hut (uma to'os) till all crops are planted. These are primarily early maturing (batar lalais) and late maturing

Table 30

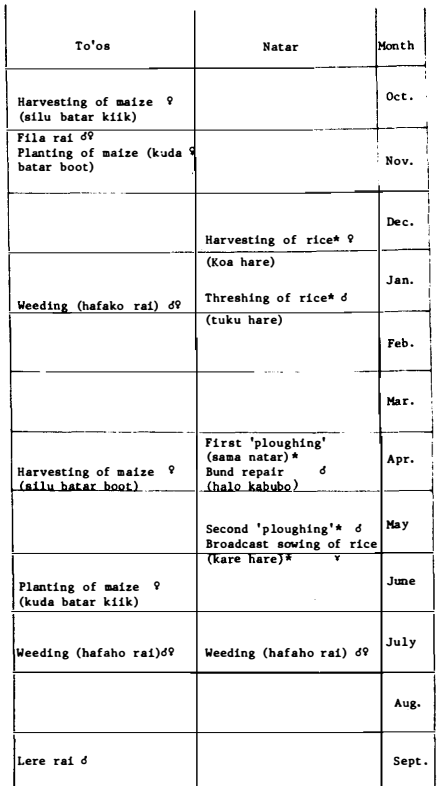


Seiçal River at river mouth, sea level
Exclusively riverfed rice fields.
♂ Activities carried out by men.
♀ Activities carried out by women.

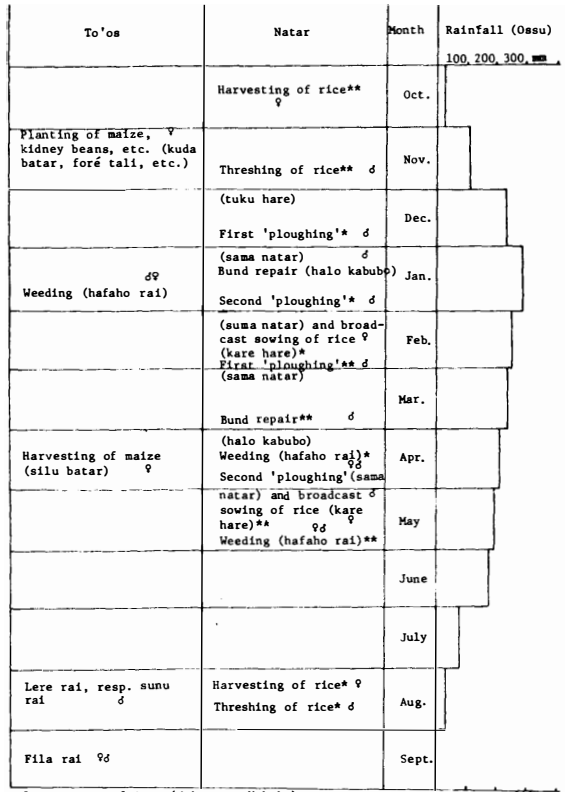


Baucau-Plateau, approx. 500 m

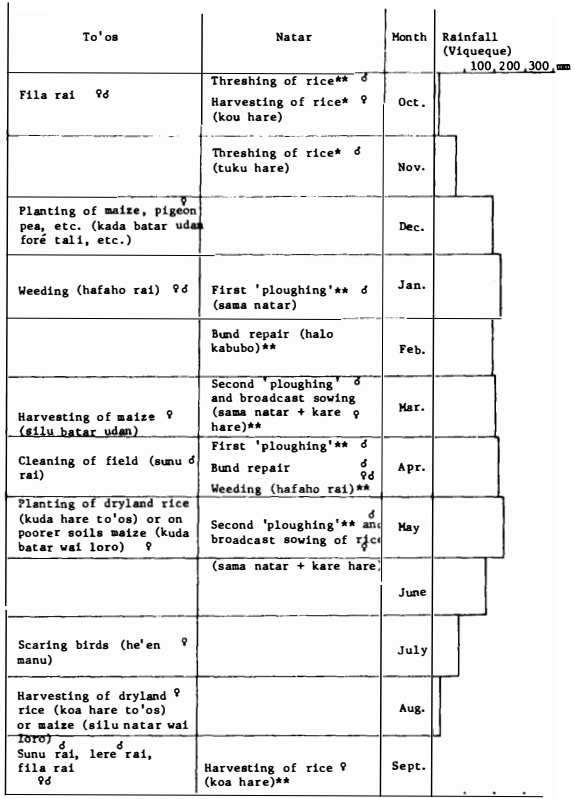
* Inundated paddy fields.
** Springfed rice fields.



Larigutu, 1000-1200 m
* inundated paddy fields.
No rainfall data available.



Lower parts of Ossu (Nahareca, Uabubo)
* Inundated rice fields.
** River- or springfed rice fields.



Viqueque, approx. 50 m
* Inundated rice fields (futudu).
** River- or springfed rice field (Ué laco, Hare Bé Oan).

(batar boot) varieties of maize and kidney beans. After this initial planting period the Timorese spend very little time in their to'os except for some sporadic weeding in the first or second month after planting.

At the same time as he is planting maize on the to'os in November, the peasant of the upland may still be busy with the threshing of rice (tuku hare) from the previous season from river- or spring-fed natar.

The amount of rainfall increases in December, and enough water is accumulated in the inundated paddy fields to permit 'ploughing' (sama natar) at the end of December. Following that operation the bunds (kabubo) have to be repaired (January). At the end of January these rice fields receive a brief second 'ploughing', after which rice is broadcast (kare hare) until the end of February.

The period from the end of October to February is the busiest of the year for the upland farmers who depend on inundated natar. Maize and rice have very narrow planting and harvesting tolerances relative to tubers which are planted and harvested throughout the year. Therefore, the farmer has to concentrate labour into a short time. For this, he will have to call upon his extended family. There is a virtual 'run' on buffaloes, because the majority of the paddy fields around Ossu are rain-dependent. Naturally there are farmers who, lacking labour or buffaloes, cannot work their wet rice field.

Those farmers who have river- or spring-fed paddy fields usually have some leeway in their working sequence after opening up the irrigation canals (kanos) and constructing brushwood dams halfway across the rivers to divert the water to the natar. This type of natar is ploughed for the first time at the end of February or the beginning of March and receives a brief second 'ploughing' in April or the beginning of May. Rice is broadcast as late as May.

Usually in April, when rains begin to abate, maize (batar boot) has to be harvested (silu batar). The early maturing maize variety (batar kiik) has already been harvested in February.

June and July are comparatively 'quiet' months. Then, in August, when the rains have stopped, the rice on the inundated paddy fields may be harvested. This operation, as

well as the subsequent threshing (tuku hare), may again require recruitment of several extra helpers. The dry season in the upland is comparatively brief. Hence, dry fields have to be prepared for the next season. Bush fallowing (lere rai) is commonly done in August and September when smoke fills the air. At this time tilling (fila rai) is also performed. Finally in October before the commencement of the next rainy season, rice from the springfed paddy fields has to be harvested. The agricultural year thus comes to a close, giving the farmer very little time for relaxation before the to'os have to be planted anew.

The agricultural calendars north and south of the central upland vary significantly from that of the lower part of Ossu. Rather than repeat the entire sequence of activities for the remaining four localities, I will mention only briefly the major differences in the agricultural year at these places.

At the mouth of the Seiçal River (Table 30a), farmers cultivate their to'os between November and March. The growing period of maize is shorter at lower elevations than at Ossu. Here no interference of to'os and natar cultivation occurs since at Seiçal all rice fields are riverfed. Hence they can only be cultivated after the floods of the Seiçal River have abated. The first 'ploughing' is usually performed after the maize has been harvested on the to'os.

On the Baucau Plateau (Table 30b) the cultivation of to'os and inundated paddy fields corresponds to that of Ossu and is concentrated within a few months. Here to'os are planted in November and harvested in March, while inundated rice fields are first ploughed in December and planted in January.

Table 30b also shows the agricultural calendar of the escarpment zone of the Plateau. Near perennial springs double cropping on wet rice fields is common. They are 'ploughed' for the first time in February, planted with rice in March and harvested in July. After a brief cleaning, trees and branches are burned on the rice field and ashes are spread. Maize (batar bé) is planted in August and harvested in November before the onset of the rainy season.

At Larigutu (Table 30c) in the zone between limestone and heavy clay, peasants have more leeway in the cultivation of their to'os and inundated paddy fields. Owing to altitude, gardens are planted here first (October). It takes over five

months heat for batar boot to mature. This is usually harvested in April during bai loro kiik. In June gardens are again planted with early maturing rice (batar kiik) which takes over four months until maturation in October.

Finally, the agricultural calendar at Viqueque (Table 30c) differs from that of Ossu in that two to'os crops are grown. As we have seen, wet rice cultivation is comparatively unimportant here in the south. It is limited to three localities only: Futudu, Bé Laco and Hare Bé Oan. The planting of maize, pigeon peas, etc. usually occurs three to four weeks after that of Ossu, i.e. December. Owing to the lower elevation maize is harvested earlier, in March (instead of April in Ossu). After bai loro kiik dryland rice is grown. This can be harvested in August.

In reviewing the sequence of activities during the agricultural year at the five selected localities it is fascinating to observe how ingeniously the two main forms of agricultural land utilization - to'os and natar cultivation - are timed. These calendars are the result of centuries of trial and error and reflect the high degree of dependency of the Timorese farmers upon climate and topography.

Impact of market forces and communications upon the land use pattern

The dominant types of agricultural activity in the Area - to'os and natar cultivation and livestock keeping - were already characteristic of the pre-Portuguese period in Timor. And during the four centuries from the first arrival of the Portuguese missionaries to the end of the nineteenth century the Timorese economy remained basically unchanged, except for the sporadic contacts with the outside world due to the sandalwood trade in which mostly liurais were engaged. It was essentially an economy based on subsistence, isolated from the outside world, in which the use of money was largely unknown. All the necessities of daily life such as food, tools, and clothing were produced within the community. The production level was consequently geared only to the necessities of the immediate future. Saving was limited to the storage of a few products for consumption during the long dry season and for ceremonies and feasts. In such an economy there was no point in producing a surplus since it would not increase the level of satisfaction.

A radical change occurred after the pacification of Eastern Timor by the Portuguese towards the beginning of this century. Under the Portuguese governors José Celestino da Silva (1894-1908) and later Filomeno da Camara (1911-17) Eastern Timor was brought under the firm control of the Portuguese administration. As a result of the intense Portuguese intervention the Timorese economy was subjected to drastic changes. One of these changes was the introduction of the head tax (imposto de capitação or imposto domiciliario)[47] under Governor Eduardo Marques in 1908 (Martinho 1943:86). Every man between the ages of 18 and 60 was liable to the payment of the annual head tax. He was now forced either to produce agricultural products beyond his own needs and to sell them on the market for cash or to accept remunerated work, for instance, as a government employee. The latter source of income was not widespread. Only ten per cent of Timor's active population (13-60 years of age) was engaged in non-agricultural activities in 1965.[48]

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[47] This head tax replaced the old finta which the entire suco had to pay (either in money or in commodities); as chefes de povoação and chefes de suco functioned as collectors they channelled a great amount of the money collected into their own pockets. The head tax was aimed at doing away with this abuse. Direct assessment and collection from the taxpayers became the rule.

[48] A. Active population:
(men and women between 13 and 60 years of age)

a) engaged in agriculture	317,417 = 56.7%
b) engaged in non-agricultural activity	35,269 = 6.3%
	352,686 = 63.0%

B. Non-active population:

a) children under twelve	165,274 = 29.5%
b) old people (above the age of 60)	41,614 = 7.4%
c) students	725 = 0.1%
	207,613 = 37.0%

Note: These data refer to principal economic activity, and do not preclude some minor income generating activity.

Source: Fortuna 1968:210.

Concomitant with the introduction of the head tax the Portuguese administration sought to introduce cash crops which were to be planted by the Timorese. In fact, the head tax was designed not only as a source of revenue for the local administration but also as a means to force the Timorese to become more market-oriented. A number of cash crops have been introduced since then. The results have not all been encouraging: the economy is still at the beginning of a process of transformation. It has to be assumed that this process will last for many years to come. The Timorese economy is still based essentially on subsistence with some supplementary cash production. The main livelihood is agriculture.

The very low degree of monetization can be inferred from Fig. 32 showing the per capita money circulation which hovered around 75$00 from 1953 to 1963. The role of money is diminished by the tendency of the Timorese to hoard,[49] as a result

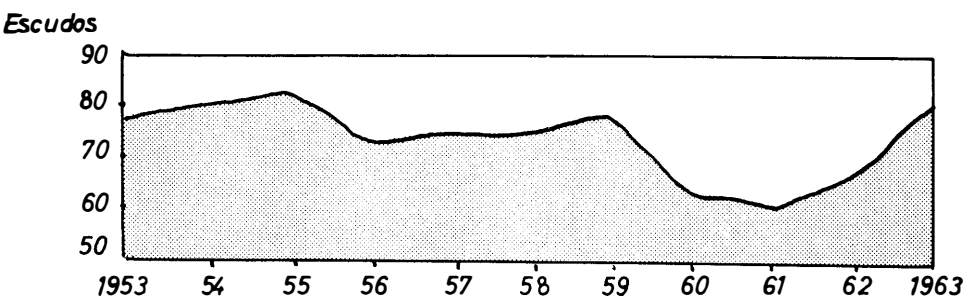


Fig. 32 Per capita money circulation in Portuguese Timor, 1953-63. Source: Fortuna 1968:209, Fig. 22.

[49] When the new Timorese Escudo was introduced in 1960 replacing the old Pataca, everybody was summoned to change his old money against the new currency. I was told that on that occasion some old, poor looking Timorese came to exchange several hundred thousand Patacas worth many times more Escudos (pers. comm. Administrator José Soares Teles; Administrator Luis Ricardo).

of which the velocity of the money circulation is reduced. In my opinion, it is thus safe to say that the role of money relative to that of direct barter is limited.[50] Nevertheless, the impact of money upon the economy should not be underestimated for it contributed in no small degree to the formation of market places (with Chinese cantinas), as well as to the production of some cash crops.

The chief agents of the money circulation became the Chinese merchants.[51] In the wake of the pacification of eastern Timor in the first decade of this century they gradually ventured out from Dili and filtered deep into the hitherto little explored interior of the island. Under protection of the nearby Portuguese forts Chinese merchants opened their shops. As elsewhere in Southeast Asia the Chinese fulfil an important role as middlemen and wholesale dealers, bringing the native population into touch with the outside world. They buy the agricultural surplus (cash crops) from the local people and sell them chiefly imported products such as clothing, knives, some food, etc. As such, the Chinese have to be regarded as pioneers who encouraged the natives to greater economic activity. With the increasing commercialization of Timorese life affecting the whole agricultural system, the number of Chinese cantinas at the various market centres has increased (see Plate 44 for a typical market centre).

In 1970 there were two cantinas in Uato Lari, six in Viqueque, three in Ossu, two in Venilale, one in Quelicai, three in Laga, two in Vemasse, and nine in Baucau.

Baucau is undoubtedly the most important market place east of Dili. Its strategic position at the cross-roads of the entire transport system east of Dili is responsible for this. Included in this area are Lautem, Lospalos (centre of livestock keeping), Tutuala, Baguia, Quelicai, Laga, Iliomar, Loré; as well as the important market centres of the south-east coast: Uato Carbau, Uato Lari, Viqueque, and the central upland, Ossu and Venilale. Because of this position it has become the second largest centre of settlement in Portuguese

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[50] There were no banking facilities in the Area in 1970. Moreover, savings deposited in Dili with the Banco Nacional Ultramarino did not bear any interest.

[51] Chinese are chiefly Hakka from Fukien Province (South China) and numbered about 5000 in 1970.

Timor after Dili, with roughly 5000 inhabitants.

As for the other market places in the Area, the number of cantinas can be taken as a rough yardstick for the economic importance of the place and the surrounding region. The only exception to this rule is Quelicai where, in spite of a very high concentration of population, there is only one cantina. According to the local Administrator (Sr José Fernando Osorio Soares) this shop has the highest turnover of all cantinas in the eastern portion of Portuguese Timor. It has its own transport and owns two other stores in Baucau and Dili, so its relative advantage is so great that no other cantina has been able to compete so far.[52]

According to the number of cantinas Viqueque is undoubtedly the second largest market place in our Area. As the administrative centre for the entire concelho of Viqueque to which the postos of Ossu, Lacluta, Uato Carbau, Uato Lari, and Viqueque-Sede belong, Viqueque is comparable with Baucau. The greater number of officials is responsible for a greater demand of goods. At both centres there are schools and hospitals, although the hospital of Viqueque is not staffed with trained doctors.

Relative to these two centres, the other market places are very much smaller. Owing to the ethnic composition of the administrative and commercial settlements these market places are essentially non-Timorese in character. One can, however, observe that gradually more Timorese chefes de suco are establishing themselves in or near these centres either permanently or for part of the year in solid brick houses, which are status symbols. They are financially stronger and usually have other suco members working for them (often free of charge), although the government is trying to do away with the traditional privileges of the suco chiefs.[53]

A prerequisite for the penetration of the Chinese into Timor's interior was the construction of roads. The road

[52] Before 1966 when Lim Kim Tjeap - the owner of the present cantina - opened his cantina there was another cantina, that of Lim Keong Tjeap, who was unable to compete because of transport difficulties.

[53] Because of the lack of government staff the Administration still depends heavily on the chefes for carrying out government orders. So, at least for the time being, the government cannot be as strict as it wishes to be.

pattern as we find it today was built shortly after pacification with statute labour. It served primarily military and political purposes. The construction of roads, however primitive they may be, links these market places with Dili.[54] This, together with the introduction of the annual head tax, the propagation and growing of cash crops for commercial purposes, and the founding of the cantinas were necessary steps towards a gradual development of a market-oriented mentality on the part of the hitherto subsistence-oriented Timorese. This process, as indicated earlier, is still in its very infancy.

The Timorese is still, generally speaking, not all that enthusiastic about growing and subsequently selling agricultural products in excess of his personal food requirements. However, to meet the annual head tax of 190$00[55] and the additional livestock tax of 10$00[56] per head of buffalo, horses or cattle, the Timorese farmers see themselves compelled either to sell some of their products or livestock or to accept remunerated work. Except for the very few jobs offered by the government - clerks in the local administration or teachers - remunerated work is limited to gardening[57] or road construction. It is heavy work which is not considered

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[54] Since the middle of the 1960s a 'bus' (= converted truck) service (carreira) links Viqueque, Ossu and Venilale with Baucau and Dili twice a week. Timorese from the interior now have a chance to visit their capital (200 km from Viqueque). Some Timorese, particularly young folk, take great pleasure in riding by 'bus' to Dili. In order to finance the trip (about 100$00 one way) they carry loads of live chickens to the Dili market, as well as a cock for traditional cock fighting.

[55] Of this amount 160$00 are earmarked for the central government in Dili, while 30$00 go to the municipality (Comissão Municipal), i.e. as far as the Area is concerned, to either Baucau or Viqueque, the only two places which have been granted municipality status because of the number of population (Diploma Legislativo no. 813 of 17 Jan. 1970).

[56] Introduced in January 1966 with Diploma Legislativo no. 699 of 13 Nov. 1965; altered by Dipl. Leg. no. 814 of 17 Jan. 1970.

[57] Often the Timorese clerks employ somebody else 'to do their to'os'.

very attractive. In 1970 daily wages for that type of manual work were at 5$50 plus food or 8$50 without food. It can be argued that these low wages were mainly responsible for the lack of labour supply. This may be true to a certain extent. On the other hand, according to information provided by the Public Works Department (Obras Públicas) which is responsible for road and bridge construction in Timor and which depends on recruited labour, the supply of labour is relatively inelastic in relation to the wage level throughout the year.[58] This means that a given percentage increase in wages is accompanied by a proportionately smaller increase in the number of Timorese who accept remunerated jobs.

The difficulty in recruiting remunerated labour occurs every year particularly after the monsoons when the gravel roads which are heavily damaged by the rains have to be repaired. Since labour cannot be voluntarily recruited, during the slack season (May to September) the chefes de suco are required by the Portuguese government to order all men capable of carrying out road repair to do the job for which the government pays fixed wages. In the spring of 1970 the road from Ossu to Viqueque was thus repaired for 29 contos.[59] Three weeks later, however, unexpected heavy rains again washed away much of the surface material. In some places such as parts of Loihuno, the road was in worse condition than before.

Without this disguised form of forced labour public works would hardly be feasible. Without statute labour the immense program of road construction under Celestino da Silva and Filomeno da Camara could never have been carried out in such a short time.[60]

More popular and more common as a source of cash income is the selling of agricultural products. Rice, maize, copra, and some candlenut (kamii) are sold. To obtain an indication

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[58] This is not to say that above a certain wage level the supply of labour may not again become elastic with respect to the wage level.

[59] 1 conto = 1000$00 escudos.

[60] In order to dodge this type of forced labour, the contribuintes (taxpayers) of a certain suco go to a neighbouring suco for the time of road repair. This was the case in 1970 with some people of Maluro (Viqueque) who went to Uma Uain de Cima (Viqueque) where as foreigners they could not be drafted for public works.

of the approximate quantities sold in the Area I have drawn upon the transit certificates (guia de trânsito) required by the government for each consignment leaving the Area. After careful consideration of other data such as the amounts of cash crops allegedly bought by the Chinese from the Timorese and other sources, the transit certificates were judged to be the only comparatively reliable figures of the Area's surplus.[61] It has, however, to be borne in mind that these figures give only a minimum indication of the quantities that left the region, not of those which were actually bought by the local merchants.[62]

Of all cash crops it is undoubtedly copra which has had the deepest impact upon traditional agriculture. Though known in Timor long before the arrival of the first Europeans, coconut as a cash crop is relatively new. Under governors Celestino da Silva (see Correia 1911) and Filomeno da Camara an enormous effort was made to introduce coconut along with other fruit trees.[63] These efforts were certainly impressive but did not succeed in fundamentally changing the attitude of the Timorese towards a greater market orientation. As soon as the pressure of the government, which ordered the

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[61] A considerable degree of error is, however, still involved owing to the fact that the amounts declared by the Chinese are subject to manipulation. All Chinese merchants of Viqueque, Ossu, Venilale, Baucau, Quelicai, and Laga have committed themselves to pay 10 centavos for each kilo of maize (30 centavos for milled rice) bought from the Timorese to a common fund from which they finance the private Chinese school (with a teacher from Taiwan) at Baucau. In order to minimize the contribution merchants often declare maize instead of rice for which higher contributions are applicable.

[62] Since quantities actually bought by the Chinese are subject to manipulation, these figures are even less reliable than those obtained on the basis of transit passes. Finally, production figures obtained by self-assessment of the chefes de suco at the time of the annual tax census are, for obvious reasons, the least reliable of all three sources.

[63] Impressive numbers of coconuts were reportedly planted and germinated in the commandos militares. These were recorded in the bi-monthly Boletim do Comércio, Agricultura e Fomento da Provincia de Timor, Dili 1914-1920, in which agricultural reports submitted by the military commanders to the governor in Dili were partly reproduced.

sucos to keep up nurseries of their own, was relaxed, the interest of the Timorese in the maintenance of the nurseries and as such in cash crops rapidly dwindled away. Only well after World War II did the government make a new effort to boost copra production when the copra price on the world market increased (e.g. 1959: 7-8$00/kg in Viqueque). Thus towards the end of the 1950s several nurseries chiefly for coconut trees were opened in our Area.[64] The seedlings were subsequently distributed free of charge to the peasants, who readily availed themselves of this opportunity. The relative ease with which copra is produced (in contrast to candlenut, oil palm and rubber)[65] and the high price obtained for copra from Chinese merchants served as incentives in Viqueque.

The real copra boom, so to say, started in Viqueque in 1965 when the first trees planted in 1958 entered the fruit-bearing stage.[66] The data on copra trade in Table 31 reveal that the initial efforts in the late 1950s and early 1960s which were systematically continued in the following years, were particularly fruitful in Viqueque. In 1969 Viqueque exported about 33 per cent (393,864 kg to Dili and 4500 kg to Baucau) of the Area's entire copra exports. Second in rank was Baucau with 290,234 kg (24 per cent),[67] followed by Ossu (13.3 per cent) and Uato Lari (11.2 per cent).

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[64] Particularly in the Southern Foothill and Littoral Plains Zone; in Viqueque for instance, at Bé Sala Bua (near Bé Aço), Balara Uain and Luca (west of River Bé Tuco) and to a lesser extent also in Baucau.)

[65] Attempts by the government at making rubber (Martinho 1948; Teles 1967a) and oil palm popular as native cash crops failed because of the comparatively large amount of skilled labour and capital needed (e.g. for the purchase of acids for coagulating the latex of the rubber trees).

[66] Pers. comm. José Soares Teles, Administrator of Viqueque (1964-70). An average of seven years is needed along the south coast for the coconut to reach fruit-bearing stage. This compares to 15 to 20 years in Ossu (700 m), particularly on heavy clay soil.

[67] Baucau is an entrepôt point where the products of the eastern section of Portuguese Timor converge. Table 31 shows the quantities of copra exported to Baucau where they are either collected for further shipment to Dili or processed in a small soap and oil 'factory' owned formerly by José Ricardo and today by a Chinese. Thus the quantities which left Baucau for Dili should not be considered as being totally produced in the posto of Baucau-Sede.

Table 31

Copra trade within the Area and to Dili

	1969		1966	
	kg	%	kg	%
Baucau	290,234	24.0	430,830*	42.9
Venilale to Dili	82,600	9.2	43,115	5.0
to Baucau	28,500		7,300	
Quelicai	113,713	9.4	45,492	4.5
Ossu to Dili	148,170	13.3	31,507	4.6
to Baucau	13,100		14,285	
Uato Lari to Dili	134,320	11.2	243,254	26.0
to Baucau	50		19,144	
Viqueque to Dili	393,864	32.9	119,100	17.0
to Baucau	4,500		51,380	

* About 30,000 kg originate in places outside the Area.

Source: Guia de trânsito, Administration of Concelhos of Baucau and Viqueque 1966 and 1969.

The figures listed in Table 31 give but a rough idea of the actual production of copra in the Area. Regional price differences, however, occasionally induce Timorese producers to transport their own copra to more distant markets. This is the case with Viqueque peasants who go up to Ossu, and Uato Lari peasants who go all the way to Quelicai. Regional price differences, which are chiefly the result of different transportation costs from places in the interior to Dili, are given in Table 32 for copra, maize, and unmilled, and milled rice at three selected places.[68]

Table 32

Regional price differences of major cash crops per kg bought, November 1970

Commodity per kg	Viqueque	Baucau	Dili
Copra	3$00	3$60	4$60
Maize	1$20	2$00	2$50
Unmilled rice (nele)	2$20	2$40	2$80
Milled rice	4$30	4$50	4$80

Note: The respective prices for Ossu and Venilale lie between those of Viqueque and Baucau.

Minimum prices[69] below which the Chinese merchants may

[68] During 1969-70 transportation cost (by truck) amounted to 20 centavos per kilo from Viqueque to Baucau; and 40 centavos per kilo during the dry season and 60 centavos per kilo during the wet season from Viqueque to Dili. The price increase during the wet season is caused by an extra charge necessary to pull trucks across the Laleia River. The cost for an entire truck load of 4.5 tonnes from Viqueque to Dili is 1800$00 (dry season) and 2000$00 (wet season), of which 200$00 to 260$00 are required for pulling the truck across the Laleia.

[69] Selling and purchasing prices are officially controlled by the government. However imperfect such controls may be, they are still relatively effective in safeguarding, at least to a certain extent, the mostly illiterate Timorese against fraud and exploitation by the merchants. Thus,

not buy copra from the Timorese are fixed and controlled by the government. These prices may fluctuate by 30 per cent and more depending upon the price on the world market as well as upon the arrival of ships to Dili. Shortly before the arrival of such a ship copra prices go up as the Chinese merchants see a chance to place the copra quickly on the foreign market and thereby obtain cash.

As indicated above, of all cash crops introduced in our Area, coconut has exerted the greatest impact upon the land use pattern. The effect of the current coconut planting boom can be observed most clearly in the Viqueque area. Wherever natural conditions permit - i.e. where there is loose, preferably sandy but also calcareous and alluvial soils - flat to'os land is converted into coconut groves (plantação). In the Southern Foothill Zone and along the Southern Littoral Plains Zone coconuts are planted in interculture with maize or upland rice. The latter two crops are cultivated for three to four years before the site becomes too shady. From that time until the fruit-bearing stage the to'os is only weeded. This protects the young coconut seedlings from becoming victims of grass or bush fires.

As a result of the planting of coconuts which was still going on in 1970, despite a far lower price, the area available for to'os cultivation is rapidly being reduced. This need not be a menace as long as there is sufficient good land available for food crops. So far it appears that the best alluvial soils have been planted with coconut.[70] However, a shortage of good agricultural land is bound to occur soon. This is heralded by the search for new agricultural land in the Luca Plain (west of Bé Tuco River), particularly by people from Caraubalo.[71]

Attention should also be drawn to the fact that coconut trees tend to be too densely planted. Competition of the trees may lead to lower copra yields. The interplanting of annual

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69 (continued)
for instance, goods have to be visibly priced. I frequently saw old illiterate Timorese doing their shopping accompanied by school children who read the prices to them.

70 E.g. on the flood plain of the Cuha River near Viqueque.

71 In 1969-70 the following number of peasants from Caraubalo had their to'os in either Luca or near Bé Aço, mostly since 1965-66:

crops, like maize, dryland rice and other food crops, in between the coconut trees is impossible because of too much shade. Moreover, it happens that once the coconut trees are bearing fruit the fallow vegetation is allowed to grow up around the coconuts to form a tangled mass. This fallow growth competes with the palms for plant nutrients and soil moisture. Moreover it becomes difficult for the grower to collect the nuts.

On the other hand, the planting of coconuts has placed severe restrictions on the practices of bush fallowing and slash and burning because fire may scar the base of the palms. As a result of the introduction of coconut trees the fila rai technique and more permanent food cropping systems may be expected. Until now, however, there is no satisfactory integration between the bush fallow system and the coconut plantation. It is interesting to note that the intensification of agricultural practices in Viqueque is basically not the result of population pressure but rather of commercial agriculture.[72]

It seems likely that the coconut boom in Viqueque will continue, provided that prices do not drop below the 1969-70 level. It appears likely also that with good agricultural land becoming scarcer peasants may space their coconut trees more widely so as to allow interplanting of other food crops. Thus, the present coconut planting boom may further modify the food cropping pattern.

71 (continued)

Village	Total taxpayers	Taxpayers having their to'os in Luca	Taxpayers having their to'os in Bé Aço or near Rai Sut
Mamulac	105	30	5
Manehat	120	40	-
Cabira Oan	197	20	5
Lamac Laran	40	19	5
Ué Sá	68	-	12
Has Abut	55	-	2
	585	109	29

= 23.6% of Caraubalo's taxpayers

72 This can be seen as an example against the thesis advanced by Ester Boserup 91965), who regards population growth as the exclusive determinant of agricutural change.

In Viqueque the coconuts are harvested three times a year: in November to January/February (main crop), May and August. Here in the lowland about 20 nuts per tree are harvested each time. Six nuts are needed for the production of 1 kilo of oil. The nuts are either collected from the ground or picked from the tree before they are completely ripe, particularly when some cash is needed. After the nut is husked copra is dried either in the sun (mostly east of Viqueque in Uma Uain de Cima) or on a simple coconut drier[73] (mostly west of Viqueque). However, copra dried by fire, the prevailing form of drying in Viqueque, is of inferior quality.[74] In addition, a loss in weight of 20 to 30 per cent is not uncommon.

The planting of coconut is not without hazard. Coconut production varies greatly from year to year depending upon rainfall and hours of sunshine. Moreover, coconut trees are menaced by the Rhinoceros beetle (*Oryctes rhinoceros*).[75]

The lack of knowledge of environmental conditions is another drawback, as is illustrated by the case of the Ra Tahu coconut plantation south of Viqueque. This plantation, which, properly speaking, is the only plantation with capital from Dili in our Area, is located along the Viqueque - Bé Aço road and mainly comprises flat land of the alluvial coastal plain. Before 1929 this site is said to have been used as paddy field by the chiefs of both Uma Uain de Baixo (Don Paulo) and Ossu de Cima (Don Francisco). Strangely enough the natar of Ra Tahu is said to have been given up in

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[73] Such a coconut drier consists of a platform about 1.50 m above the ground, made of bamboo, on top of which the copra is dried by the smoke from a smouldering fire kindled by the fibrous material of the coconut shells.

[74] According to the Chinese merchants in Viqueque far higher prices could be obtained for copra if the quality could be improved.

[75] *Oryctes rhinoceros* is said to prefer to attack *Borassus flabellifer* and *Corypha utan* palms. Thus, failure to leave some of these palms when preparing the land for a coconut plantation may result in a complete loss of the coconut trees. This happened to the coconut plantation near the mouth of the River Manoléden (north coast), belonging to Tam Sui Ting where 6000 trees planted over 70 ha were destroyed by the beetle. In that case the former corypha vegetation had been completely cut (see Plate 7).

1929.[76] After World War II the whole site was acquired by a Dili-based company[77] whose objective was to convert the entire site into a coconut plantation. The heavy clay layers (of the Bobonaro Scaly Clay Formation) which underlie the entire study area (see Fig. 10) crop out here at Ra Tahu.[78] Thus, it proved to be wholly unsuitable for the cultivation of coconut trees, which require loose, sandy, well-drained soil with a water level not too deep below the surface. Here at Ra Tahu the roots of the coconut trees cannot spread easily. Thus the coconut trees grow very slowly and need more than twelve years before they bear fruit. Moreover, the fruits are comparatively small.

In addition the Sota plot with approximately 10,000 trees (in 1969-70) suffers from heavy growth of *Imperata cylindrica* grass (duut manu lain) which impedes the growth of the young coconut trees. In order to combat the grass invasion the company first tried a motor mower which proved inadequate. Also, the labour cost was high. Recently, Bali cattle especially suited to the hot lowland climate were introduced. They fulfil the dual role of keeping the grass low and providing meat for the Dili area and eventually even for export. So far the results with Bali cattle (in 1969: 1077) at Ra Tahu has been successful although the size of the herd must be increased as the growth of *Imperata cylindrica* is very fast in this coastal lowland (pers. comm., Administrator José Soares Teles, 14.5.1970).

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[76] It is not unlikely that as a result of heavier slashing and burning in Ossu after pacification the Cuha River silted up. As a consequence the drainage channel of the Ra Tahu paddy field became useless and thus the rice field had to be abandoned because there was no spring. Rainfall dependency was also too risky. This was similar to what happened in the nearby Hare Bé Oan natar and Lakerek Mutin natar in the Luca plain which had both been given up in the early 1950s.

[77] The Ra Tahu area comprises 718 ha (Fazenda de Santa Fé) to which an additional 86.47 ha (Fazenda de Santo Isidro) were acquired in the middle of the 1960s from a European by the name of Justino Corona. The registered owner of the whole complex is the Sociedade Agricola de Fomento Lda, Dili (Sota).

[78] The name Ra Tahu, in Tetum probably 'Rai Tahu' meaning 'clay', is already suspicious and should have been a warning to those who planned to convert it into a coconut plantation.

Still, the Ra Tahu coconut scheme has been a failure. By 1969-70, it had not yielded any net returns. This example as well as those of Bénara and Laliu[79] (also located in the southern coastal plain) which were faced with similar soil problems, should demonstrate that a careful ecological analysis of the particular locality has to precede any large-scale commercial operation. Otherwise, failure is bound to occur.

The local population is apparently more familiar with environmental conditions required for coconuts. They have chosen more fertile alluvial soils in the flood plains of the Cuha, Bé Bui, and Bé Tuco, some regosols (RC) near Bé Aço, as well as the calcareous soils of the Southern Foothill Zone (CR- and CMC-soils). Thus they have shunned the heavy clay soils and clay outcrops at various spots of the coastal plain.

The introduction of copra has certainly left its imprint on the native economy in parts of the Area. It has visibly transformed the landscape particularly in the south around Viqueque. And more than any other cash crop it has led to greater market orientation on the part of the indigenous population.

A similar triggering effect has been recorded for rice in the Uato Lari Plain. Wet rice, as we have learned, has been long known in Timor. Still, the southern coastal plain

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[79] From 1959 the Comissão Municipal de Viqueque operated two experimental coconut plantations at Bénara and Laliu (38.5 ha) which finally had to be given up in 1965 (H.d.A.G. Soares 1964:5; A.M. Ramos 1959, 1960). For these two fields alone 430 contos were spent between 1961 and October 1964. At Laliu high grasses - *Imperata cylindrica, Saccharum spontaneum* - caught fire and destroyed the entire plantation. A new experimental field (13 ha) in the Laliu plain nearer to the sea was opened in 1969. This field is irrigated by a canal and entirely given over to the cultivation of annual crops such as rice and maize.
Bénara is now also primarily devoted to the cultivation of annual crops (maize, castor plant). The Comissão Municipal de Viqueque seems to be more successful today with an experimental field at Bé Sala Bua (near Bé Aço) (19 ha), which was opened up in 1967, originally designed as a coconut nursery but continued as an experimental field. In 1969-70 about 2000 coconut trees were planted with an average of 119 trees per hectare. (Pers. comm. Regente Agrícola António dos Santos, R.P.A.F., Dili 9.11.1970.)

has been almost wholly devoid of paddy fields until recently. The prime reason for this, as mentioned earlier, is the high incidence of malaria in the swampy lowlands. In addition, there is a serious shortage of water for irrigation in the Viqueque area. Table 33 shows that by far the chief exporter of rice in our Area is Uato Lari with 645 tons of nele (unmilled rice) (= 67 per cent of the Area's exports)[80] and 4 tons of fos (milled rice) (= 2.3 per cent) in 1969. Actual exports are probably even higher since rice quantities shown for Viqueque of 30 tons nele (= 3.1 per cent)[81] and 27 tons fos (= 14.4 per cent) most likely did originate in Uato Lari, as local production (at Ué Laco, Hare Bé Oan and Futudu) is consumed locally. The same is true for Quelicai figures which also include rice harvested in Uato Lari by people from Quelicai and sold at Quelicai because of higher prices.

Second to Uato Lari in rice exports is Baucau with 132 tons of nele (= 13.6 per cent) and 115 tons fos (= 60.8 per cent). The comparatively high percentage of fos at both Baucau and Viqueque has to be explained by the fact that rice hullers are located at these places which are operated by a Chinese (Baucau) and by the Comissão Municipal (Viqueque).[82] The Timorese producers usually sell nele to the Chinese merchants who put it through the rice huller for a fee of 18$00 per 100 kg. During this process the rice loses 30 to 40 per cent of its weight in comparison to a loss of over 60 per cent when milled in the traditional way by means of mortar (neçun) and pestle (alu).

The figures on Table 34 indicate that there has been a substantial increase in exports of rice over the last eight to ten years throughout the Area. This increase was due to the introduction of new high yielding rice varieties such as IR-8, IR-5, as well as to the new technique of transplanting. Nowhere else has the change been more striking than in the plain of Uato Lari. This region, already heralded as Timor's 'granary' of the future (pers. comm. Albino dos Santos Brendão, Administrator of Uato Lari), has not only witnessed a complete change of its landscape but may moreover be regarded as the first successful agricultural development along the southern coastal plain of Portuguese Timor.

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[80] Includes 601 tons to Dili and 44 tons to Baucau.

[81] Of these 22 tons went to Dili and 8 tons to Baucau.

[82] A third Chinese-operated rice huller is located at Laga.

Table 33

Rice exports from the market centres of the Area in 1969

Postos	Unmilled rice (nele)		Milled rice (fos)		Total exports in terms of rice (nele)*	
	kg	%	kg	%	kg	%
Baucau	131,717	13.6	115,340	60.8	323,951	25.25
Venilale	29,300	3.0	4,000	2.2	35,967	2.80
Quelicai	96,067	10.0	38,550	20.3	160,317	12.50
Ossu						
to Dili	26,900	(3.6	-		26,900	2.10
to Baucau	7,450	(	-		7,450	0.58
Uato Lari						
to Dili	601,365	(66.7	4,442	2.3	608,768	47.45
to Baucau	44,000	(	-		44,000	3.43
Viqueque						
to Dili	21,965	(3.1	27,225	14.4	67,340	5.25
to Baucau	8,300	(	-		8,300	0.64
Total	967,064	100.0	189,557	100.0	1,282,993	100.00

* Milling conversion ratio assumed to be 60 per cent.

Source: Guia de trânsito of Concelhos of Baucau and Viqueque for 1969.

Table 34

Rice exports by postos
kg

Posto	Nele	Fos	(year)	1966 Nele	1966 Fos	1969 Nele	1969 Fos
Baucau-Sede	13,600	333,450	(1960)	130,266	126,465**	131,717	115,340
Quelicai	9,940	82,940	(1959)	39,654	44,636	96,067	38,550
Venilale	-	-		61,657	520	29,3000	4,000
Ossu	5,000	10,294	(1961)	12,655	507	34,350	-
Viqueque-Sede	-	-		1,822	597	30,265	27,225
Uato Lari	7,080	7,590	(1961)	152,533	1,788	645,365	4,442
Total				398,587 v	174,513	967,064 v	189,557
Total exports in terms of nele*				689,442		1,282,992	

* 0.6 kg of milled rice (fos) calculated as being equivalent to 1 kg of unmilled rice (nele).
** Included 6400 kg from Laga.

Source: Guia de trânsito of Concelhos of Baucau and Viqueque.

Until 1964 the plain of Uato Lari, consisting of several smaller units like Narequiçi, Fatun, and so forth, was only marginally used for to'os cultivation. Upon the initiative of the local administrator a great number of peasants of all sucos of Uato Lari began opening up the plain for wet rice cultivation in a joint effort in 1965. By the end of 1969, 2604.5 ha, of which over one-third was in Narequiçi, were converted into paddy land owned by 1445 peasants - thus averaging slightly less than 2 hectares per person.[83] The population, of course, continued living in the foothills. Eighty per cent of Uato Lari's total population is estimated to live around the administrative centre (pers. comm. Administrator Albino dos Santos Brendão). Owing to the incidence of malaria in the plain, the whole scheme became successful only when the Health Service of Portuguese Timor (RPSAS) opened up a dispensary (posto sanitário) on the west bank of the Bé Bui River immediately adjacent to the new rice fields. This enabled the malaria-stricken peasants to obtain instant medical treatment from the local medical officer. Until then the only dispensary in Uato Lari was located at the administrative

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[83] These figures were obtained from an unpublished survey (Brendão 1970) carried out in 1969 by officials of the administration of Uato Lari. On this occasion all wet rice fields in Uato Lari were surveyed (by simple measurement), although no plan was drawn indicating the exact location of these fields. As pointed out earlier, no official land register exists in Timor. The purpose of the survey was simply to give the peasant an idea of how much chemical fertilizer (which was to be imported) he should use on his field. The following table illustrates the number of peasants having rice fields and the total area of these fields in hectares:

Suco	Number of peasants having rice fields	Total area of wet rice fields in ha
Macadique	449	733.2
Mata Hoi	192	597.5
Uai Tame	140	209.9
Afoloicai	286	599.9
Babulo	222	276.7
Vessoro	156	187.3
Total	1445	2604.5

Actual sizes of natar were mostly around 1-2 ha per peasant with a few very large holdings like one of 102 ha belonging to the chief of Macadique and even one of 137 ha belonging to the chief of Mata Hoi.

centre of the posto. It could not be reached for days during the rainy season when the high waters of the Bé Bui rendered any crossing for peasants from the rice fields of the plain impossible.

The local population of Uato Lari - being less active owing to the hot climate - was unable to cultivate the new rice fields alone. Additional manpower was needed. Since 1965 when the plain was gradually opened up this extra labour has come from the over-populated hinterland, mainly from the sucos of Abo, Lelalei, Maluro, Macadai de Cima, Macadai de Baixo; thus all from Quelicai. These peasants only come for the planting period (around April) and stay for four to five months till the harvesting in Uato Lari. The magnitude of these seasonal migrations can only be estimated, since few migrants go through the trouble of applying for a transit pass (guia de trânsito) from their posto.[84] Thus, these estimates vary between a few hundred to roughly 600 taxpayers (pers. comm. Administrator Albino dos Santos Brendão, 19.10.1970, referring to April 1970), who, if all family members are to be included would amount to as many as 3000 persons.

The people from the upland, as indicated earlier, generally shun the malaria-infested lowlands. Thus particular circumstances were necessary to induce the highlanders to come down to the coastal plain of Uato Lari. Consequently, the farmers of the latter place, who were now owners of the new paddy fields, had to offer more favourable socio conditions in order to lure the experienced wet rice cultivators of Quelicai down to the plains of Uato Lari. The latter are known as being some of the most skilful in the Area. Around Baucau the yield is divided into three equal portions among the owner of the natar, the owner of the buffalo, and the

[84] Every Timorese is required by law to apply for a transit pass if he wishes to leave his posto temporarily or permanently. In the case of Uato Lari, people foreign to the posto only arm themselves with the transit pass when they are new and want to have some protection in case of quarrel over socio shares after the harvest. But since many Quelicai people from sucos like Maluro, Abo, Lelalei, Macadai de Baixo, and Macadai de Cima which are adjacent to Uato Lari, have relatives in the latter place with whom they conclude socio contracts, they simply head for Uato Lari instead of going all the way back to the administrative post of Quelicai to apply for a transit pass.

labourer. In Uato Lari farmers had to offer 50 per cent of the crop to the labourers, while the remaining 50 per cent went to the owners of the paddy field and the buffaloes. At the beginning of the development in 1965 some farmers from Quelicai are said to have also brought their buffaloes down to the plain. However, several of these highland-accustomed buffaloes died. Evidently they need a certain time to adjust themselves to the hotter climate of the lowland. Thereafter, Quelicai migrant farmers were reluctant to bring their buffaloes down to Uato Lari.[85]

Ever since 1964, but particularly since 1968, Uato Lari has been experiencing what might be called a veritable 'rice boom'. Of the entire harvest about half is estimated to be consumed locally while the rest finds its way to the Chinese cantinas. The commercial importance of Uato Lari's rice crop is underscored by the fact that at harvest time in October 1969, not only the two local Chinese shop keepers but also seven Chinese merchants came to buy rice in Uato Lari, often straight from the natar. As the harvest coincides with the dry season the road to Viqueque via Bé Aço becomes passable and some of the rice can be shipped to Dili overland by truck.

Of great advantage to the Uato Lari plain is the nearby anchorage of Aliambata at the mouth of the Bé Bui River. Two landing craft, the Lois and the Comoro as well as the coastal vessel O Arbiru serve Uato Lari regularly during the northwest monsoon. During the southeast monsoon, however, coastal shipping is rendered difficult and usually has to be suspended. Owing to the high damage normally incurred with this type of transport, Chinese merchants at Uato Lari seem to prefer overland transport which, although generally more expensive, is less risky.

The opening up of the coastal plain at Uato Lari was done by local farmers of that posto, although under the compulsion of the local administrator. At the beginning in

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[85] Because of the buffalo shortage in Uato Lari buffaloes were brought in chiefly from Viqueque-Sede which has similar climatic conditions to the sucos of Uato Lari. Thus buffaloes came particularly from Uma Uain de Cima and even Uma Uain de Baixo, where with the exception of Bé Laco and Hare Bé Oan there are no paddy fields and hence buffaloes are not needed for sama natar. If not under socio contract buffaloes are rented out for 400$00 to 500$00 for sama natar of a quarter hectare.

1965, people were not generally enthusiastic about the idea, for it meant more work and there was the threat of malaria. Six years later the attitude of the residents had changed considerably as the advantages of wet rice cultivation in Uato Lari became evident. Owing to the new high-yielding varieties[86] rice has become the number one cash crop in that posto. The returns are considerable.[87]

The economic motivation which has been of prime importance in the development of the plain is almost entirely due to a sudden unprecedented desire by the elders (greatly encouraged by the local administrator) to send their children to school (pers. comm. Joalino Maher Simões, teacher at the Escola do Municipio of Uato Lari in 1970). In 1960 there was no school in Uato Lari; since 1968 there have been six primary schools, one in each suco, providing education for the first and second year. At the administrative post of Uato Lari there is one school (Escola do Municipio) providing education for the first and second year which had 60 pupils in 1968-69 and 230 in

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[86] Although broadcasting still persists as the most usual form of wet rice cultivation in Uato Lari, rice yields have increased tenfold from 20-30 latas/ha to 300-400 latas/ha, i.e. 3.6-4.8 t/ha. In 1970 the Comissão Municipal de Viqueque carried out experiments in Narequiçi on 6 ha of which 4 ha were transplanted (180 kg seed) and 2 ha were broadcast (90 kg seed). The growing period was March to July. The 4 ha transplanted yielded 10,720 kg while 2 ha broadcast yielded 3,409 kg. Although the results were not extraordinary because of adverse rain conditions and a rat plague, the yields (almost 3 t/ha transplanted and 1.7 t/ha broadcast) were encouraging (information provided by Administrator Albino dos Santos Brendão, 5.12.1970).

[87] On the basis of the 1969 figures of rice leaving Uato Lari i.e. 645,365 kg nele and 4442 kg milled rice (=7,403 kg nele), amounting to a total of 652,768 kg nele, and assuming 2$20 per kg, 1,436,090$00 went to the local population alone from the sale of rice. Uato Lari, which had a total population of 12,810 in 1969, would therefore derive a revenue of 112$00 per person; or, if we include the unverified number of 3000 Quelicai people, we would still have 90$00 per person. By Timor standards this is a fairly high cash income. (Note: excluded from these figures is the rice consumption of local officials and the sale of Uato Lari rice offered at Viqueque, Quelicai, and, possibly, Ossu.)

1969-70. Altogether there were about 1200 pupils in Uato Lari in 1969-70.[88]

Local farmers tend to be unwilling to share their newly attained prosperity with migrant farmers from Quelicai or Ossu. In October 1970 I was told by the chief of the suco of Macadique, Sr João de Meneses, that from 1971 onwards residents of Uato Lari had become increasingly reluctant to make socio contracts with outsiders from other postos, as there were still residents who did not own any natar in 1970. In the long run, this attitude of Uato Lari people will affect the migration from the hinterland.

For the time being, however, the 'rice boom' at Uato Lari seems to be self-sustaining. For example in 1970 on the recommendation of the local administrator local farmers bought 33 tonnes of chemical fertilizer (Ammonium sulphate which contains 21 per cent nitrogen) which was to be applied in 1971. They also ordered simple agricultural tools through the Administration.

The whole undertaking is, however, not without risk, as the basic agricultural methods have not changed. The highly variable rainfall is still the greatest hazard to agriculture. In October 1970 I witnessed the partial destruction of the rice harvest in Uato Lari when after four consecutive days of rain the rice harvested and put on the bunds for drying was rotten. Moreover, the uncut flowering rice was knocked down into the water and subsequently destroyed.

In addition, the dependency on the two local Chinese merchants and on transport in this seasonally isolated part of our Area has its hazards. In order not to discourage local farmers who had experienced severe losses, the Portuguese government (Repartição Provincial de Economia) had to interfere in the market in October 1970 by guaranteeing a fixed minimum purchasing price of 2$20/kg. Local merchants were not prepared to offer more than 1$50 to 1$60/kg for unmilled rice. For this purpose the Repartição de Economia had a fund of about 200 contos available with which they hoped to buy all rice offered at Uato Lari. Price fluctuations and price

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[88] Apart from the schools mentioned there was also an Escola Militar (for third and fourth school year) in Uato Lari run by Portuguese soldiers with about 140 pupils in 1970.

differences were to be counterbalanced by this fund.[89]

The discussion of both coconut in Viqueque and rice in Uato Lari has made it clear that the cultivation of these two crops is not completely free of hazards. Still, these were the only two promising examples from our Area which are likely to bring a higher degree of commercialization into the native economy. This might entail the beginning of a modest economic development in, at least, parts of our Area. It is, however, premature to make any firm predictions as to the final impact of these two crops in the particular regions. A highly cautionary attitude is required in view of the numerous examples of agricultural undertakings which have mostly failed to leave any lasting impact on the native economy.

At this point one is reminded of the first years after pacification of the interior of Portuguese Timor when the government made enormous efforts to increase agricultural production.[90] However, the remarkable agricultural and silvicultural development during that time was largely conditioned by the dynamic personality of the governor, who gave strict orders to the Timorese with respect to the maintenance of nurseries, the transplanting of trees, the introduction of new trees, new maize and rice varieties, etc. It was therefore no surprise that, when less dynamic governors, often less interested in agriculture, came to Timor, these nurseries were neglected, and the Timorese soon reverted to their traditional agricultural methods.

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[89] By virtue of the guias de trânsito for goods the Repartição de Economia has a rough idea of supply and demand in Portuguese Timor.

[90] Evidence of these efforts can be found in the Boletim do Comércio, Agricultura e Fomento de Timor issued in Dili between 1914 and 1920. It published the monthly reports on the agricultural activities which each district commander was required to submit. All former reinos (kingdoms which were dissolved after 1912) were obliged to maintain nurseries and to plant trees. Their records give a fairly detailed account of the volume of agricultural and silvicultural activities at that time. Unfortunately no more reports were published after 1920; instead statistical data were merely included in the annual reports of the administrators. Most of these reports were destroyed during the Japanese occupation from 1942 to 1945. Some evidence of pre-World War II efforts in the field of agriculture is contained in Cardoso 1937b, 1937c; Terra *et al.* 1939.

Long before World War II the government had made repeated efforts to train pairs of buffaloes for natar cultivation with ploughs, as is customary in other Southeast Asian countries. The impact of these measures on the native economy has been insignificant. Today all paddy fields in our Area are still trampled sama natar.

One might cite several other examples of such failures from our Area. Before World War II the government tried to introduce oil palms (Den Den), which were planted throughout the Area. We still find some of them at isolated places such as in sucos of Loihuno and Loilubo; at the administrative post of Ossu; in Caraubalo (Viqueque), and along the road between Loihuno and Viqueque. Because of difficulties in processing the oil kernels the cultivation of oil palms never gained a foothold in the native economy.

This was also the case with rubber (*Hevea brasiliensis*). Before World War II and as late as 1955 rubber was reportedly cultivated in Viqueque, as well as at Bétice (Viqueque) by chiefs from Ossu and Viqueque (pers. comm. Administrator José S. Teles, 14.5.1970). This cash crop requires a relatively high degree of skill and experience which nobody in Timor really had.[91] In addition, it was difficult to buy acids for coagulation of the latex, as this required a certain amount of money which had to be advanced by the cultivators. Therefore, the rubber scheme of Bétice was a complete failure. It was taken over by the Comissão Municipal of Viqueque and in 1968 was discontinued.

These examples demonstrate that the introduction of crops which were alien to the Timor environment required a high level of technical know-how which the Timorese lacked. Moreover, after an initial effort, generally little more was done by the government in the way of guaranteeing a fixed price, so fluctuations of the world market price seriously affected these new enterprises.

Poor knowledge of ecological requirements also explains the failure of coffee growing on the Mundo Perdido Range. Coffee was introduced into Portuguese Timor in 1816 by Governor José Pinto Alcoforado de Azevedo e Sousa (1815-18) (Duarte 1930:27). It became Portuguese Timor's number one

[91] For this a Javanese was said to have been brought in to teach the Tetum how to tap rubber trees in the late 1940s.

export crop towards the end of the nineteenth century,[92] and is said to have been planted (chiefly *C. arabica*) on a large scale in the forest of Mt Mundo Perdido between 1924 and 1930. Apparently the government had already ordered each suco in Ossu to maintain coffee nurseries in 1915 (see B.C.A.F.2, 1915:222). Very optimistic views were held with respect to the productivity of the Mundo Perdido area. However, actual production was disappointing[93] as a result of the calcareous soils considered unsuitable for coffee production.[94]

Today the little coffee that is still found in the Area is grown in Afoloicai (Quelicai) on the western slope of Mt Mata Bian and at Cailubo Oli forest (suco of Gari Uai) on the Baucau Plateau. Most of the coffee sold at Quelicai and Ossu, however, originates in the posto of Baguia (belonging to the concelho of Baucau) east of the Area. Owing to its extensive areas of calcareous soil and infertile clay soils, the Area has never been an important coffee growing region of Portuguese Timor.

On the other hand, silvicultural possibilities - such as the exploitation of the forests for commercial purposes - have not yet been recognized by the Timorese. The forests supply the Timorese with berries and fruits in times of general food shortage. Moreover, certain plants are used for medicinal purposes and for house construction. The only plant that is commercially exploited is the rattan palm (*Calamus rotang*) which is sold to the Viqueque furniture factory run by the Comissão Municipal of Viqueque.[95]

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[92] It is still today Portuguese Timor's major foreign exchange earner, accounting for 88 per cent of its total export earnings in 1968. For more detail on coffee growing in Portuguese Timor see H. Lains e Silva (1956, 1960) and Daenhardt (1968).

[93] According to B.C.A.F.(4, 1915:472) 7000 picos of coffee (1 pico = 62 kg) (i.e. about half the coffee production of Portuguese Timor) were expected for that year, but according to Duarte (1930:144) each coffee bush produced only about 10 grams.

[94] In 1964 (MEAU Rel. An. 1964:6) and again in 1970 the Mundo Perdido coffee area was visited by MEAU coffee expert Regente Agricola Marcelino Lima Rodrigues. The coffee (already small trees) was completely covered with lichen (*usnea* sp.) and heavily infested with *Hemileia vastatrix*.

[95] This is the only real industrial enterprise in the Area. It is run at a profit.

Before World War II the government had teak (*Tectona grandis*) planted in the Southern Foothill Zone and around Viqueque. Environmental conditions were obviously favourable, although the cultivation of this tree does not lend itself to rapid change in the degree of commercialization since the trees need about 100 years to grow before cutting.

No impact on the native economy could, therefore, be expected from either rattan or teak. The modest degree of commercialization that today exists in the Area has to be largely attributed to the initiatives of the European administration, however inadequate that may be, and particularly to that of the Chinese who are engaged in the intermediate and retail trade. The latter found an overseas market for the native produce and they handle all imports. Moreover, they manufacture articles like shorts, blouses (kebaya) and sarongs (tais Timor) which the local people cannot make themselves. Their role as pioneers who stimulated the Timorese to greater economic activity is unchallenged. They usually speak several native languages. As is characteristic of them throughout Southeast Asia, Chinese tend to live humbly and on a standard of living comparable to the wealthier Timorese. Because of their extensive family ties they are able to run a business at far lower cost than a European would probably be able to do in Timor. On the other hand, Chinese invest only little in the province. Money transfers to China are said to be substantial.

Commercial activities carried out by the Timorese are insignificant relative to those of the Chinese. Before pacification, it is assumed (Ormeling 1955:116) that trade was probably limited since exchangeable agricultural surplus was almost non-existent. Ormeling even believes that markets were rare or even non-existent. Some intertribal commercial contacts must have existed, however, as in the case of salt, which has long been used as a means of barter between the people of the lowland and the central upland. Conditions for salt making are particularly favourable on the north coast with its shallow embayments and its long dry season.[96]

[96] Salt making is carried out in a primitive though ingenious fashion (see Almeida 1959) whereby salty mud is heaved onto a scaffolding. Water is then poured over the mud thereby dissolving the salt. The water is then evaporated in a pan over fire. Considerable quantities of timber are burned in this process. As a result, the areas around the coastal points of salt production are now almost completely devoid

The creation of markets was thus a direct result of the pacification and subsequent construction of roads which linked the administrative and commercial settlements of the interior with the coasts. Today the Sunday market[97] is part of Timorese life. Still, trade carried out by the Timorese themselves does not constitute any serious competition to the Chinese merchants. The Timorese sell exclusively agricultural produce which is not for export, like tobacco, betel, areca nut, bananas, bread-fruit, oranges, beans, maize, a little rice, pumpkins, etc. Barter is still common, although the degree of monetization is increasing rapidly.

A detailed description of the market of Viqueque has been given by Hicks.[98] These markets fulfil an important social function, in that they enable the farmers who come there from widely scattered hamlets (cnuas) to exchange news and to indulge in the traditional Timorese sport of cock fighting, which is customarily held as soon as the market is over.

The Timorese is generally reluctant to sell any of his buffaloes, horses, pigs, goats, etc. Only if he is short of cash at the time when annual taxes are due will he sell some of his small livestock. Large livestock, however, are kept for funerals, marriages, and other feasts.

Excepted from the above statement is the rather active trade in buffaloes and horses which has developed between the concelho of Viqueque and the coffee-growing areas of Maubisse, Ermera, etc. in the west. On account of the shortage of buffaloes and the higher degree of monetization in the latter districts, Viqueque livestock owners can obtain at least twice the price for their livestock which they could receive in Viqueque. For instance, in 1970 buffaloes sold

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96 (continued)
of vegetation which, since this is an extremely dry part of Timor, has entailed serious devastation by erosion (Plate 4).

97 At the larger centres like Baucau and Viqueque markets are held twice a week - Sundays and Wednesdays.

98 Hicks (Paper Two, p. 13) gives a detailed account of the Viqueque market. He estimates that only goods worth less than about 12 escudos are subject to barter. He also maintains that eventually bartering will completely disappear.

for 7-800$00 per pardau[99] in Viqueque and Ossu as compared to 1500$00 to 1700$00 in the western coffee districts where buffaloes are in high demand particularly for estilos (traditional feasts) during the dry months of the year (May to October). Thus every summer buffaloes and horses are driven hundreds of kilometres from Viqueque and Ossu overland to the west. The trip takes several weeks, and the guardian is paid what is called aidassa of 60$00 per head of buffalo or horse. Table 35 gives some idea of the volume of this trade which in this Area is limited to Ossu and, more specifically, to Viqueque. Since Viqueque-Sede is almost completely devoid of wet rice fields there is little direct use for the buffaloes other than as a bride price for barlaque.

Figures are given for the trade of both buffaloes and horses to the coffee-growing districts as well as to places within our Area for the years from 1967 to 1970 (October) where they usually constitute exchanges in connection with barlaques. While the trade in horses is relatively modest, that in buffaloes is of far greater significance. The number of buffaloes exported to the coffee areas in the west steadily increased from 217 (1967) to 446 (until October 1970) with a top export of 924 head in 1969. If we assume an average price per head of buffalo of 2000$00 (at 1969 prices)[1] 1,600,000$00 would have flowed into the hands of the people of Viqueque and 246,000$00 into those of Ossu alone from the sale of buffaloes outside the Area in that year. The flow of these funds into the hands of the local population who handle this trade among themselves without Chinese intermediaries is considerable. However, it has not perceptibly changed the Timorese attitude towards a greater market orientation.

The impact of malaria upon the demographic pattern

Malaria, in my opinion, plays a decisive role in the island ecosystem. A thorough comprehension of its impact and implications upon the relationship between man and his particular environment therefore seems indispensable.

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[99] A pardau (this may be an old Chinese measurement) is about 22 cm measured at the outer side of the buffalo horns. At the time when taxes are due there may be a greater supply of buffaloes, and the pardau might sell at only 300$00.

[1] According to the local veterinary service (RPSV Rel. An. 1969:13) the average price for buffaloes was 2000$00, and for horses, 1200$00 per head.

Table 35

Livestock trade (buffaloes and horses) within the Area and to the coffee growing districts

Type of livestock	From	To places within the Area				To the coffee-growing districts			
		1967	1968	1969	1970*	1967	1968	1969	1970*
Buffaloes	Viqueque	58	36	37	4	158	148	801	354
	Ossu	-	42	43	-	59	134	123	92
	Total	58	78	80	4	217	282	924	446
Horses	Viqueque	32	31	33	-	30	44	-	38
	Ossu	24	30	33	-	-	-	43	1
	Total	56	61	66	-	30	44	43	39

* Until 31 Oct. 1970 only.

Note: Dislocations of large livestock which the Timorese are required by law to report to the local administration have to be accompanied by a guia de trânsito de gado chiefly for tax purposes.

Source: Guia de trânsito para gado, 1967-69, Administration of Concelho of Viqueque.

The island of Timor is notorious for its incidence of malaria.[2] The extent of this disease in Portuguese Timor is emphasized by the fact that, according to official statistics, 61,986 cases of malaria were recorded in the entire province in 1969, thus accounting for 10.3 per cent of the entire population or 19.7 per cent of all medical consultations.[3]

For our Area the incidence of malaria[4] by postos for 1968 shows a range of between 2.4 per cent (Ossu) and 12.6 per cent (Vemasse).[5] Malaria is by far the number one disease.[6]

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[2] For a full account of the impact of malaria in Eastern Timor see Metzner 1976a.

[3] RPSAS, Rel. An. 1969:3 and 17. Corresponding figures for previous years were (*idem* p.45):

1966 = 8.9% (19% of all consultations)
1967 = 9.8% (20% of all consultations)
1968 = 10.8% (22.5% of all consultations)

One has to be careful however in arriving at hasty conclusions, since any febrile case that cannot unambiguously be diagnosed is customarily listed by the local health officer under number 116 (= other forms of sezonism of the WHO classification of diseases - this corresponds to A 37 g of the 'Lista intermediaria das 150 rubricas para a apresentação do quadro de mobilidade e de mortalidade' (RPSAS, Dili 10 Feb. 1965). In the absence of laboratory analysis in the majority of all cases, it has to be assumed that some of the undetermined cases listed under 116 WHO classification are actually non-malarial.

[4] Expressed as a percentage of the population of the posto.

[5] 2.4% Ossu; 5.3% Quelicai; 6.4% Venilale; 6.9% Uato Lari; 7.1% Baucau; 7.4% Laga; 10.6% Viqueque; 12.6% Vemasse. Calculated from quarterly reports for 1968 filed by district health officers (enfermeros) to RPSAS, Dili. Population figures provided by Rep. Prov. dos Serv. de Estatística, Prov. de Timor (Celestino A. Beirão Amador).

[6] Surprisingly, fatalities due to malaria are reportedly very low (WHO 1959:321). As primary and secondary causes of death are often not clearly distinguished by health officers the actual number of deaths is most likely to be significantly higher. According to WHO statistics the following number of deaths were attributed to malaria:

1950	21	1954	68
1951	33	1955	99
1952	69	1956	86
1953	60	1957	78

On my field trips I was frequently confronted with için malirin (meaning malaria in Tetum) in villages and in hamlets where a great number of the villagers were unable to attend to their fields because of the disease (e.g. sucos of Maluro, Ossoala, and Seiçal). The Timorese have come to live with this disease and have certainly developed a degree of tolerance to malaria. Frequent recurrent attacks of malaria have no doubt seriously debilitated the resistance of the population in general. Many Timorese still treat için malirin in their own traditional way, e.g. with infusions of the bark of *Strychnos ligustrina* (ai baku moras) (Meneses 1968:65) without reporting to health authorities. Therefore the percentage of malaria-stricken persons in Portuguese Timor is likely to be higher than 10.3 per cent. Table 36 shows the number of febrile cases reported as malarial for the various postos of our Area. A breakdown of these statistics for individual sucos or even villages (povoações),[7] however desirable this may be, could not be obtained. Usually there is only one dispensary per posto, located at the administrative centre of the posto. These postos sanitários, as they are called, which in our Area are placed at Ossu, Uato Lari, Quelicai, Laga, and Vemasse are headed by a health officer (enfermero - they are male nurses trained in Timor), most commonly a Timorese to whom the indigenous population comes for consultation.

Viqueque and Baucau have small hospitals (hospital rural) where patients can be treated more adequately. In 1969-70 there were, however, only two doctors - one civil and one military[8] - stationed in Baucau providing medical assistance to the population of the entire area of the concelhos of Baucau and Viqueque (with a population of 136,685 in 1968), thus including our entire study area.

In view of the poor road conditions, particularly during the rainy season, and the inaccessibility of most sucos by automobile, medical assistance by qualified doctors is virtually non-existent. Enfermeros try to fill part of this gap by visiting each suco at least once every two months on horseback. Unfortunately, because the visits are so infrequent, monthly records of malarial cases, if given for particular sucos at

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[7] The administrative term povoação designates a complex of hamlets which geographically may be far apart from each other.

[8] At times in 1970 there was only one doctor at Baucau.

Table 36

Febrile cases reported as malarial, by postos, 1956-69

	Baucau	Vemasse	Venilale	Laga	Quelicai	Ossu	Viqueque	Uato Lari	Total
1956	2044	956	2040	772	-	348	246	479	6885
1957	1847	693	713	464	-	983	281	592	5573
1958	874	501	937	495	396	798	558	1014	5573
1959	-	-	571	-	357	928	316	594	2766
1960	977	546	475	-	417	782	400	648	4245
1961	-	-	440	-	514	592	474	678	2698
1962	1381	838	510	-	269	503	459	993	4953
1963	2234	332	828	-	9	919	362	1207	5891
1964	1926	837	717	-	25	1070	697	1000	6272
1965	-	-	479	-	1052	345	1158	871	3905
1966	-	-	849	-	1257	142	2070	931	5249
1967	-	-	825	-	1958	165	1612	973	5533
1968	1226	741	722	1023	1022	379	1473	1056	7642
1969	1628	983	574	836	1224	428	1416	1390	8479

Source: Quarterly reports filed by district health officers to RPSAS, Dili 1956-69.

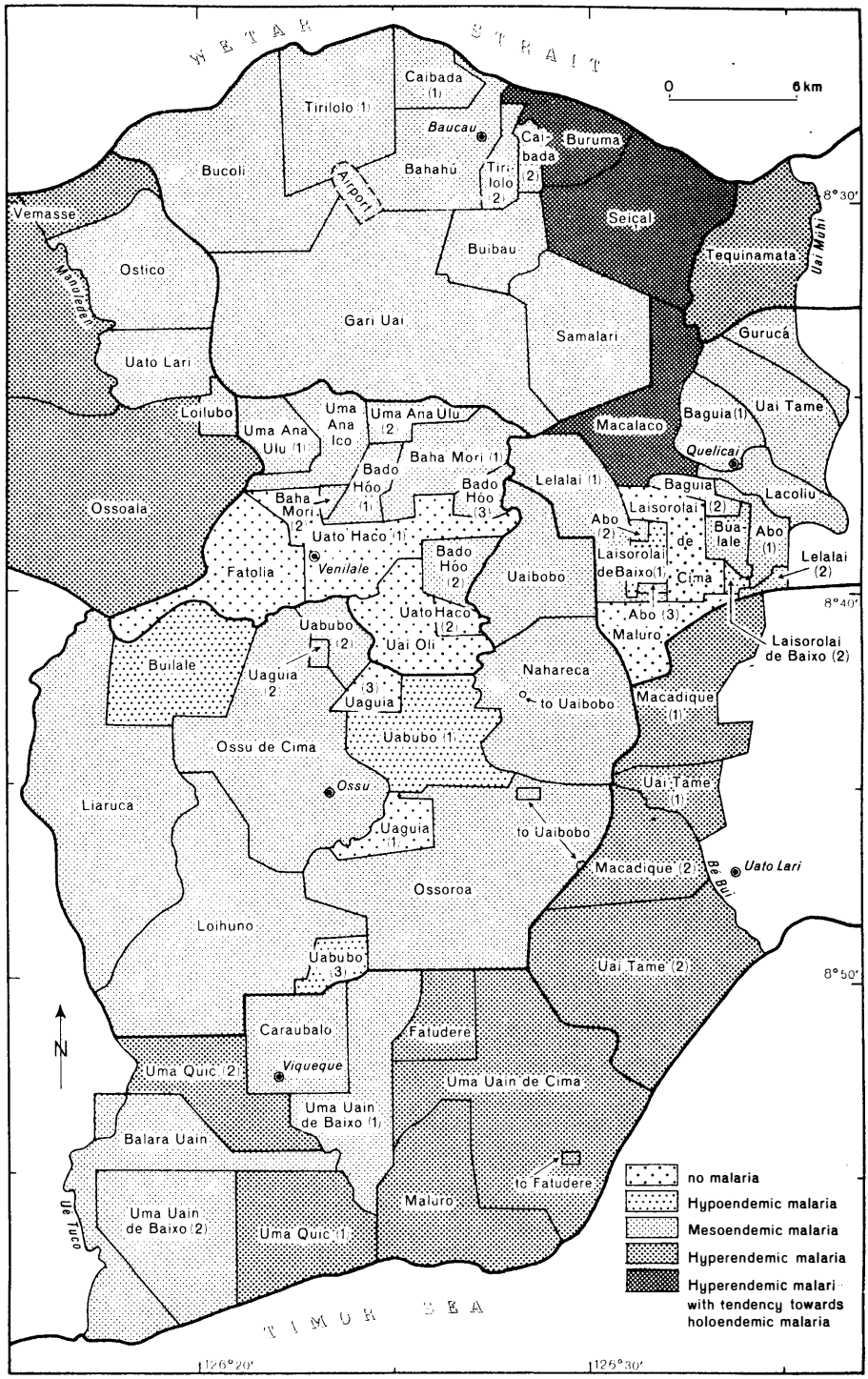


Fig. 33 Malaria endemicity within the Area

all, cannot usually be correlated with climate. Neither is it feasible to correlate the environment with the incidence of malaria, as peasants frequently move from the upland to the lowland for natar and to'os cultivation even within the same suco or posto. Still, with all these reservations in mind the figures in Table 36 have been compiled to demonstrate at least major regional differences in the degree of malaria infections. The data show that more so-called 'malarial' cases have been reported for the coastal postos than for the upland postos of Venilale and Ossu. Quelicai, although an upland posto, does not really seem to fit in our stereotype of an upland place that is little affected by malaria. In fact, Quelicai showed a low incidence of reported malaria cases until 1964, but since 1965 the figures have soared. A possible and most likely explanation of this phenomenon lies in the seasonal migration of Quelicai peasants to the malaria-infested Uato Lari for wet rice cultivation.

Among the few studies that have been undertaken on malaria by Portuguese researchers one showing the degree of malaria endemicity by sucos deserves attention (Ferreira and Breda 1961 and 1963). This study was carried out by a team of doctors between 1959 and 1962 during the dry season only and included 32,327 persons in almost all of eastern Timor's 403 sucos. The results of the part of the investigation within our cross-section are represented in Fig. 33. The findings of this study support the conclusions drawn from Table 36.

Broadly speaking, the severity of malaria endemicity is closely correlated with the physiography of the terrain. Thus lowland sucos, i.e. those along the north and the south coast, are hyperendemic areas (i.e. between 51 and 75 per cent spleen rate)[9] or even tending towards holoendemicity (over 75 per cent spleen rate);[10] while socos of the central upland and hypoendemic (1-10 per cent spleen rate) or free from malaria.[11] The remaining socos are all mesoendemic (11 per cent - 50 per cent malaria incidence).

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9 Sucos of Tequinamata, Vemasse, Uai Tame (Uato Lari), Uma Uain de Cima, Maluro (Viqueque), Uma Quic, Ossoroa, Fatudere and Macadique (Uato Lari). Spleen rate in children 2 to 9 years of age.

10 Sucos of Buruma, Seiçal and Macalaco.

11 Sucos of Fatolia, Uato Haco, Uai Oli, Uaguia, Bualale, Uabubo, Maluro (Quelicai) and Laisorolai de Cima.

Thus, this study roughly confirms what had been known long before. The coastal and intramontane lowlands of Timor are heavily infested with malaria. Although sucos like Bucoli, Tirilolo, Bahahú, and Uma Uain de Baixo are coastal sucos, they are classed as mesoendemic since in all these sucos the population does not live near the coast at sea level but at higher elevations (i.e. Baucau Plateau or Southern Foothill Zone).

This basic relationship between altitude and incidence of malaria has long been recognized by the Timorese. They have always shunned the coastal lowland, particularly that of the south coast where there are two rainy seasons, primarily because of the high malaria incidence. This is made evident by the indices of the sucos of Uai Tame (Uato Lari) and Maluro (Viqueque) which have the highest spleen indices of 94 per cent and 93.5 per cent respectively. As a result, the population is concentrated in the central upland where the incidence of malaria, though not completely absent, is significantly lower (see Fig. 6 for population density). The highest densities of 300 persons per sq km (Abo) and over (Laisorolai de Baixo 2) are encountered here, in contrast to nine in Maluro, 13 in Uma Uain de Cima and ten in Uai Tame (Uato Lari).

The alluvial lowland soils are often more fertile than many upland soils which are now under cultivation by the highlanders (ema foho). However, malaria, the hot climate and the heavy grass soils (*Saccharum spontaneum* and *Imperata cylindrica*) which are too heavy to till with the given type of agricultural implements, have prevented the Timorese from occupying these lowland localities.

The effective 'colonization' of the malaria-infested south coast constitutes a serious problem (see Ferreira 1957a). Since about 1960 the Portuguese administration has made repeated efforts to induce highlanders to move to the coastal lowland, for instance to Natar Bora, Betano, and Quiras (see Fig. 2). In 1969-70 one could say that in spite of support by the government in terms of tractors, houses, agricultural extension, fertilizers, etc. provided at very favourable terms for the new farmers, these efforts had proved unsuccessful as some of the new lowland farmers apparently succumbed to malaria, As a result the remaining farmers abandoned the place which had become lulik (sacred) in their eyes and headed back to their old settlements in the adjacent foothills.

Against this background is set the success of 'colonization' efforts in the plain of Uato Lari. In my opinion this is the only case of an agricultural development project along Portuguese Timor's south coast that can be regarded as successful. The creation of a second dispensary[12] on the west bank of the River Bé Bui adjacent to the paddy fields of the plain undoubtedly had a decisive bearing on the success. The dispensary made sure that the malaria-stricken peasants who stay in temporary huts (uma to'os or uma natar) on their fields during part of the year are at least given immediate medical treatment. Still, in spite of the dispensary, the malaria edemicity of Uato Lari, particularly in the suco of Uai Tame, is one of the highest in Portuguese Timor (see Ferreira and Breda 1961, 1963). Peasants continued to prefer living in the lower hills of the Foothill Zone, instead of in the coastal lowland.

Knowledge about the ecology of the three major factors - parasites acting as agent, human beings, primates and birds acting as host, and anopheles mosquitoes acting as vector - involved in the malaria cycle in Timor is certainly still very sketchy.[13] In view of the great contrasts in population densities and future agricultural potential between the central upland and the southern coastal plain there is, however, a pressing need to find a rapid solution to the malaria problem. At this stage of our analysis it is sufficient to draw attention to the fact that with the population still increasing in the central upland, the imbalance between man and his environment in that part of the Area will continue to grow; erosion problems and devastation of the natural resources will ensue. Should the balance of the ecosystem be restored the control of malaria on the island is pivotal. The solution

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[12] There is one dispensary already at the administrative centre of Uato Lari (257 m), i.e. on the eastern bank of the River Bé Bui and difficult to reach from the rice fields during the rainy season when high floods of the river block the passage for days and sometimes weeks.

[13] Cf. Annual report 1969 of the RPSAS, Dili 1970, pp. 43f. The knowledge about the intermediate host, i.e. man, is particularly scanty. Owing to uncontrolled migrations malaria occurrence can no longer be related to a certain environment. Closer contacts between WHO and the Portuguese Health Service in Timor were envisaged. No WHO delegates were, however, reported in Portuguese Timor until spring 1973.

of that problem will pave the way for the agricultural development of the fertile alluvial soils of the entire south coast. As new settlers from the upland are given an opportunity to make a living in the lowland, the ecological balance between man and his environment may be restored at least to some degree in the upland areas.

Possible future demographic development and impact on the environment in the Baucau-Viqueque Area

It is obvious that any land would support only a limited number of people in perpetuity. This limit, known as the critical population density or as the carrying capacity of the land, is imposed by physical factors and by the way in which the land is actually used. Given a certain system of land usage, a whole process of degenerative changes is set in motion once this population limit is exceeded.

From the information already given it will be evident that the Timorese system of bush fallowing depends essentially on the restoration of soil fertility by allowing for sufficiently long fallow periods. In our Area further evidence was contained in statements of village elders and suco chiefs that as population increases lere rai tends to be replaced by fila rai. Fallow periods have been shortened in association with the increase in the number of years a field remains under cultivation. In the absence of fertilizing or manuring this practice has triggered off a process characterized by a loss of minerals, oxidation, reduction, disappearance of organic matter and nitrogen, and degradation of the vegetation. All this has led to a rapid decline of soil fertility.

However, such a decline is accepted by the Timorese when, despite decreasing returns per harvest, the overall yield derived from the land throughout the rotation period is at least maintained or even increased through more frequent cropping. This explains why the population generally tends to overwork the better soils until their productivity declines to or even below the production level of the agriculturally less productive soils.[14] This low level must have been

[14] This phenomenon has repeatedly been observed among others by Löffler (1960b) for tribes in the Chittagong Hill Tracts between Bangladesh and Burma. He makes clear that as long as the utilization of the soil is only governed by the tendency toward greatest possible economization of the

reached in parts of Quelicai (Lelalai, Maluro, and Macalaco) where the scarcity of land has forced the people to work the soil year after year without respite. This is particularly harmful when no improving crops are planted.[15] Here, part of the population has resorted to heavy clay soils which have been completely destroyed and rendered uncultivable through overworking (see Plate 45). Congestion and cumulative land deterioration could have been avoided, in theory at least, if the population had occupied and worked the land according to its natural productivity. Suco and administrative boundaries have stood in the way of the attainment of such a natural distribution of the population.

This process of land deterioration has been caused indirectly by the removal of population checks - like intertribal wars, endemic diseases - by the Portuguese who pacified the country and introduced modern medicine at the beginning of this century. Since then the population has increased rapidly as shown on Table 37. These figures, although based on heterogeneous sources, indicate a marked population increase except for the years 1947 and 1950 when the population was feeling the effects of World War II. The figures point to an average yearly increase of 1.7 per cent for the whole of Portuguese Timor as compared to 1.8 per cent for our Area over the last ten years.[16]

Annual census figures for our Area on a suco basis, however, give a rather motley picture, as seen in Fig. 34. Percentage changes vary greatly between sucos. On one hand, there are sucos that display a net population decrease over that decade -

14 (continued)
energy to be expended for agricultural work, the carrying capacity is not determined by the total area of the cultivable land but only by the extent of the better soils.

15 In this respect cassava (ai farinha) is particularly harmful although maize and tobacco also draw heavily on soil fertility.

16 The Area's population was 69,813 in 1959-60 and 83,226 in 1969-70. For purposes of comparison the 1959/60-1969/70 figures had to be chosen, as owing to a reshuffling of the administrative units in 1957 the posto-Sede of Baucau was divided. Part of the former Baucau area went to the new posto of Quelicai while a small portion was also joined with Venilale.

like Fatudere (minus 1.6 per cent per year) and Uma Uain de Cima (minus 0.4 per cent).[17] On the other hand, there are sucos that have top increases like Bahahú (7.4 per cent annually), Gari Uai (4.5 per cent),[18] Uai Tame (Quelicai) (3.7 per cent) and Guruçá (3.1 per cent). The population changes of the remaining sucos lie somewhere in between these extremes.

Table 37

Population of Portuguese Timor, 1862-1970

1862	150,000*
1882	301,600**
1927	451,604***
1930	472,221#
1947	433,412##
1950	442,378###
1960	517,079+
1970	610,541++

* Castro 1862:470 estimates the population for the whole of Timor Island at 300,000 distributed equally over the two portions of Timor.
** Pe.J.G. Ferreira 1902:131 (estimates).
*** Duarte 1930:116 (annual census).
\# Agencia Geral do Ultramar 1965:23 (annual census).
B.O.T. Vol. 48, 29 Nov. 1947:451 referred to annual census of 30 June 1947.
Censos da População do Ultramar de 1950 (1952:7-9).
\+ WHO (1963:17 (annual census).
++ Census data provided by Rep. Prov. dos Serv. de Estatistica, Prov. de Timor, Dili (Sr Celestino A. Beirão Amador).

[17] If the period 1949-50 to 1969-70 is taken as a basis, Maluro (Viqueque) figures also point to a net decrease of 0.4 per cent per year.

[18] This high increase is mainly due to the influx of people from the surrounding sucos into the village of Baucau (suco of Bahahú). The same is true for the Baucau Plateau (suco of Gari Uai) where new settlers from overpopulated sucos in Venilale and the escarpment zone were allowed to settle.

Erosion is one clear indicator that the carrying capacity of the land has been surpassed. Signs of erosion, one of Timor's major problems (M. Mayer Gonçalves 1966), although severest on heavy clay soils in Ossu and Quelicai, are visible throughout the Area on all soil types. From the wide occurrence of soil deterioration, the effects of gully and sheet erosion are by far the most conspicuous. Thus the topography is characteristically scarred by deep gullies particularly on heavy clay soils (CN) as can be seen near Venilale (Plate 46) or in the suco of Uabubo (1). Also gravitational creep of the surface due to stagnating water on wet rice fields on heavy clay soils referred to above at Uato Iro (suco Uma Ana Ulu) and slumping due to undercutting of rivers (e.g. in Uabubo at River Sauma) are typical signs of imbalance. Further signs are denudation on steep hill sides (e.g. at Mt Ossoala) and the occurrence of badlands (e.g. suco of Seiçal at rivermouth (Plate 4) . These are striking examples of the imbalance between soil forming and soil destroying forces. The dynamics of the ecosystem are also evident from the wholesale surface soil wash spilled into the valley bottoms where its deposits are responsible for the braiding of most rivers in their lower reaches. These rivers are shallow and extremely unstable and dotted with sandbanks, scrolls and oxbows (e.g. Seiçal River in the suco of Seiçal). The rapid silting up of rivers like the Cuha has been observed particularly since the beginning of the 1950s. This suggests an overworking of the land in the central upland. Therefore, drainage channels of irrigated rice fields in the lower courses of the rivers have to be constantly adjusted to the new water course.

The age-old practice of shifting cultivation for which great areas of forest are required has been chiefly responsible for the destruction of most of the forest that presumably once covered the entire Area. What is left of the forest today is restricted to the crests of a few mountains in the central uplands, as well as to swamps and patches around springs. Their survival has to be attributed to no small degree to their lulik character (except for swamps). Gradual encroachment upon these forest remnants threatens, however, even these lulik forests - for instance, at Mt Mundo Perdido and Mt Builó. Unless this process can be halted now these forests will soon have completely disappeared. What this means for the population in our Area which is wholly dependent upon agriculture for subsistence is obvious. The removal of the forests at the watersheds will materially accelerate the erosion process and thereby deprive the local population of

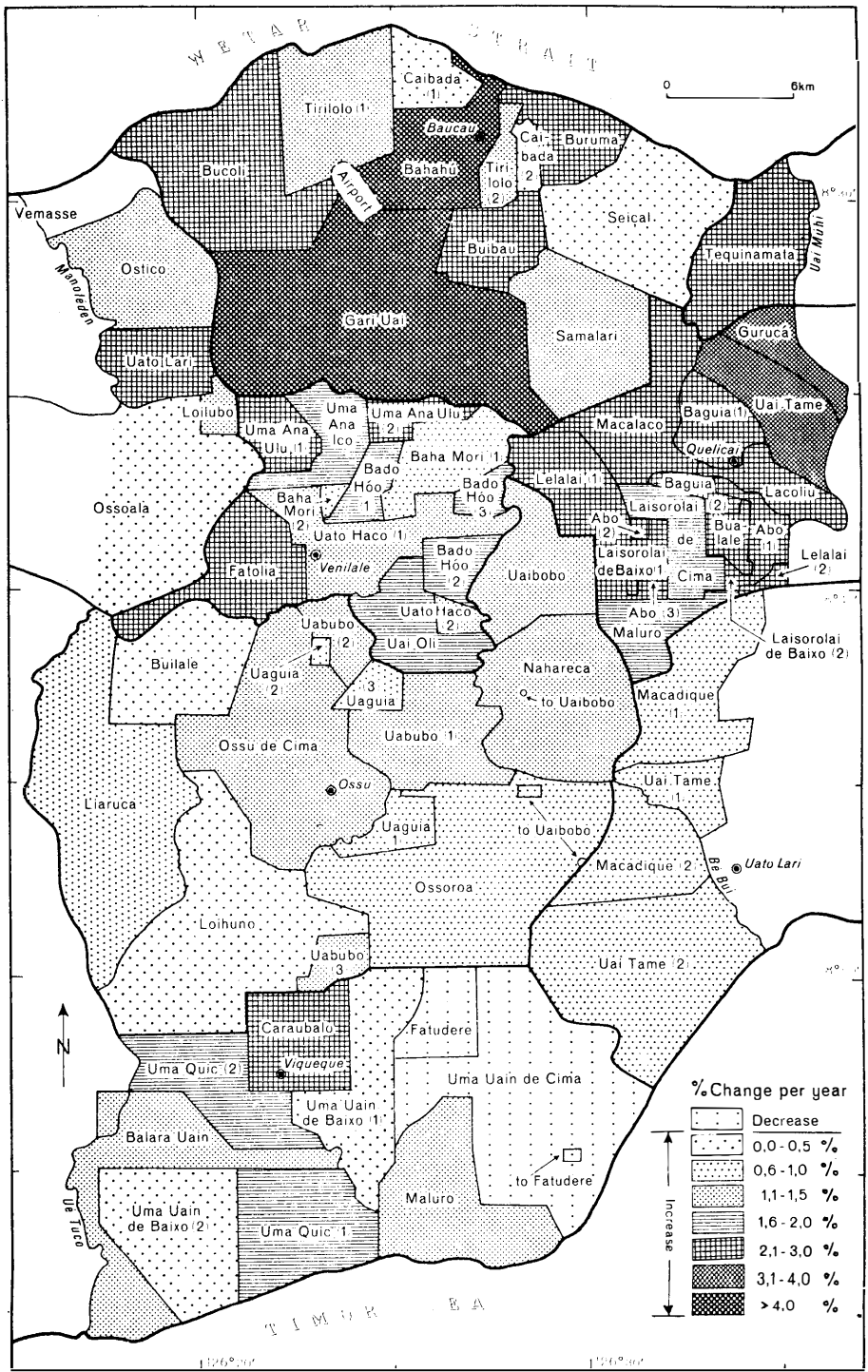


Fig. 34 Population changes, 1959-60 to 1969-70

the little remaining land that is of agricultural value.

Deforestation is not only the result of excessive to'os cultivation, but also of tree cutting for house and fence construction. It is clear that with land becoming scarcer more attention is paid to fencing in order to keep livestock out. Wood requirements for fences are enormous.[19] Moreover, wood serves the Timorese as fuel in the house, as well as for salt and lime making.

Deforestation is also precipitated by bush fires laid annually for hunting purposes (e.g. around Viqueque). Moreover, fires are commonly set on savannas and grasslands to destroy ungrazed grass stems which are unpalatable because of their coarse and dry fibre material. As a result of fires, new grass shoots sprout, and these have a higher fodder value. In the Southern Littoral Plains Zone, where high *Saccharum spontaneum* mixed with *Imperata cylindrica* grass is common, my Timorese travel companions took great pleasure in setting fire to the dry grass.

In our Area, repeated burning led to the destruction of the old vegetation cover and has given rise to the establishment of fire resistant species.[20] Except for the evergreen tropical montane cloud forest, parts of the medium altitude moist evergreen forest and the edaphic formations like the swamp forest and mangrove, all other forms of vegetation are severely affected by human activities. Owing to fires, the unprotected soil is exposed to wind and rain. Since these burnings occur usually during the height of the dry season, when wind velocity is highest, wind erosion takes place, as is evidenced by the large amount of dust filling the air at this time of the year. At the beginning of the rainy season heavy rains hit the ground and carry away what little soil there is.

The Portuguese administration has attempted to curb the forest burnings and cutting practices of the Timorese since 1912, when the population was required by law to report all

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[19] Cf. Leendertz (cited by Ormeling 1955:208), who estimates the wood requirement for a fence about 10 m long at about 1 cubic metre.

[20] According to the FAO report (1960:56) the rate of degradation from forest to scanty open grasslands also seems to have been accelerated in Indonesian Timor in the recent past.

burnings and cuttings of trees to the Administrator.[21] Once authorization was granted the Timorese had to pay a lump sum.[22] However, most of the population was ignorant of this law. Because of the vital necessity of eking out a living, they remained aloof from this and other regulations and continued cutting and burning.

Similarly, the Administration obviously hoped to remedy the deteriorating situation with two other laws in 1946[23] and 1966,[24] which however also remained quite ineffective. In this context, another abortive attempt by the government to detect offenders against this law in flagranti was requiring the pilots of Timor's airline (Transportes Aéreos de Timor) to report all fires to the Administration. The ineffectiveness of these attempts to enforce legal measures could, of course, have been foreseen. The Administration was betraying a profound lack of understanding of ecological relationships. The failure to enforce such a law, which simply prohibited the age-old practice of burning so vital for to'os cultivation, hunting, and preparation of grazing grounds, was not surprising. Even less surprising was the failure on the part of the Administrator to provide alternative agricultural methods which would have enabled the population to meet the increased demand for food.

The erosion problem is not only caused by to'os cultivation, but also by livestock keeping. Because of excessive grazing (e.g. at Larigutu) the grass cover is cut by a maze of small footpaths formed by animal hoofs which have given rise to small irregular terraces highly susceptible to erosion (Plate 48). Small livestock (goats and sheep) in particular, which are predominantly kept in the dry northern part of the Area, inflict heavy damage on the growth of trees. This is demonstrated for instance in the lower parts of the escarpment of the Baucau Plateau.

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[21] Regulamento para a Administração Florestal da Provincia de Timor decreed by Portaria 56, 16 May 1912. (Source: B.O.T. 34, 20 Aug. 1949, pp.284-5.)

[22] E.g. 1949, when the tariff was increased, a person desirous of cutting palm leaves for 15 days was required to pay 3 patacas (= Portuguese Timor's currency till 1960. 16 patacas equalled 100$00 of Portuguese Timor's currency after 1960).

[23] Portaria 1172, 27 Mar. 1946.

[24] Diploma Legislativo 716, 7 May 1966 (in B.O.T. 18, 7 May 1966, pp. 629-30).

Table 38 shows the Area's livestock population expressed in standard head of livestock (SHL) per posto. Since the Area's surface is 178,340 hectares and assuming that the entire Area was usable for livestock grazing (a rather unrealistic assumption), there would have been 2.6 hectares per animal unit which equals 0.36 SHL per hectare. Actual stocking densities (on the basis of the grazing grounds only) may be 5 to 10 times higher. The Area's livestock population is thus far in excess of carrying capacity, which is estimated by FAO experts as between 5 and 10 hectares per 'animal unit', which roughly corresponds to our standard head of livestock (FAO 1960:164).

Table 38 , moreover, reveals that livestock numbers (expressed in SHL) still increased by 13 per cent during the ten-year period 1959-60 to 1969-70, from 68,130 to 77,058, which is 1.2 per cent per year. This increase was realized in all but two postos (only Vemasse and Venilale showed net losses). Over this period the increase in livestock population was accompanied by a similar increase in the number of taxpayers (11.3 per cent) which meant that the number of animal units per taxpayer remained roughly the same for the whole of the Area, although strong regional contrasts occurred if we go by sucos. As illustrated on Fig. 35, sucos of Baucau-Sede (except for Seiçal), Quelicai (except for Baguia), Venilale (except for Fatolia) and the lowland sucos of Viqueque show values of SHL/taxpayer that are below the Area's average of 3.64. Far above average range most sucos of Ossu, topped by Uaguia, Liaruca, Loihuno, and Ossu de Cima, where there are comparatively extensive ranges for livestock grazing. Lowland sucos and densely populated sucos, in contrast, show lower values.

The carrying capacities of the land have been locally exceeded as will be shown in the next section. This is also clearly evidenced by the high degree of migration from Quelicai. In the absence of reliable statistics on migrations[25] I had to depend on oral information provided by the administrator of Quelicai and Chinese recruiters from Dili. Apparently, before World War II, Quelicai people had already made socio contracts as quasi-tenants with rice field owners in Baucau (particularly in the suco of Seiçal) and Venilale. They have been highly welcomed by the population of the latter regions for their great skill in rice cultivation.

[25] These are all seasonal. Thus people used to return to their own suco where they remain registered.

Table 38

Livestock density (SHL) per taxpayer, 1959-60 to 1969-70

	1959-60			1969-70		
	SHL*	Taxpayers	SHL per taxpayer	SHL*	Taxpayers	SHL per taxpayer
Baucau-Sede	10,203	3,980	2.56	11,020	4,340	2.53
Vemasse (4 sucos)	5,556	972	5.71	4,619	929	4.97
Venilale	8,522	2,503	3.40	7,538	2,734	2.75
Tequinamata	747	181	4.12	1,339	203	6.60
Uato Lari (2 sucos)	2,828	1,312	2.15	6,528	1,486	4.39
Ossu	21,320	4,131	5.16	25,213	4,410	5.71
Viqueque (7 sucos)	9,209	2,039	4.51	10,256	2,367	4.33
Quelicai (11 sucos)	9,745	3,845	2.53	10,545	4,652	2.26
Total	68,130	18,963	3.59**	77,058	21,121	3.64**

* For the calculation of the SHL the livestock figures obtained at the annual tax census have been corrected with the following multiplication factors: horses, goats, pigs and cattle 1.2; buffaloes 1.3 and sheep 1.02 (see Table 22). These corrected figures were then multiplied: buffaloes, horses, cattle = 1 SHL; pigs = 0.20 SHL; goats and sheep = 0.10 SHL (see Table 23).

** Average figures.

Since 1965 when the Uato Lari Plain was rendered cultivable for rice, Quelicai people have been invited to join in as socio partners. They were granted especially favourable socio conditions. Throughout the Area, Quelicai people are considered to be relatively more industrious and willing to accept remunerated work. Because they have a good reputation as labourers Chinese contractors have come from Dili to Quelicai in search of manpower. In 1970 over 1000 were said to have accepted work in the capital.[26] In view of the reluctance of the Timorese to accept any type of work, paid or unpaid, away from their homes, the high degree of seasonal migration reflects the hard conditions in Quelicai.

The nutritional conditions of the population are no less indicative of the deteriorating environment.[27] Unfortunately, we cannot draw upon any recent nutritional studies. The only survey carried out in Timor was between November 1955 and March 1956 (Azevedo *et al.* 1958a, 1958b). Although based on only eight families, of which one came from Baucau, it supports what I was told by a local medical doctor.[28] According to this survey the Timorese diet is characterized by deficiencies in caloric intake,[29] proteins of animal origin, fats, calcium, iron, and vitamins (except for niacin), and an excess of carbohydrates (from maize and tubers). The Timorese's food pattern is largely vegetarian. An average of only 3 g of meat per person a day was calculated on the basis of the officially declared slaughter of livestock. Hardly any fish is consumed because of a general lack of interest in fishing on the part of the Timorese. Only the coastal population in the north collects some seafood on the reefs at low tide.

Timorese have adapted themselves to the unsatisfactory nutritional conditions by adjusting their work schedule at a lower level of physical stress. The poor physical resistance

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[26] Quelicai people were the only ones of our Area to accept remunerated work in Dili.

[27] For a general survey on nutritional habits in Portuguese Timor see Silvestre (1953).

[28] Pers. comm. Dr Liladar Amarchanda, physician in Baucau. For comparison see nutrition survey of Western Timor cited in Ormeling 1955:210-11.

[29] In the Baucau family the caloric intake was 2276 cal. per person per day and as such was below the minimum of 2600 calories assumed for Timorese for light to moderate work (FAO 1957).

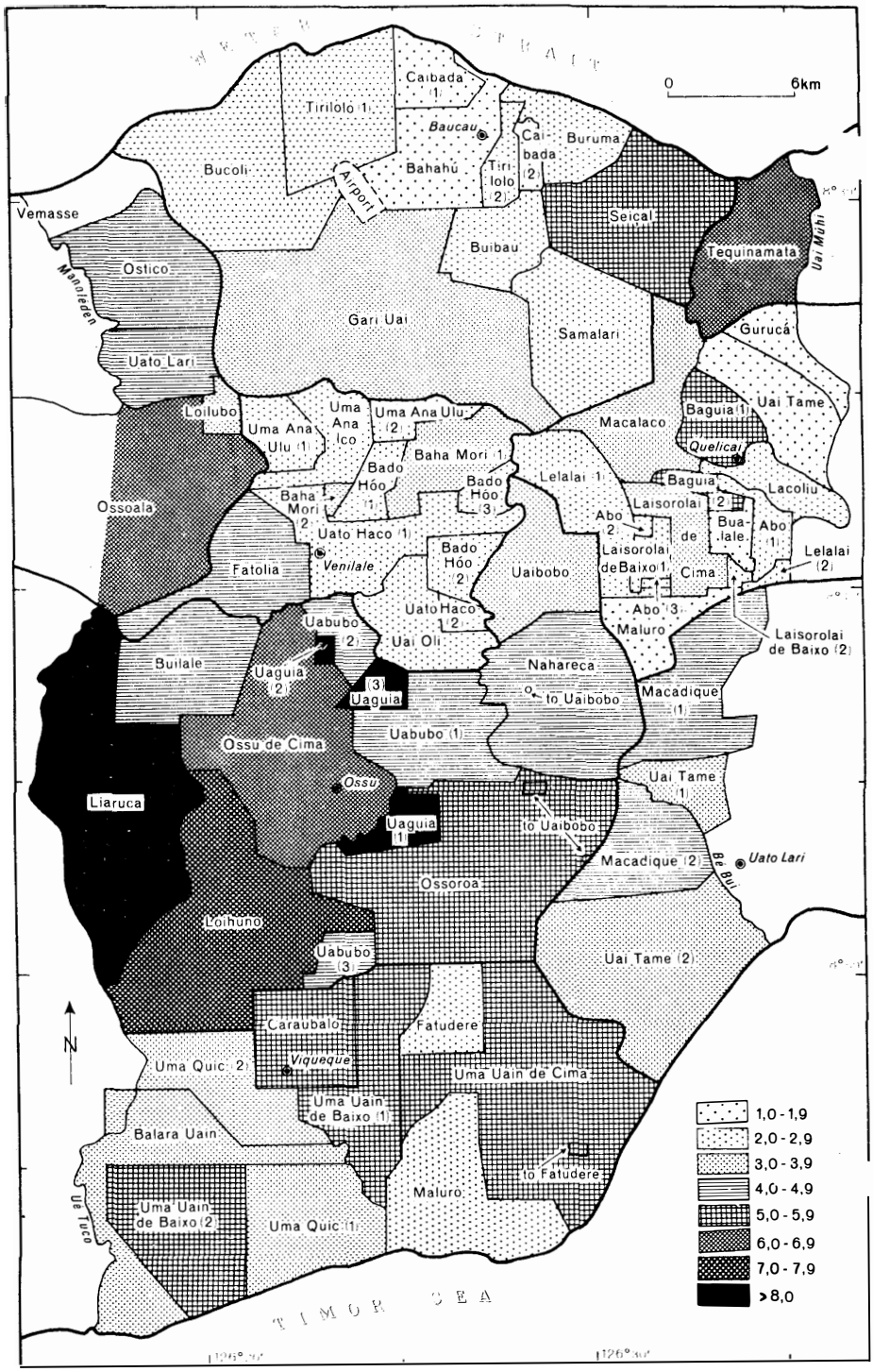


Fig. 35 Standard head of livestock per taxpayer, 1969

of the Timorese lamented by administrators throughout our Area is thus an expression of these conditions. Still, food shortages are common, particularly at the end of the rainy season before new crops are harvested and when old stocks have been exhausted. Then the Timorese materially reduce their diet to a handful of maize. Betel is then frequently taken as a substitute 'to kill the hunger'.[30] In such a deteriorating environment it can be expected that with a population increasing particularly in the mountainous districts, the present undernourishment of the population will worsen. To what extent the present system of land use leaves any margin for supporting a larger population, or for increasing per capita production, will be discussed in the next section.

Carrying capacity and density of occupation index

I want now to attempt a substantiation of the remarks made in the last section. For planning purposes a thorough quantitative analysis of the adequacy of suco territories seems to be mandatory. Such an analysis will allow us to gain a better understanding of the actual pressure of population upon the land. It will also allow us to obtain an idea as to when the potential of the Area will be exhausted assuming no technological change.

By virtue of an analysis of the development under existing conditions the regional planner can orient himself on the possible development in the entire Area (not only sucos where the population/land imbalance is obvious) under the assumption that present agricultural usage remains unchanged. Such an analysis is a suitable instrument for recognizing thresholds where intensification of land utilization, needs for technological change or emigration might commence.

The maximum number of persons capable of living on a piece of land without setting in motion a process leading to land degradation has been termed 'carrying capacity'. For any given region the estimated land carrying capacity is, of course, not an absolute but rather a relative indication of a particular system of land usage. For this, the present types of land utilization to be found in the Area form the basis for our calculation. To calculate the carrying capacity (cf. Löffler 1960a, 1960b) formulae have been produced by

[30] An increasing food shortage is also reported for Indonesian Timor by the FAO report (1960:159).

Allan (1949), Conklin (1961), Carneiro (1960) as well as by Brookfield and Brown (1967).

I prefer to base my calculation essentially on Allan's method. Notwithstanding some difficulties in the estimation of certain components, it was comparatively easy to obtain the data in the field required for this method. Under condition of bush fallowing the land requirement per person for a given region can be calculated if we know the land under cultivation per person (L) in hectares and the cultivation cycle. The latter can be determined by the so-called cultivation factor (C), which is expressed as follows:

$$C = \frac{\text{cultivation period + fallow period}}{\text{cultivation period}}$$

Moreover, since not all land is cultivable for crops, the land requirement per person can be expressed meaningfully only in terms of cultivable area (P) (expressed as a percentage of total area).

By using these three variables L, C and P, the land requirement per individual (X) is:

$$X = \frac{100 \cdot CL}{P} \text{ in hectares}$$

The carrying capacity of a given area[31] will then be obtained by dividing the total area (A) of a particular type of land by the land requirement per individual (X).

$$Y = \frac{A}{X}$$

[31] In my calculation of the carrying capacity, livestock will be disregarded as there was no information on the actual extent of grazing grounds nor on the land requirement per standard head of livestock (SHL). I do not underrate the importance of livestock as a significant factor causing land shortage. As indicated above, livestock density in the Area is one of the highest in Portuguese Timor (in the concelhos of Baucau and Viqueque: 28 SHL/km^2). Moreover, 1 and 0.4 SHL per person was counted in Viqueque and Baucau (cf. Table 23) respectively. If we assume that 1-2 ha of land are needed per SHL (RPSV, Rel. An., 1968:14) we arrive at an additional land requirement of 77,058-144,116 ha (i.e. 77-144 sq km) (see Table 38). The inclusion of livestock in our calculation would therefore substantially aggravate the situation.

The critical population density (expressed in the number of inhabitants per sq km (Z) is then:

$$Z = \frac{Y}{A}$$

Finally, the quotient of the actual population of a given area divided by the carrying capacity yields the so-called density of occupation index[32] which provides a means of classifying and assessing the urgency of land problems. Although the formulation of the carrying capacity is simple, the estimation of the three components is not and in certain cases presents insuperable difficulties.

Starting with L, the amount of land cultivated per head: this factor has been estimated by intensive field sampling[33] which largely consisted of measuring the fields under cultivation of selected families in the Area's major ecological zones. These families were selected on the basis of some knowledge of the family relationships. Families who received substantial support from their relatives without giving an equivalent amount in return have been omitted. This often indicates that they are not able to maintain themselves from the produce of their own to'os or natar. This, however, is not normally done in Timor. The amount of food given by a family to visiting relatives is here assumed to be equal to what the family receives when visiting others.

The cultivated gardens of a total of 63 families were measured. Owing to the highly varied ecological zones characterized by great differences in climate (rainfall and temperature), soils and relief, substantial differences in land utilization occur within our Area. It is thus no easy task to determine L for all of the various landforms. It is all the more difficult since two or three forms (like lere rai, fila rai, and natar cultivation) may be practised by a single family. Cases where one form of land utilization is practised exclusively by one family are rare. Moreover, since soils, topography, and climate tend to modify L for a given land use type, an immense number of values for L is

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[32] A term introduced by Brookfield and Brown (1967). Allan uses the term 'Population Land Factor' (cf. Allan 1949:119).

[33] Not only were these fields difficult to measure owing to topography and irregular shape, but they were also mostly kilometres apart.

possible. For the purpose of this study, however, we have made certain assumptions as indicated below. Thereby, we obtained a clearer idea of the broad regional differences in L.

In order to gain a first insight into the land under actual cultivation per person, I started in Viqueque, where, with the exception of two rice fields (Bé Laco and Hare Bé Oan), nothing but to'os cultivation is practised. For this bimodal rainfall zone with consequently two to'os crops per year we estimated an average area of 0.12 hectare per person on CR, CMC and Plc-soils. Differences in acreage for fila rai and lere rai fields were only slight and could be disregarded.

In the monomodal rainfall zones, where only a single to'os crop is feasible on fertile calcareous soil (CMC and PF), the average area cultivated per individual is higher than in the south and amounts to 0.20 hectare. On the Baucau Plateau (VR soil), particularly in its northern portion where limestone outcrops reduce the area to be cultivated, the average to'os size under cultivation increases to 0.25 hectare, while it is 0.30 hectare on poor heavy clay soils (CN).

As the sample survey has shown, these average acreages are on the whole also given when natar cultivation is practised in conjunction with to'os cultivation. We calculated 0.20 hectare of paddy fields which were located in floodplains and on calcareous soils, while 0.30 hectares were assumed on paddy fields with heavy clay soils. This might be surprising as natar cultivation usually requires more labour than to'os cultivation.

The data on the cultivation cycle - and thus for the cultivation factor (C) - were obtained by accounts provided by local informants, verified and checked against the state of the land, particularly by the fallow vegetation. The amount of information thus collected allowed me to obtain a fairly good idea of actual cultivation cycles. Because of the small scale of the map I had to disregard cultivation practices occurring only on very small parts of a particular ecological zone. Thus, for instance, more intensive fila rai practices on small valley floors in the Southern Foothill Zone had to be disregarded.

Instead of applying certain cultivation factors obtained at particular sample sites to remote places (as was the technique chosen by Allan), I established cultivation factors for each environmental zone, thus arriving at cultivation factors in line with actual agricultural practices. It was, however, not possible to ascertain - except for extreme cases of obvious land degradation - whether these cultivation factors were actually still acceptable, particularly with respect to the long-term effect on the soils.

Finally, there was the problem of determining the cultivable percentage (P) of a given environmental zone. This was by far the most difficult and certainly also the most doubtful element of the calculation. As Allan (1949:10) points out, a practical limit to the cultivable percentage of land is set by physical and psychological factors, i.e. by material resources of the people and the amount of energy which they are willing to invest. As a consequence, marginal land which would only be cultivable under intense liming, manuring, as well as by application of grass leys, and sophisticated irrigation and drainage measures, would not be considered as cultivable in a society like that of the Timorese.

The cultivable percentage in our Area has to be assessed in terms of the actual Timorese system of agricultural usage for a particular environment. Basically, slope gradient and rock outcrop have been taken into account. Thus, unstable clay soils with slopes of over 8° and calcareous and other soils having slopes of over 22° were left out. Likewise, ill-drained or waterlogged areas like mangroves and swamps which the Timorese are usually not capable of working or draining, as well as roads, burial grounds, and lulik groves (e.g. the tropical montane cloud forest of Mt Mundo Perdido) were eliminated. Finally, areas either completely stripped of their topsoil or having shallow soils (e.g. Barique Formation of Mt Ossoala, Mt Ossoaque, Ai Bubur Laran (Fatolia) as well as forests growing on rocky limestone outcrops (e.g. Bé Ro forest near Bé Aço, forest of Mt Foho Manu near Narequici Plain, and Hai Bai forest near Fatoliana) were considered uncultivable. Another problem was presented by land under permanent tree crops, as under coconuts in Viqueque. No more food crops are produced on such land, so I have also eliminated this from the estimation of the cultivable percentage. In assessing the cultivable percentage, aerial photographs proved to be

Table 39

Example of computation of density of occupation index for suco Uato Lari (posto Vemasse)*

E.Z.	Area (ha)	To'os cultivation										Natar cultivation					
		Av. no. years under cult. (A)	Av. no. years under fallow (B)	Cult. factor C = A+B / A	Mean area under cult. per head (L) (ha)	Hectarage according to slope classes 0-3°	3-8°	8-14°	14-22°	Cultiv. % (P)	Land required per person 100 x CxL / P = X (ha)	Population carrying capacity for to'os Y = A / X	Area under natar (ha)	Mean area of natar per person (ha)	Population carrying capacity for natar	Total carrying capacity (Col.10+13)	Population 1969-70	Density of occupation index
4	250	3	3	2	0.25	250	-	-	-	80	0.625	400	25	0.20	125	525		
5	300	3	6	3	0.20	-	300	-	-	80	0.750	400	30	0.20	150	550		
6	975	2	22	12	0.30	-	475	450	50	20	18.000	54	300	0.30	1000	1054		
7	200	-	-	-	-	-	-	-	-	-	-	-	40	0.30	133	133		
Total	1725	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2262	816	0.36

* See Plate 49.

Note: Uai Hare Boi village with 174 persons (1969/70) is located outside the study area, but has been included in the computation of the density of occupation index.

an extremely valuable auxiliary to ground observation.[34]

Given a sufficient knowledge of the three factors C, P and L the estimation of the land carrying capacity is a matter of simple arithmetic, as shown in the example of the suco of Uato Lari (Vemasse). Table 39 summarizes the data obtained from our survey for this suco. Column 1 lists the environmental zones found within the suco (E.Z. 4, 5, 6 and 7) and their respective areas (in hectares) calculated planemetrically (column 2). From the potential to'os land those areas that are currently used for natar cultivation have been singled out from the beginning. This has been considered in the computation of the cultivable percentage (P) (column 8). The total carrying capacity of to'os (column 10) and natar cultivation[35] (column 13) is calculated at 2262 persons. Actual population of Uato Lari suco in 1969-70 of 816 persons divided by the carrying capacity yields the density of occupation index of 0.36 (column 16). Given the present type of land usage, this index shows to what extent the suco has approached its maximum carrying capacity. The latter is attained at an index value of 1.0. Index values in excess of 1.0 indicate that the land carries more people than it can support under the given system of land usage, thus these values indicate congestion.[36]

As seen in Fig. 36 the density of occupation index calculated for all 50 sucos of our Area ranges widely from 0.08 (Maluro, Viqueque) to 5.0 (Uaguia 2). Particularly striking is the concentration of sucos that have exceeded their population carrying capacities in the central upland. These sucos have been grouped according to their index value

[34] The fact that these airphotos were taken in 1962 did not really matter as land utilization had changed little since.

[35] The fairly realistic assumption is made that the total area of riceland is constant and cannot be enlarged owing to a shortage of water under given irrigation techniques. Differences in rice yields could not be considered because of a shortage of reliable statistics.

[36] However, a reservation has to be made: since the statistics used for the computation of the index are based on the place of registration of the suco members, rather than on the actual residence, the index does not allow for migrants - e.g. Quelicai people in Dili - as these return to their sucos for the annual arrolamento. Thus the index values above 1.0 are presumably slightly exaggerated, which does not, however, materially affect the general statement of the analysis.

in Table 40:

Table 40

Sucos with density of occupation index above 1.0

Index value 1.0 - 1.19	Index value 1.20 - 1.49	Index value 1.50 - 1.99	Index value over 2.0
Uai Tame (Quelicai)	Builale	Laisorolai de Baixo (2)	Guruça
Uai Oli (Venilale)	Ossu de Cima		Bualale
	Macadique		Uato Haco (2)
	Maluro (Quelicai)		Uabobo (1)
	Fatolia		Uaguia (2)
			Uaguia (3)

North and south of these highly congested upland sucos the density of occupation steadily decreases and reaches its lowest values (under 0.20) along the southern littoral in the sucos of Uai Tame (Uato Lari), Uma Uain de Cima, Maluro (Viqueque), Uma Quic (1) and Uma Uain de Baixo (2).

The differential pressure on the land in the Area has to be attributed chiefly to differences in climate. Climatic conditions in the central upland have been conducive to an agglomeration of the population, while the hotter lowland climate, particularly that of the south coast, has always been less attractive except for the cultivation of wet rice in the fertile flood plains. Thus, the single rain areas (November-April) of the central and northern section of our Area where only one crop per year is grown, have been given preference by the population in contrast to the southern areas where fertile soils and a more evenly distributed rainfall regime allow for higher land carrying capacities. However, the uneven population pressure upon the land is also due to the lack of natural water supplies which prevents the exploitation of an area to the full extent of its carrying capacity. An example for this is given by several sucos located around and on the Baucau Plateau, such as Gari Uai, Ostico, Uato Lari, and Bucoli. Although they exhibit low densities of occupation, their respective populations are concentrated in the Escarpment Zone around the plateau, where water seepages enable them to make a living. On the

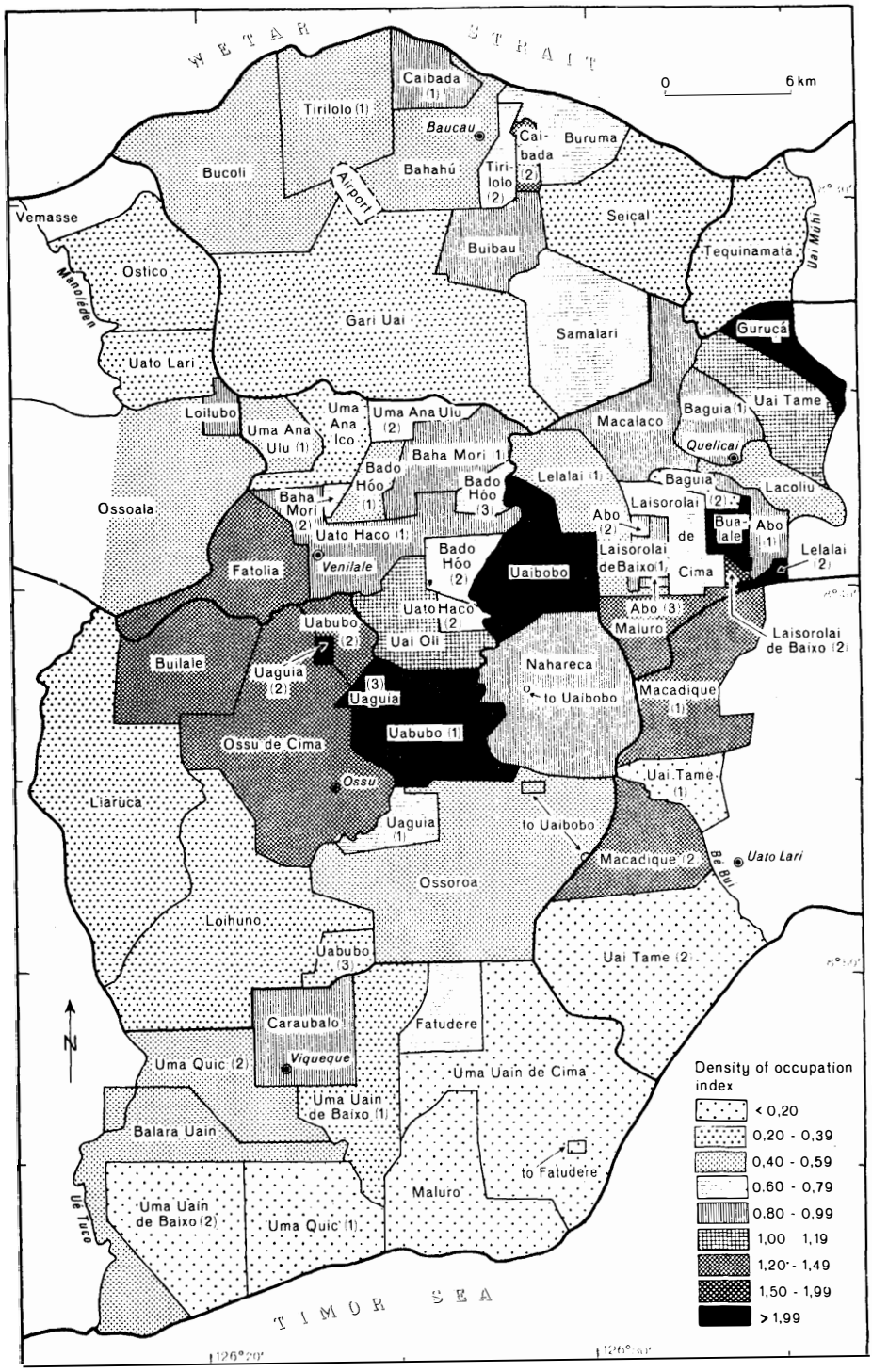


Fig. 36 Density of occupation index

other hand, the plateau, however fertile it may be, is hardly inhabited,[37] and dryland farming is practised along the rim of the plateau not too far apart from the abodes of the peasants in the escarpment. An exception to this rule are paddy fields which are found on the plateau along ephemeral water courses (e.g. Uai Behe Ana, Uai Reça, Uai Lacama).

Open land is not used to its full natural potential, i.e. calculated carrying capacity, because of barriers to free movement of the population, like tribal and kinship ties and suco boundaries. Also the tendency of the peasants to overwork the agriculturally more suitable soils to such an extent that yields have dropped to the production level of the low yielding soils has had similar results.

The results of this analysis, summarized in Fig. 36, are consistent with our observation in the field. In sucos with high index values (above 1.0) either land degradation (e.g. Uaibobo, Uabubo, Osso de Cima, Maluro in Quelicai) or seasonal migration (from Quelicai) is typical. In these congested sucos of the central upland, hunger for land is severest. These are therefore the areas on which planning measures have to be focused. The alternatives are either to transfer part of the population from the congested highland sucos of Quelicai and Ossu to less populated places in the south or outside the Area, or to intensify agricultural production. The analysis in this section has provided some guidelines along which we may proceed in the following chapter on aspects of regional planning.

[37] Except for Tirilolo (1) in the north of the plateau and some wet rice fields in Lequi Leuato (around Aubaca).

Chapter 5

ASPECTS OF REGIONAL PLANNING IN THE BAUCAU-VIQUEQUE AREA

Objectives, strategies and problems of regional planning

The preceding analysis of the Area's ecosystem has thrown light on the disrupted relationship between man and his environment which calls for ameliorative action. Since the problems of the Area are closely interrelated, all regional planning ought to be comprehensive, that is, seen from various disciplines and based on a thorough understanding of the Area's geo-ecology. Viewed from such an angle, it follows that the principal objective of land use planning in the Area should be the restoration of the equilibrium between population and land. This may be attained by pursuing the following three subordinate objectives:

land conservation;
improvement of subsistence agriculture;
economic production.

The discussion of the measures to be taken for achieving these three objectives will be oriented towards the nature of the problems to be solved. Consequently in this chapter we will first deal with the dimension, impact and potential solution of those problems which concern the Area as a whole, while additional problems specific only to certain regions of the Area will be dealt with in the next section.

Land conservation. The phenomena of deforestation, soil deterioration and erosion have already been discussed in Chapter 4. The native agricultural systems have generally been admirably adapted to the environment, as we have seen. However, surprisingly enough, very little has been done by the Area's population to prevent land degradation.

In my view the achievement of the aforementioned three objectives is clearly linked in one way or another with the solution of the erosion problem. Prompt anti-erosion measures

are therefore an absolute necessity. This implies the protection of headwaters, reafforestation and the creation of forest reserves. The planting of the leguminous shrub *Leucaena leucocephala* should be given priority.[1] Meijer Drees (1951) has provided a list of trees and shrubs that, in his opinion, lend themselves to reafforestation for ten ecological environments in Timor. For each ecological site he indicates the species suitable for timber and firewood production, afforestation, soil protection, protective strips against fire and livestock. He also mentions the species that lend themselves for artificial shelter to create favourable conditions for natural afforestation or for shade requiring timber species (Meijer Drees 1951:18, 24-31). However theoretically feasible such a reforestation campaign may be,[2] serious difficulties in the planting and maintenance of nurseries are likely to arise because of the unwillingness of the Timorese to take up regular employment.[3] Patient efforts in education, aimed at bringing about a greater appreciation of the environment on the part of the population, would certainly be helpful. Nevertheless, such a process would be a slow one and insufficient in the short run in view of the alarming wholesale land degradation. In such a situation I believe the only appropriate way to combat soil erosion effectively is to coerce.[4]

It seems, however, a rather short-sighted policy simply to prohibit the cutting of trees by law if, first, there is no chance actually to enforce such a law owing to a shortage of personnel. Secondly, the local population, in sheer despair because of the need to obtain enough food for subsistence, sees no alternative to encroaching upon the land that has hitherto been lulik. The objective of land conservation will therefore not be achieved unless the present system of bush fallowing can be replaced by a more sedentary form of agriculture. In addition, the land would have to be

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[1] Very encouraging results have been obtained with this legume in the reafforestation program of the nearby province of East Nusatenggara, specifically in West Timor and Flores.

[2] Silvicultural problems in dry monsoon areas are discussed by Meijer Drees (1953).

[3] See also Ormeling 1955:241.

[4] Ormeling (1955:241) made similar suggestions for West Timor. The village forester (makleat) (see Fn 37, p.139) might assume a pivotal role in the reafforestation campaign.

earmarked according to the use for which it shows greatest potential. Ideas of land use zoning were repeatedly advanced by Ormeling (1955:242), FAO (1960:164), H. Lains e Silva (1956:108), and RPSV (Rel. An. 1968:12). For a capability map I would suggest that certain areas be segregated from the rest on the basis of slopes and soil types:

1) Ridges at present under forest as well as watersheds should be protected and earmarked for forest reserves;

2) Heavy clay soils (CN) in excess of 3° slope gradient as well as all other land in excess of 22° slope should be earmarked for reafforestation;

3) Heavy clay soil (CN) above 300 m and having a slope gradient not exceeding 3°, as well as all other soils between 14°and 22° slope gradient should be reserved for livestock grazing;

4) Terraced paddy fields should only be allowed on slopes not exceeding 14° gradient;

5) To'os cultivation on all soils other than heavy clay soils (CN) should be restricted to slopes having a maximum gradient of 14°. All to'os on land between 10° and 14° slope gradient should be terraced with stone walls;

6) Wherever possible tree crops should be propagated.

If such land use zoning could be effectively enforced in the Area, the area of land earmarked for farming purposes would be substantially reduced, compared to what is now under cultivation. What the population used to harvest on a much larger area in addition to what is needed to fill the nutritional deficit would thus have to be produced on this remaining portion of land. Subsistence farming would therefore have to be considerably intensified. This brings us to the second objective.

Improvement of subsistence agriculture. The intensification of agriculture is linked with a planned changeover to more permanent types of agriculture. From repeated indications in the preceeding account of the various forms of agricultural activity in the Area we have seen that agricultural practice is undergoing a process of slow change from extensive (e.g. Southern Foothill Zone) to intensive agriculture (e.g. crop rotation on the Baucau Plateau and permanent to'os cultivation on terraced fields in Quelicai). These forms have developed

without European assistance or intervention. Still, this process of adaptation to the local environment under population pressure does not seem to keep pace with the rate of population increase. Here help from outside is urgently needed. To introduce sophisticated techniques completely alien to the people's work and scale of life must not be attempted. What is suggested are those possibilities which offer themselves out of a study of the existing agricultural systems and which require little or hardly any importation of alien methods.

As a prerequisite for permanent to'os cultivation Timorese would have to be taught how to maintain (or even to increase) soil fertility more adequately. The restoration of soil fertility is, however, not completely unknown in the Area. We recall, for instance, that twigs and branches of casuarina and other trees are burned on wet rice fields in the escarpment zones of the Baucau Plateau. This is usually done after the rice has been harvested and the field is prepared for the planting for irrigated maize, sweet potatoes and onions.

For the restoration of soil fertility the planting of leguminous plants should be encouraged. Particularly suited to the Timor environment seems to be the leguminous shrub *Leucaena leucocephala* (ai tahan lotuc or ai café, which, preferably, should be planted in rows along contour lines on the fields. Thereby erosion would be reduced as soil washed downhill would tend to accumulate behind these hedges (so-called 'indirect terracing'). These hedges would have to be cut regularly lest the entire field be invaded by this shrub. The leaves could be used as mulch preferably near the hedge so that the soil could accumulate. Leaves would also serve as an excellent green fodder for cattle, buffaloes and pigs. Because of its high mimosine content it may however cause loss of hair to horses. The leaves may also be dried and used as hay or processed into pellets[5] to be used as fodder during the dry season. Where land is not in short supply *Leucaena* seed might be broadcast on abandoned fields so that entire slopes could be covered with this shrub as in parts of Viqueque and particularly in Amarassi in west Timor.[6]

Alternatively, the restoration or maintenance of soil fertility could be effected by the planting of leguminous

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[5] As is done in the Philippines (see Why Not Leucaena? 1972, p.23.)

[6] For a full discussion of the utilization of this legume in Sikka Flores, thus in an environment in many ways similar to that of the study area, see Metzner 1976b.

crops whose beneficial effect - e.g. that of beans which are grown together with maize - on soil fertility is widely recognized by the Timorese. Crop rotation practices with peanuts in one year and maize in the other on the same field, as is customary on the Baucau Plateau, should be encouraged wherever possible.

Attention should also be paid to composting. For this, young green grass seems to be particularly suitable as it is richer in nitrogen and phosphorus than older growth. The higher nitrogen content combined with a more favourable carbon/nitrogen ratio leads to a more rapid decomposition. Consequently, a greater amount of nitrogen becomes available than in the breakdown of older growth. The grass should therefore be cut in December/January and allowed to wilt and rot on the ground under aerobic conditions. These are particularly suitable at this time of the year when sufficient moisture is available. At the end of the rainy season the remains have to be heaped for further breakdown. The production of compost would be improved if fresh wood, ash, or soil on which rubbish and tree-remains had been burned in the dry season had been added to young grass. Thereby, acidity which would otherwise develop in the breakdown process could be checked. Besides young green grass young weeds and suckers and some easily decomposed garden refuse could also be used. Badly needed weeding would therefore have to be encouraged.

Equally effective in restoring soil fertility would be manure from livestock. The free roaming of livestock has hitherto prohibited the collection and utilization of animal manure for agricultural purposes. As a consequence of land use zoning livestock would have to be corralled in fenced-in pastures which would facilitate the retrieval of dung.

Along with the preservation of soil fertility, new seeds of higher yielding strains of batar and other to'os crops, more weeding, disease and rat control, small farm implements like hoes, better storage facilities, etc. would all tend to improve the peasant's lot, at least temporarily. These measures are, however, not likely to bring much relief to the peasant in the long run. Owing to the rather unfavourable climatic, topographic,[7] and soil conditions of the greater

[7]Thus for instance the use of ploughs seems to be limited on unterraced to'os.

part of the Area, the cost of these inputs - in terms of labour and money - will most likely be out of proportion to the expected yields. It appears to me, therefore, that the solution to the problem of the economic efficiency of the Area as a whole does not lie so much in the extension and intensification of to'os cultivation but rather in an improvement of natar cultivation and in a diversification of cash crop production.

As far as natar cultivation - the most intensive type of agriculture in Timor - is concerned, further improvement and intensification is not likely to come from the Timorese. Help has to be provided from outside. Of particular value, in my opinion, seems to be the construction of irrigation facilities, such as small concrete dams and water reservoirs to counterbalance to some degree the irregularities of the rainfall regime. Such irrigation facilities, which the Timorese are not capable of building themselves alone, would be particularly beneficial to wet rice production, as roughly 90 per cent of all wet rice fields in our Area are wholly rain dependent. But even the remaining 10 per cent of the paddy fields, although they can be cultivated for more months during the year than the first group of natar, can hardly be planted throughout the year. Much time and labour is dispensed each year on the repair of irrigation channels (kano and earth dams across rivers to divert water for rice irrigation. Although a water resource engineer (Ramos 1962) visited Timor in 1961 and 1965, no material improvement in terms of the construction of irrigation facilities had taken place until 1971 owing chiefly to financial difficulties. The construction of such facilities would, in fact, be a prerequisite to the successful introduction of new high-yielding rice varieties throughout the Area in so far as they would require transplanting techniques for which water has to be administered in doses independent of the actual rainfall regime.[8] Proper, more permanent irrigation facilities

[8]The present practice of constructing small earth dams half way across the rivers to divert the water to the rice fields for irrigation makes the farmer so highly dependent upon the rainfall regime that he can only start repairing and constructing these dams when the rainy season approaches its end and when no more torrents can be expected. This causes considerable delay in planting. Often, therefore, only short growing, low yielding rice varieties can be used.

would moreover have the advantage that far less seed would be required for transplanting than is customary with kare hare. The peasant would also be somewhat more protected against resowing, which so far has often completely used up his rice reserves (as in November/December 1969 in the Baucau-Venilale region).

Finally the construction of irrigation facilities would be a must if double cropping of rice (at least on the lower riverine terraces of the Seiçal) is envisaged. Trials in this direction were being planned at the Seiçal experiment fields of the MEAU in 1970, but had to be given up because of late financing of the project. Double cropping on wet rice fields[9] would most certainly require the application of fertilizer, green manure or dung. The small indigenous leguminous plant, called dagarassa (*Cassia tora*),,that is widely found on fallowed rice fields helps fix nitrogen in the soil. However, the amounts are insufficient to replace what is taken out of the soil. Trials with other legumes should be started.

The potential increase in rice production by means of new varieties and improved management is enormous. While hectare yields obtained by the Timorese peasant with traditional rice varieties hover around 500 kg and seldom reach 1 ton, experiments by the MEAU at Manatuto experimental station[10] have yielded average results of 5-6 t/ha. These were obtained with varieties like IR-8 and IR-5 (imported from the Philippines) by transplantation, application of fertilizers, weeding, herbicides, pesticides, etc., IR-8 was propagated in several places in the Area in 1970.[11]

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[9] Even on double cropped springfed rice fields along the escarpment zones of the Baucau Plateau a rice crop in the first season is followed only by a crop of maize, sweet potatoes or onions, all demanding considerably less water than rice.

[10] The MEAU-Brigada de Timor has existed since 1962. In the Province it chiefly carries out research aimed at improving coffee and rice cultivation. Since 1967 it has conducted experiments at its Manatuto rice research station aimed at improving local rice varieties and at introducing high quality rice seeds from abroad. Because of a shortage of qualified personnel only the latter objective was pursued in 1969/70.

[11] The only people in the Area who had IR-8 rice planted in 1970 were a few suco chiefs.

As farmers do not materially modify their traditional cultivation practices, yields obtained with this new variety are seldom more than 2-3 t/ha. Thus broadcasting, lack of weeding, pests and diseases as well as wasteful threshing methods tend to keep production levels low. Owing to unsuitable storage facilities rats, mice, and insects (e.g. *Calandra oryzae*) finally inflict heavy damage on the rice yield.

Closely related to the improvement of rice cultivation is the issue of sama natar, the disadvantages of which have already been alluded to in detail.[12] However, there is no justification for advocating the introduction of sophisticated ploughing with small tractors or metal ploughs.[13] They have been tried repeatedly in various parts of Portuguese Timor, including our Area, although with little success.[14]

What seems more suited to the scale of life of the Timorese are small wooden ploughs, similar to those used in neighbouring Java and Bali, drawn by a yoke of trained buffalo or oxen.[15] Since the Timorese are already familiar with buffalo as well as with the processing of wood for tools and house construction, there seems to be a good chance of success for the utilization of buffaloes as draft animals.[16] Far

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[12] Apart from the high labour input the formation of an impermeable layer caused by the hoofs of the animals has to be considered as the major disadvantage of sama natar.

[13] Small tractors were, for instance, favoured by Administrator Luis Ricardo (pers. comm.) and Eng. Agr. Danilo Augusto Bizarro (MEAU chief in Timor 1967) (MEAU, Inf. Int. Téc. 2/67, Dili, 14 Jan. 1967).

[14] Mechanization has to be viewed with great reserve. Repeated failures with heavy European steel ploughs should have taught a lesson. In most cases the terrain (steep slopes and stoniness) prohibits the use of ploughs. Only on deeply weathered soils, e.g. in the southern coastal plain and on valley floors, may mechanization prove fruitful. A few tractor-drawn ploughs owned by the municipalities operate, for instance, in Viqueque and Baucau.

[15] In 1969 16 pairs of trained oxen were distributed by the RPSV, mostly to the municipal councils of various postos throughout Portuguese Timor (RPSV Rel. An. 1969, pp.2 and 22).

[16] For reservations see Meneses (1968) who draws attention to the reluctance of the Timorese to use buffaloes as draft animals. Experience in Western Timor, however, proved the contrary.

fewer buffaloes would be required for the preparation of a rice field. Therefore, the acute shortage of buffaloes at the beginning of the rainy season, which, as a rule, does not allow all wet rice fields to be cultivated at present, may thereby be overcome.

A reduction in the number of buffaloes will also be in line with the recommendations of a livestock expert of the RPSV.[17] He suggests that the number of buffaloes be reduced as far as possible and replaced by Bali cattle. The reasons are the well-known under-utilization of the buffaloes (with the exception of one or two weeks a year for sama natar) and overstocking of Timor's grazing grounds. Land use zoning should fix the carrying capacity for grazing. Less land will become available for substantially less livestock than is held at present in the Area. Carrying capacity of the ranges will nevertheless have to be increased. This will entail the introduction of drought-resistant, more nutritive grasses. So far, nothing has been done in the way of pasture improvement and grassland management. To bridge the long dry season at the end of which the livestock usually offers a poor appearance, it seems useful to conserve enough grass as hay or silage, instead of burning it.[18] Also, maize straw may be used as fodder. The strong seasonal contrasts in Timor make it necessary that livestock management practices be very flexible and adjusted to the climatic pattern. Thus the FAO experts who visited Western Timor rightfully demand that grazing time be controlled and animal numbers be reduced at the end of the growing season of the grass (FAO 1960:168).

Economic production. The suggestion of substituting Bali cattle for buffalo brings us to the third major objective of regional development: economic production (i.e. cash cropping, keeping livestock for sale, and manufacturing of goods for the market). As the techniques in the subsistence sector improve and surplus labour occurs it will be necessary to channel this labour surplus into economic production by providing incentives. One of these incentives may be the

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[17] Pers. comm. Dr Hernâni Rui Baron de Gabriel da Silva, chief of the RPSV till 1969.

[18] Ormeling (1955:242) even suggests controlled rotation-lopping which in our Area, however, because of the already rapid destruction of the remaining forest and the difficult supervision of this technique, is not to be recommended.

wider propagation of Bali cattle.[19] Thereby the RPSV also hopes to help fill the wide gap of animal protein deficiency of the local population.

Assuming the population of Portuguese Timor to be 600,000 and assuming an average 'clean meat' (cf. RPSV Rel. An. 1966, p.155-6) yield of 100 kg per head for cattle and buffalo, 40 kg for pigs and 10 kg each for sheep and goats, the numbers of livestock that would have to be slaughtered each year to provide 30-40 g meat per person per day are as shown in Table 41.

Table 41

Livestock needed for slaughter to provide 30-40 g of meat per person per day

Type of livestock	Number to be slaughtered	Actual livestock population in 1969*
Cattle	20,494	67,039
Buffaloes	46,310	123,900
Pigs	84,243	202,510
Sheep	20,420	41,548
Goats	90,172	201,404

* RPSV, Rel. An. 1969, p.18.

On the other hand, by introducing Bali cattle the RPSV hopes to trigger off a development toward a commercial sense on the part of the local population. The government intends to increase the cattle population of the entire province from 56,000 (1968) (cf. RPSV, Rel. An. 1968, p. 62) to 300,000 as a minimum.[20] This would allow an export of 15,000 head of

[19] There were hardly any cattle registered in our Area in 1970 except a herd of about 1000 head of Bali cattle owned by the Sota coconut plantation at Ra Tahu, Viqueque, which is not considered here.

[20] In 1961 Indonesian Timor already had a cattle population of 337,278 (Information provided by Dinas Kehewanan Daerah Propinsi Nusa Tenggara Timur, Kupang). A sixfold increase of east Timor's cattle population will, however, only be feasible if the carrying capacity of the grazing grounds is increased and the number of buffaloes reduced.

cattle per year (i.e. 5 per cent of the total cattle population). An additional advantage of Bali cattle is its faster reproduction rate, with a gestation period of only nine months compared to 11.5 for buffaloes, as well as the allegedly greater resistance to disease of young Bali cattle.

Another economic linkage may be - and to some extent has already been - created by the introduction of economic crops. In view of a constant erosion hazard due to a dynamic relief and a high rainfall intensity, tree crops should be sown wherever possible. It appears that this has been recognized by the Administration which has made various efforts at making such tree crops popular with the Timorese. While coffee has certainly had the major impact on the people in the western half of Portuguese Timor, there have been no crops of similar importance in the eastern parts of the province. Coffee here has generally failed, for instance at Mundo Perdido, owing to the calcareous fatu soils unsuitable for coffee growing.

In recent years copra production has become the Area's number one cash crop, particularly in the south around Viqueque. However, the pace and enthusiasm at which coconuts are planted has considerably lessened within recent years. In order not to allow copra to become obsolete and thus suffer a fate commensurate with that of most other crops introduced by the Administration since pacification in our Area, increased efforts are now necessary to provide further economic incentive by subsidizing the processing of copra (e.g. in providing more efficient driers in order to improve the copra quality) and transport to secure higher prices for the peasants.

On the other hand, however beneficial the planting of copra may have been in helping to bring about a modest market orientation, the indiscriminate planting of coconut on mostly flat alluvial land has locally already led to a serious land shortage (e.g. in Caraubalo) as a result of which people are forced to make their to'os elsewhere (e.g. in Luca). A possible solution to this obviously unforeseen dilemma between subsistence farming and cash cropping may be intercropping of coconut palms with other food crops, like maize, dryland rice, mangoes, cocoa, pineapple, citrus, vegetables, caju, sisal, cassava, and peanuts (the latter are only planted with immature palms), as well as intergrazing with livestock (sheep, goats, buffaloes or Bali cattle).

To be sure, the Timorese are not completely unfamiliar with this type of mixed cropping as they commonly interplant food crops like dryland rice, maize, taro, cassava, beans, gourds, etc. on immature coconut holdings for up to seven years till the coconuts come into production. After that, however, such cropping is deemed impracticable because of too much shade which adversely affects the growth of low-standing vegetables. Intercropping on mature coconut stands (plantação) is, however, entirely unknown to the Timorese. In view of the mostly positive experiences (cf. FAO 1966) gained in other parts of Southeast Asia with interplanting and intergrazing more attention should be paid to the introduction of this type of mixed farming in Timor. The practice of intercropping has the advantage that, through growing of seasonal crops, regular soil cultivation (either by machine or hoe) takes place from which the coconut yields usually benefit.

Moreover, intercropping may bring about a better utilization of the soil by plants with different, non-competitive root systems and a more efficient exploitation of the 'micro-atmosphere' through a two-storey build-up of canopies whereby the upper canopy may provide protection against the sun for shade-loving intercrops (FAO 1966:29).

In addition to ploughing of the coconut grove soil fertility may be improved by the application of organic or green manure (or even fertilizer). A prerequisite to interplanting seems to be a proper spacing of coconut palms. Ten to eleven metres have been suggested (pers. comm. Reg. Agr. António dos Santos). This is opposed to the present practice of spacing 7 m or less which not only adversely affects the growth of coconuts but also renders interplanting of other foodcrops impossible. The interplanting of annual foodcrops (such as maize, dryland rice)[21] and semi-perennials (such as bananas, pineapples) is to be preferred to truly perennial tree crops (such as rubber, jack-fruit, mango) which are admittedly harmful to coconuts (FAO 1966).

Besides intercropping, coconut groves may also be intergrazed, as demonstrated by the Sota at Ra Tahu. The grass is kept low thereby, provided the size of the herd is commensurate with the size of the pasture. However, intergrazing is not without hazard, in so far as soil respiration may be

[21] Here more experimenting is needed to determine the optimal crop combination for particular environments.

impeded when Bali cattle and other heavyweight livestock cause soil compression, particularly when they are tethered at a tree around which the soil becomes packed hard. Moreover, the growth of grass, particularly *Imperata cylindrica* with its dense tangle of rhizomes, may reduce the yield of coconuts as it tends to prevent soil respiration. The selection of the right grass varieties for pastures has still to be done. Finally, grazing livestock may help little in restoring soil fertility.

The example of intercropping may have shown that there is still scope for intensification and diversification of cash crop production. The improvement of agricultural methods for cash cropping and for subsistence agriculture is greatly impeded by the shortage of agricultural extension officers. In 1970 there was only one officer of the RPSAF for the whole of the eastern part of Portuguese Timor, i.e. the Baucau-Viqueque area and further east. Extremely poor road conditions often make it impossible for the officer to reach even the administrative posts during much of the year. Moreover, tribal isolation conditioned by dispersed settlement tends to obstruct the progress of education. Thus, to improve the lot of the peasant is tantamount to developing the infrastructure of the Area. Besides the construction of metalled roads which permit motor vehicles to pass throughout the year,[22] medical assistance and education have to be greatly improved. This will again hardly be possible unless population is grouped in villages (see also Azevedo 1958b:171). Such measures will have to be accompanied by a resettlement of part of the population. Suco boundaries (balizas) which hitherto prevented the migration from overpopulated to underpopulated areas, will consequently have to be adjusted.

Planning regions and recommendations for their development

It is recognized that these posto boundaries are far from forming ideal planning units. However, I feel that the present administrative division should be adhered to, at least, for the time being, chiefly for reasons of statistics (however meagre they may be) and present infrastructure (posto sanitario, schools, Sunday markets, Chinese cantinas, centre of administration, etc.). Within the posto boundaries the environmental zones (see Appendix I) are of course to form the basic units of reference in any planning recommendations.

[22] For the transport of perishable cash crops like vegetables and fruit to Baucau or Dili all-weather roads are indispensable.

Quelicai This posto comprises the most densely populated part of our Area (over 250 persons/sq km in sucos of Abo and Bualale). In terms of the given level of technology of the Timorese the potential carrying capacity has long been reached and exceeded, as evidenced by the high values of the density of occupation index.

By Timorese standards the degree of agricultural intensification has attained its maximum. Permanent to'os cultivation and fila rai practice are common. Moreover, terracing has been necessary since more than half of the agriculturally highly valued greyish brown soils (from diorite) (CD) have gradients of over 25 per cent. The pressure on the land is moreover accentuated by the high SHL number - 10,545 in 1969 (see Table 38).

The scarcity of cultivable land and thus also of pastures has been a serious handicap for livestock keeping. While fallowed to'os land is commonly used for livestock grazing throughout the Area, the permanent to'os cultivation in Quelicai does not permit it. The problem of shortage of grazing grounds is particularly serious for the duration of the rice cultivation when livestock is not allowed to graze on rice fields. By common agreement some sucos (Baguia, Macalaco, Lacoliu, Uai Tame) therefore decided to specify certain parts which are less suitable for to'os cultivation like the heavy clay areas of Macalaco (EZ No. 7; see Appendix I) as pastures to be used by all members of the allied sucos. This example may be considered as a crude form of native land use zoning.

The high population pressure in Quelicai has recently resulted in the occupation of highly unstable less fertile clay soils (CN), which, through overworking, rapidly degraded. Badlands in Lelalai and Maluro bear witness to this process. For the restoration of the population-land balance, the paramount objective of land use planning in our Area, there seems to be little scope for further intensification of to'os cultivation (except for further intensification of vegetable growing, European potatoes and peanuts). Moreover, the growing of tree crops like coconuts, candlenuts, etc. does not have great prospects either owing to a shortage of free land suitable for these cultures.

In my opinion the restoration of the aforementioned balance would probably be attained more readily by the transfer of at least one-third to one-half of the present population

of this posto to new land, preferably on the south coast. The population pressure on the land in the congested posto would thus be reduced, as would be the danger of food shortage and, in some cases, actual starvation. Finally one would have gained time for experiment and introduction of new agricultural methods.

The prevalence of migration - clear evidence of actual living conditions - of Quelicai people to Baucau and Venilale, and more recently (since 1965) to Uato Lari as skilled and highly esteemed socio rice cultivators or as simple paid labourers on rice fields, or as labourers to Dili - has absorbed at least part of Quelicai's surplus population in the past. The result has been that a high proportion of the able-bodied men work outside the posto, while women cultivate the to'os at home. Resettlement is, of course, not to be regarded as a substitute for agricultural intensification.

Uato Lari. Because of the high incidence of malaria in the Littoral Plains Zone the bulk of Uato Lari's population is concentrated in the coastal hills around the administrative centre[23] and in the adjacent mountainous hinterland. The picture conveyed by the map of the density of occupation index (Fig. 36) is thus misleading. It shows very high values for the suco of Macadique (between 1.20 and 1.49) and extremely low ones for Uai Tame (<0.20). The plain of Uato Lari was opened up for wet rice cultivation upon the initiative of the local administrator in 1965. It is, in fact, used by members of all sucos of Uato Lari in addition to the people from Quelicai, Ossu (Uaibobo, Nahareca, Uaguia), and Viqueque (Uma Uain de Cima) who joined in as socio partners.

After five years of experience the scheme, completely carried out by local labour and with local money, was considered a success despite temporary setbacks. It is thus the only such scheme whereby the population of the overpopulated central upland has been successfully induced to come down to cultivate the malaria-infested lowland. Hardly any of the new cultivators settle permanently in the plain. As true ema foho (hill people) they prefer to return to their homesteads in the hills at the end of the cultivation period. Obviously the malaria hazard no longer prevents them from descending to the plain. The establishment of a new posto sanitario near the rice fields was largely responsible for the new attitude. The circumstances that have led to success

[23] In complete disregard of suco boundaries.

were thus particularly favourable at Uato Lari. Had it not been possible to induce the upland population of Quelicai or that of the mountainous part of Uato Lari to come down to the plain, rice cultivation would not likely have assumed its present scale. The population of Uato Lari has responded significantly to the new 'rice boom' by obliging their children to attend primary school.[24] It is thus the exception in the Area and probably also in Portuguese Timor.

Despite this encouraging development there are a number of imminent problems. Many Uato Lari residents, who were hesitant to develop the plain for rice cultivation in 1965, are now without rice fields. Therefore, as some suco chiefs (e.g. of Macadique) told me, they no longer want to share their harvests with people from Quelicai. It will be thus only a matter of a few years until the outlet provided in the plain of Uato Lari, particularly for Quelicai residents, will cease to exist.[25] In this context old suco rivalries are certainly not to be underestimated. In my opinion a restoration of the man-land balance has to be brought about on an interregional basis (i.e. between sucos and even postos). Although a strong influence is at present working from the rice plain of Uato Lari attracting a great number of ema foho, a resettlement scheme must not necessarily be restricted to the boundaries of our Area. Other suitable sites may be found along the Southern Littoral Plains Zone, e.g. west of the River Bé Tuco.

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[24] In 1968-69 there was but one school (Escola do Municipio in Uato Lari village for the 1st and 2nd grade) with about 60 pupils. In October 1970 there were 230 pupils in the same school, in addition to an estimated 840 pupils in the escolas militares in each suco (1st and 2nd grade), besides the escola militar at the plain of Narequiçi near the Bé Bui River. The latter school had 140 pupils (3rd and 4th grade).

[25] In order not to deprive Uato Lari residents of the fruit of their work, in 1969 residents from Quelicai and Ossu who worked as socio partners in Uato Lari were not allowed by the administrator to take home more than 150-200 kg of rice per person for private consumption after each harvest. It is hoped that the bulk of the harvest will thus find its way to the market. Thereby a modest economic development may be initiated. Such an order is, however, rather futile because it is impossible to enforce.

Another problem that weighs heavily on the development of the plain of Uato Lari is the poor state of communications. The road linking Uato Lari with Viqueque and thus with Baucau and Dili is open to motor vehicles for, at most, three months of the year (August to October). The road linking Uato Lari eastward with Uato Carbau and further with Baguia and Baucau or along the coast with Iliomar is in similarly poor condition during most of the year. Maritime connections via the anchorage of Aliambata are likewise poor, since coastal vessels find it difficult to land for most of the year because of the rough surf of the Timor Sea.[26] Owing to its isolation, no more than two Chinese cantinas are to be found in the village of Uato Lari. These merchants are the sole local buyers of the annual rice harvest - apart from other itinerant traders who, road conditions permitting, come with trucks directly from Dili to buy straight from the natar. The monopoly of the Uato Lari merchants is very much felt by the Timorese rice cultivators. At the time of the rice harvest in 1970 the two Chinese offered an all-time low price of 1$50 per kg unmilled rice. At such a price the Timorese rice farmer would not deem it worthwhile to do extra work for cash. The promising start in the Uato Lari plain could be thus rapidly offset, as was the case with so many undertakings in Timor, if the development were not flanked by supporting measures from the government. Thus the conversion of the Uato Lari-Viqueque road into an all-weather road, along with the subsidizing of transport costs for rice shipments from Uato Lari to Dili, and the guarantee of a fixed minimum price for rice by the government would certainly further encourage rice production. It should therefore be the government's special endeavour to sustain the present encouraging agricultural development in Uato Lari which is unequalled anywhere in the Area. The Uato Lari Plain is hailed as Portuguese Timor's future 'granary' (Port.: celeiro) (pers. comm. Reg. Agr. António dos Santos, 18 July 1970).

Present production levels in rice cultivation can only be maintained on the moderately fertile coastal lowland soils (P1c) if fertilizers are applied. Here green manuring and the application of compost would help restore soil fertility.

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[26] Chinese merchants, for fear of the high loss likely to be incurred at loading or unloading the coastal vessels, are reluctant to avail themselves of this means of transport, though it is by far the cheapest way to Dili (0$30/kg instead of 0$60/kg by truck). Sailings are infrequent.

An obstacle in the way of further expansion of rice land in the Uato Lari Plain may be the scarcity of springs and rivers for irrigation. In 1970, less than 50 per cent of the rice fields were irrigated (see Fig. 25). The majority of all natar in the plain were rainfed rice fields dependent on impounded rainfall. Transplanting and double cropping are thus rendered impossible on such fields. The help of a hydrologist and a water resources engineer would thus be extremely useful in improving irrigation facilities.

Viqueque. Except for the suco of Caraubalo the entire posto area is still underpopulated. The density of occupation index lies below 0.20 in the sucos of the Littoral Plain and (except for Caraubalo with 0.83) never exceeds a value of 0.60. As a potential area for resettlement it may relieve some of the population pressure in the central upland, provided malaria eradication is successful. Water supply is the main problem for the opening up of the coastal plain (EZ No. 23) for rice cultivation. The scope for augmenting the water supply appears to be limited. The expertise of a hydrologist and a water resources engineer is needed to determine the possibilities for irrigated rice cultivation in this zone. The waters of the Cuha River which usually has a perennial flow should be better utilized for rice cultivation (pers. comm. Reg. Agr. António dos Santos, 18 July 1970). This would require the construction of dams and irrigation channels. Plans for developing the plain of Luca - west of the River Bé Tuco - were envisaged by the RSAF in 1970.[27] Constant shifting of the riverbed due to irregular flow of water and heavy silting and build-up of rubble of the Cuha and Bé Tuco renders the construction of irrigation facilities difficult. For this reason, various paddy fields in the plain of Luca, at Ra Tahu and at Hare Bé Oan at the beginning of the 1950s had to be given up by the local population.

The scarcity of rivers crossing this environmental zone (No. 23 see Appendix I), particularly the portion between the Rivers Cuha and Bé Tuco (see Plate 14), however, indicates highly permeable soil. A few small creeks south of Loho (suco of Uma Uain de Baixo 2), for instance, disappear underground upon leaving the coastal hills (EZ No. 19).

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[27] There is only one rice field in Viqueque, that of Hare Bé Oan which belongs to the suco of Uma Quic. It is irrigated by the waters of the Cuha.

There is no surface run-off. Thus it is likely that a diversion of water from the Cuha River may be impossible on account of considerable loss of water during conveyance caused by the high permeability of the soil, not to mention the loss by evaporation.

If this is verified by a hydrologist the Littoral Plains Zone (EZ No. 23) offers great possibilities for livestock grazing. Underground water is likely to be available at low depth for livestock. For this the construction of wells (by means of wind-propelled pumps) is suggested. To get through the dry season, hay production should be envisaged. Young grass shoots ought to be cut at the beginning of the rainy season since the grazing value of the dominant savanna grasses (*Imperata cylindrica* and *Saccharum spontaneum*) is low when old (cf. Heyne, III 1924:1587-8). Grasses and legumes with a higher fodder value should be introduced.

The legume *Leucaena leucocephala* should be more widely propagated both as a valuable plant for fixing nitrogen in the soil and as a forage crop. In recognition of these advantages some cultivators of Viqueque used to throw seed of this plant on their to'os at the end of the cultivation period. As a forage crop it may be converted into highly nutritive silage for cattle, buffalo, pigs and chickens. It is not recommended for horses since it causes them to lose their hair.

The peat soils of EZ No. 21 and EZ No. 24 have remained largely uncultivated so far. If rendered cultivable, they may offer opportunities for the planting of crops even during the dry season. This additional food may be used in the hunger period before the main harvest. Peat soils could be rendered productive by proper drainage and tilling. Acidity may be overcome by the application of lime from the adjacent limestone areas as well as by the burning of wood.

The copra boom has brought some wealth to the residents of Viqueque since the beginning of the 1960s.[28] The planting of coconut trees has been made at the expense of subsistence crops. The cultivation of the latter is now chiefly done on agriculturally less suitable shallow greyish calcareous soils

[28] This is evidenced by the relative easiness with which the annual taxes (head tax and livestock tax) are collected in Viqueque, in contrast to most other parts of Portuguese Timor.

from the Viqueque formation (CMC) (EZ No. 19) on steep slopes. The erosion hazard has thereby been increased. It is therefore recommended that in the future coconuts and other tree crops be planted on these slopes, while the fertile alluvial or colluvial soils be reserved for the cultivation of subsistence crops. The high dependence of the Viqueque population on copra has its drawbacks as mentioned above. As a consequence, crop diversification is suggested. Both as a subsistence and as a cash crop peanuts seem to be particularly promising.[29] They should be tried on light textured CR-soils of the lower portions of the coastal hills in rotation with maize. On these soils cotton might also thrive well, as trials near Bénara have suggested.

Trials with castor-oil plant (*Ricinus communis*) and banana as intercrops with coconut trees should be resumed.[30] These trials, started in October 1959 on the experimental field of the Comissão Municipal de Viqueque at Bénara plain,[31] were stopped in the 1960s as soon as the soil (Plc) proved unsuitable for coconuts because of clay outcrops (Bobonaro Scaly Clay).

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[29] Peanuts are also suggested by the administrator of Viqueque José Soares Teles (1965:9). Experiments with peanuts carried out at Bétano Experimental Station located in a similar environment to that of the Viqueque coastal plain yielded good results with a variety from former Portuguese Guinea, particularly if planted January-February (cf. J. Santos Oliveira 1968).

[30] Trials carried out at the Bétano Experimental Station (concelho of Same) yielded excellent results which seem to warrant further encouragement (cf. J. Santos Oliveira 1966).

[31] The Comissão Municipal de Viqueque (C.M.V.) over the years did not seem to have had a firm hand in the selection of sites for experimental fields. In 1959 a field at Bé Tice (north of Viqueque village) was given up; coconut trials at Bénara proved a failure, another copra project at Laliu (old site) failed because of clay outcrops and had to be abandoned. A new experimental field near the old one but further south towards the sea at Laliu on sandy soil was opened in the late 1960s and has been planted with rice and coconuts. Bénara and Bé Sala Bua (near Bé Aço) and, more recently again, Bé Tice were cultivated by the C.M.V. in 1969-70.

Here in Viqueque, as well as in Uato Lari, coastal fishing should be started (Teles 1968b). Because of transport difficulties fish might not be readily sold in Dili. However, the local Chinese population of Viqueque, the military stationed in Ossu, and the mission of Ossu would guarantee a ready market at the beginning before native consumption habits adjusted. Such an adjustment, however, does not seem to be much of a problem.

The development of some crops like peanuts and cotton may lead to the founding of ancillary industries (e.g. a small refinery for peanut oil, a milling plant, etc.). One industry that is already operating with remarkable success[32] and which as such is unique in Portuguese Timor, is the 'Industria de Rota' at Viqueque village. Here cane furniture is produced which is in great demand throughout Portuguese Timor and even more so in Australia. Unfortunately, despite repeated efforts by the local administration of Viqueque the large-scale export of this furniture to Australia has been impeded by a shortage of shipping facilities (see Teles 1968a, 1969).

Baucau. Fig. 36 shows that except for the sucos of Buibau and Caibada no other suco has yet reached its maximum carrying capacity, given the present level of technology. In the low-lying parts of Baucau-Sede, as well as in those sucos of Vemasse and Laga which are part of our Area, the brief growing season certainly limits agricultural possibilities. While the heavy clay areas up to 300 m should be earmarked for reafforestation, the area of low-lying calcareous soils (EZ No. 3) and along the coast (EZ No. 1) seem to be suitable for tree crops (coconuts, candlenuts, cashewnuts, jackfruit and mangoes). For these, water supply is less of a problem. Because their root systems are deeper and more extensive than those of cereals, they can tap water from a wider range and deeper horizons.

The Baucau Plateau could be more fully used for grazing. The water shortage has so far prevented the Timorese from

[32] The factory which is linked with a modern sawmill and a repair shop for agricultural machines (tractors and jeeps maintained by the C.M.V.) was said to have operated at a profit in 1970. Timorese are shown to be highly skilled. They were easily trained for a number of jobs linked with furniture production (pers. comm. Administrator José Soares Teles).

keeping their big livestock on the plateau during the dry season. Only sheep and goats are kept on the plateau throughout the year. If the subsurface drainage system could be tapped and water be pumped to central tanks, the plateau would provide good grazing conditions since many of the grasses found have a high grazing value.

Attention should be paid to the development of horticulture - i.e. the growing of vegetables for home consumption and as cash crops wherever a perennial flow of water permits this. The Escarpment Zone (EZ No. 5; EZ No. 2 at Baucau) seems to be particularly suitable for the cultivation of irrigated vegetables. Likewise, vegetables could be grown on ricefields along the Seiçal as a second crop. Even on the Baucau Plateau there seems to be a potential for horticulture as a Chinese showed at Uai Lia Bere in 1969 when he tapped an underground river. The enormous and rapidly increasing demand for vegetables by the urban population in Dili and Baucau - particularly government officers, military personnel, hotels, Chinese population - would certainly make such an effort pay. The lack of knowledge of vegetable growing, the communal interest on the part of the Timorese[33] and the general lack of interest among Timor's Chinese population in agricultural activities (other than coffee, copra, and tea plantations) have hitherto prevented the cultivation of vegetables.

In view of a substantial deficiency of animal proteins in the diet of Timor's population particular attention should be given to the commencement of coastal fishing and the creation of fish ponds in lagoons. Since the major centres of population - Dili and Baucau - guarantee a ready market, such action should be started on the north coast.

Ossu. Along with Quelicai this is the most densely populated part of our Area. Occupation density has reached extraordinary figures in Uabubo, Uaibobo, Builale and Ossu de Cima and is near capacity in Nahareca. Livestock density is among the highest for the whole of Portuguese Timor. In view of the poor soils (mostly CN) and rough topography, the man-land balance can materially be restored only if part of the population be resettled elsewhere. Also the number of livestock should be reduced.

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[33] The initiative of individual Timorese in any economic activity soon comes to an end when - as is usual in Timor - agnates descend upon him for help.

The heavy clay areas (EZ No. 7) should be reafforested, preferably those with a slope gradient above 3°. The remaining portion of this land would form good grazing grounds. Incentives should be devised to discourage the maintenance of buffalo and to encourage that of cattle for commercial purposes. The quality of the present grassland would have to be improved by the planting of legumes with a high fodder value. Hay and silage making would also be advisable to tide the animals over the rainless season.

Venilale. By comparison with the other two upland postos, Quelicai and Ossu, Venilale suffers less from pressure of the population on the land. A relatively large amount of fertile soil (PF, CD, CMC) and a great number of perennial springs have given rise to intensive natar cultivation which is locally accompanied by irrigated maize and sweet potato cultivation. Hence Venilale offers good prospects for the growing of fruit (citrus fruits, candlenut trees, mangoes) and vegetables, particularly on fields around 800 m. Irrigation facilities should be improved.

Promising conditions seem to exist for the cultivation of European cereals like wheat and chick pea. The former is claimed to have been successfully cultivated before World War II around Venilale village on calcareous soil. Its production was, however, discontinued after the war when local milling facilities were destroyed. Since then wheat cultivation has never really been resumed except by the chief of the suco of Uato Haco, Don Cristovão Guterres. At present, Portuguese Timor has to import almost all of its wheat every year.[34] The Timorese have acquired a taste for bread, so that demand for wheat will increase.

Rice fields and ponds near perennial springs should be used as fish ponds. The consumption of fish may conflict with traditional consumption patterns of the Timorese, so that education is necessary here. The consumption of fish would help reduce the animal protein gap. On account of the favourable water conditions (springs and a perennial flow of water in the Seiçal River) the cultivation of specialized cultures, like spices, may be envisaged.

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[34] In 1968 Portuguese Timor imported 1200 tons at an equivalent of 3,804,558$00. However, wheat is at present only grown around Maubisse, in very small quantities.

CONCLUSION

The subject matter of the present study has been an analysis of the ecosystem of the Baucau-Viqueque area in Eastern Timor. Within this north-south cross-section of Timor striking regional and seasonal contrasts - i.e. the spatial and temporal differentiation - are characteristic. The physiognomy of the landscape provides evidence even to the casual visitor of an imbalance between man and his environment. This first impression was substantiated by the subsequent analysis.

The Area's population was found to live under severe physical conditions indicated by strong contrasts between wet and dry seasons and enhanced by a pronounced variability of the rainfall regime, Timor's dominant climatic factor. The drawbacks of such an erratic type of climate for the agriculturist weigh obviously more heavily in a society like that of the Timorese whose level of agricultural technology is but little developed. Despite the various agricultural devices designed to spread the risk and thereby to counterbalance in some way the disadvantage caused by climate, the Timorese are still highly dependent upon the rainfall regime.

The Area's topography and soils adversely affect agricultural activity, too. By far the greatest part of the Area is made up of rugged, deeply incised mountain land dominated by three fatu blocks. Level ground is rare and limited to the Baucau Plateau, a few floodplains and the southern coastal plain. Moreover the greater part of the Area is made up of poor soils in which wide stretches of heavy clay soils, highly susceptible to erosion, are prominent.

Against this background it is strikingly clear that, although on the whole man has adapted remarkably well to the drawbacks imposed by nature, he has not made full use of his environment in all instances. This is reflected in an uneven distribution of the population. The few level pieces of ground of the Area, the Baucau Plateau and the Southern Littoral Plains Zone, are very thinly populated; whereas rugged hill and mountain land in the centre of the Area with its high proportion of poor heavy clay soils is largely

overpopulated. In the case of the southern littoral plain this peculiar distribution of the population has to be attributed chiefly to the occurrence of malaria in the coastal lowland. A shortage of surface water appears to be the reason for it on the Baucau Plateau.

Provided the population remains low enough, a balance, however delicate, between man and land may be attained at subsistence level even in such an environment. Yet once such population checks as tribal warfare (head-hunting), disease, and a high rate of infant mortality are at least partly removed, as was the case in Timor around the turn of this century, it is not surprising that the precarious balance is upset, especially if agricultural techniques remain unchanged. As seen in Quelicai and Ossu, Timorese have made efforts to adapt themselves to this new situation by intensifying cultivation practices. However, the process of adaptation did not keep pace with the increase in the population (1.8 per cent per year) and the number of livestock (1.2 per cent per year).[1]

A rapid process of land degradation characterized by erosion, land slides, impoverishment of the soils, and formation of badlands, was thus set in motion. It is feared that unless rapid remedial action is taken, this adverse process will accelerate.

How far this process has already advanced is demonstrated by an analysis of the land's carrying capacity and the density of occupation index for which it was assumed that present agricultural techniques remained unchanged. This assumption seems to be sufficiently realistic for our Area if a span of 20 years is considered. Fig. 36 clearly demonstrates an alarming stage of development.

As the Timorese are obviously incapable of tackling the situation by themselves and channeling the development back towards an equilibrium between population and land, it appears that urgent help has to be provided from outside. The assistance given by the Portuguese administration has brought comparatively little relief to the population so far. The remedial steps tended to be neither suited to the environment, nor to the people's scale of life. Moreover, they showed a lack of co-ordination of the departments involved and thus remained largely ineffective.

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[1] Based on the 10-year period 1959-60 to 1969-70.

As the analysis of the ecosystem has shown, the close interrelationship of the problems to be overcome makes comprehensive land use planning based on an intimate knowledge of the environment and the Timorese way of utilizing it necessary. To this purpose 25 distinct environmental zones were differentiated in the Area under investigation. These zones form the basic units of reference for the discussion of the measures likely to be useful in re-establishing the man-land equilibrium. With this overall intention in mind the following three objectives were recognized for the development of the Area:

1. land conservation,
2. improvement of subsistence agriculture, and
3. economic production.

Thus the principal objective is not to increase income or to accelerate economic growth, objectives commonly brought forward by economists. Our aim is more modest and oriented to the people's scale of life. An adequate supply of food to the population is considered a reasonable yardstick. Even so, the question remains whether the population is willing to co-operate. So far the Timorese have been unappreciative of the dangers of a deteriorating environment. A set of unfavourable socio-economic conditions, such as the lack of motivation and enthusiasm to work, traditional consumption patterns, religious taboos, etc. are likely to jeopardize the success of any of the suggestions made. The essential prerequisite for successfully readjusting the relationship between man and his environment in the Baucau-Viqueque area of Eastern Timor will thus be to win the population for the new ideas.

Appendix I

A regional differentiation of the Area under investigation into environmental zones

In the course of my study I was confronted with a multitude of environmental differences in the Baucau-Viqueque area. These contrasts were characterized by the range in altitude from sea level to 1750 m; by the diversity of the rainfall pattern, such as annual rainfall (Laga, 802 mm, Ossu, 1908 mm); rainfall variability (coefficient of variation of annual rainfall: Venilale 17.9 per cent; Uato Lari 28.3 per cent); rainfall distribution; by lithology and soils; and, last but not least, by the degree of human interference. The interaction of these elements has given rise to a number of distinct environmental patterns which are clearly distinguishable in the landscape by their physiognomy, on the basis of differences in vegetation and land use. In my opinion sound land use planning can only be successfully accomplished under full recognition of the ecological relationships. Therefore, I have attempted to define the ecological pattern of the Area in Fig. 37 and for the profile in Fig. 38. Twenty-five distinct environmental zones (E.Z.) have been differentiated for which brief summary descriptions are presented.

E.Z. 1: Northern Beach Zone

1) Description: typical pan-Malaysian beach vegetation on beaches, foredunes, beach ridges; locally clay plains with *Borassus flabellifer* palm thickets and dense undergrowth of *Jatropha gossypifolia*.
2) Distribution: small coastal strip along the north coast from mouth of River Manoléden (west) to Cai Ra Vela and further east to Uai Ono clay plain; east of Baucau Plateau at Lecrace Lale plain; east of Seiçal River along coast to estuary of River Uai Muhi.

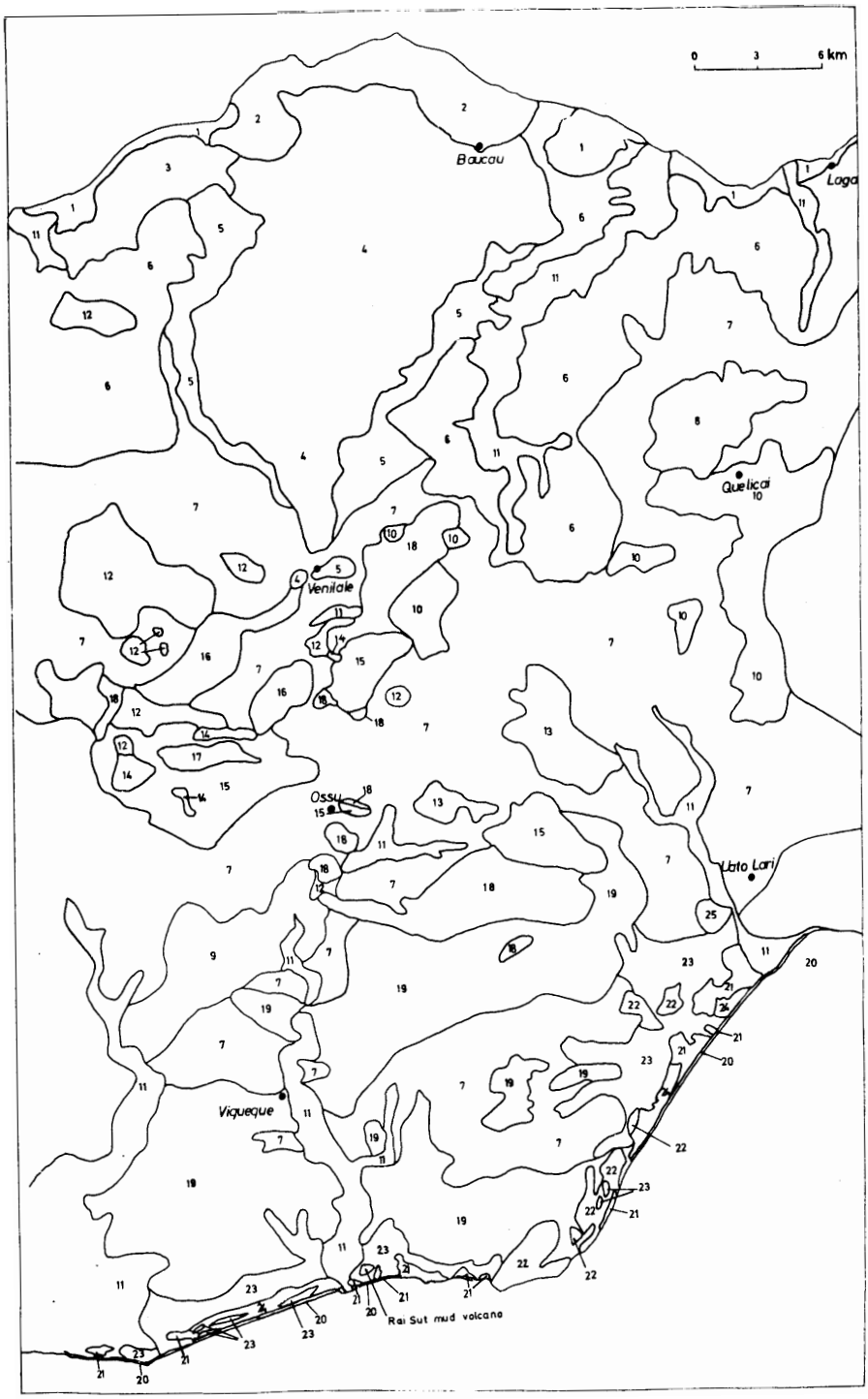


Fig. 37 Environmental zones of the Area

ENVIRONMENTAL ZONES

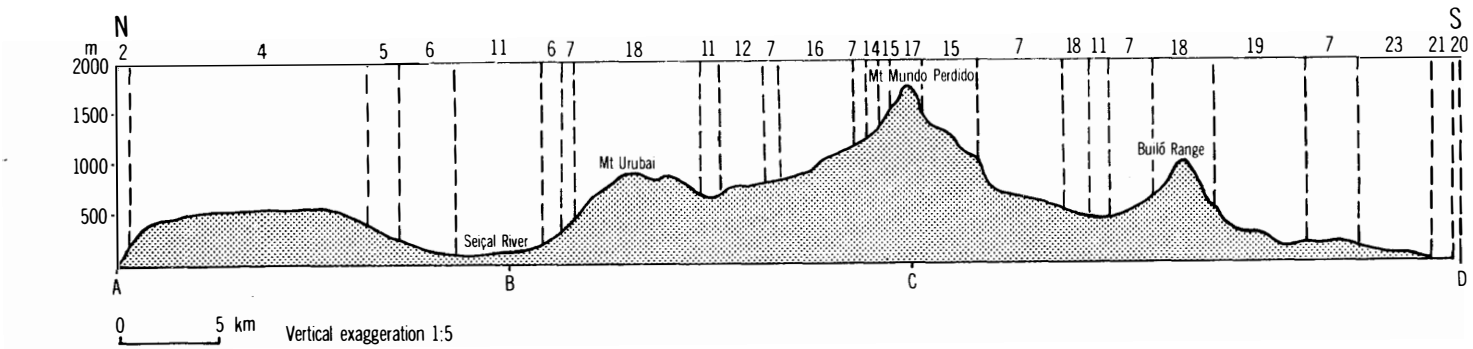


Fig. 38 Environmental zones along profile

3) Flora:
   a) Trees and shrubs: *Borassus flabellifer, Jatropha gossypifolia* var. *elegans, Pandanus tectorius, Pterocarpus indicus, Zizyphus mauritiana, Annona squamosa, Acacia leucophloea, Tecoma stans, Calotropis gigantea, Spinifex littoreus, Ipomoea pes-caprae, Hibiscus tiliaceus, Terminalia catappa, Cassia fistula, Dolichandrone spathacea, Vitex negundo* var. *bicolor, Premna corymbosa, Terminalia microcarpa, Lumnitzera racemosa, Millingtonia hortensis.*

   From Meijer Drees (1951):
   Lysiphyllum binatum, Dodonaea viscosa, Pipturus argenteus.

   From Gomes (1950c):
   Pongamia pinnata, Hibiscus timorensis, Dichrostachys cinera, Pithecelobium umbellatum, Aegiceras corniculatum.

   b) Grasses: *Perotis hordeiformis, Dactyloctenium aegyptium, Enneapogon pallidus, Eragrostis elongata, Eleusine indica, Echinochloa colonum, Leptochloa panicea, Aristida adscensionis, Panicum repens.*

   c) Sedges: *Cyperus rotundus, Bulbostylis barbata.*

4) Climate: See Laga and Vemasse.

5) Soils: Calcareous Psammitic regosols (RC), locally overlain by a clay layer (soil wash from adjoining coastal hills).

6) Land use: Coconut groves (Uai Ono, Cai Ra Vela); some sisal between Uai Ono and Cai Ra Vela; tuak production from *Borassus flabellifer* at Uai Ono and east of River Seiçal; single cropping natar at Cai Ra Vela, Lecrace Lale; a few to'os (bush fallowing).

7) Photographs: Plate 7.

E.Z. 2: Marine Terrace Zone

1) Description: Pleistocene marine terraces (up to 10); rising staircase-like from sea level to about 450 m on the Baucau Plateau; covered with strongly deciduous forest and *Eucalyptus alba* savanna locally grading into *Eucalyptus alba* woodland. Slightly denser vegetation is typical near water seepages at foot of terraces.

2) Distribution: North coast between Uai Ono (west) and Baucau village (east); including terraces from Baucau village down to the sea; 0-450 m.

3) Flora:
   a) Trees and shrubs: *Eucalyptus alba, Zizyphus mauritiana, Schleichera oleosa, Tecoma stans, Pterocarpus indicus.*

   b) Grasses: from FAO (1960): *Sporobolus* sp., *Setaria verticillata, Cynodon dactylon, Panicum* sp., *Desmodium laxiflorum, Rhynchosia minima.*

      From F.A. Soares (1963): *Dichanthium caricosum.*

4) Climate: 0-200 m; see Vemasse and Laga; above 200 m: see Baucau airport.

5) Soil: Shallow, reddish, calcareous soil (from coral reef limestone) (VR) and grey calcareous skeletal soil (CR) with limestone outcrops. Where humic acids have accumulated a humus layer, rai metan, occurs.

6) Land use: Hardly used save for some to'os; bush fallowing; lere rai cultivation; very long rotation periods (1-2/25); Baucau, owing to two strong springs, double cropping natar.

7) Photographs: Plate 9.

E.Z. 3: Escarpment Zone of Bucoli

1) Description: Escarpment zone of Baucau Plateau; straight slope from sea level to rim of Plateau; covered by strongly deciduous forests with a dominance of *Tamarindus indica* (and absence of *Eucalyptus alba*).

2) Distribution: Comprising roughly western half of the suco of Bucoli; 0-500 m.

3) Flora:
   a) Trees and shrubs: *Tamarindus indica, Schleichera oleosa, Zizyphus mauritiana, Melia azedarach, Caesalpinia pulcherrima, Pterocarpus indicus, Tecoma stans, Sterculia foetida, Garuga floribunda, Corypha utan, Gyrocarpus americanus, Alstonia spectabilis, Ficus* sp., *Eugenia litorale, Xylosma luzonensis, Zizyphus timoriensis, Acacia leucophloea, Albizzia tomentella, Cassia fistula.*

      From Meijer Drees (1951): *Pterocarpus indicus* var., *longistipitatus, Lysiphyllum binatum, Bridelia ovata, Grewia eriocarpa, Millingtonia hortensis, Morinda*

tomentosa, Homalium tomentosum, Hymenodictyon excelsum, Schoutenia ovata, Wrightia calycina, Wrightia pubescens, Zizyphus celtidifolia, Grewia microcos, Helicteres isora, Protium javanicum, Rauvolfia reflexa, Voacanga grandifolia, Albizzia lebbeck, Albizzia procera, Antiaris toxicaria, Fagara rhetsa, Dillenia pentagyna, Exocarpus latifolius, Antidesma ghaesembilla, Antidesma montanum, Cassia javanica, Cassia timoriensis, Celtis wightii, Cordia dichotoma, Cordia monoica, Dichrostachys cinera, Voacanga grandifolia, Euphorbia barnhartii, Strychnos muricata.

b) Groves: *Emnapogon pallidus, Bothriochloa bladhii, Heteropogon contortus, Alloteropsis semialata, Chloris ruderalis, Bothriochloa pertusa, Sorghum timorense.*

4) Climate: See Vemasse and Laga.

5) Soil: Shallow, skeletal, grey calcareous soil derived from coral limestone (CR); extensive limestone outcrops.

6) Land use: Scattered to'os cultivation; lere rai (1-2/20 rotation cycle); locally near springs wet rice fields; patches of rai metan where humic acids have concentrated.

7) Photographs: Plate 9.

E.Z. 4: Baucau Plateau

1) Description: Northern half and southern extremity largely deforested and covered with *Tecoma stans* scrub with scattered *Schleichera oleosa*; central portion of the plateau covered by *Eucalyptus alba* savanna. Locally, at Cailubo Oli and Hai Bai forest (Fatulia) subsurface drainage gives rise to slightly deciduous forest. *Borassus flabellifer* occurs gregariously in the northeast corner of the plateau at 400 m.

2) Distribution: Baucau Plateau; from 450 m (north) to 700 m (south) fringed east and west by escarpments (= E.Z. 5); limited to the north by E.Z. 2 and E.Z. 3.

3) Flora:
a) Trees and shrubs: *Tecoma stans, Schleichera oleosa, Eucalyptus alba, Sterculia* sp., *Borassus flabellifer.* Slightly deciduous forest at Cailubo Oli and Hai Bai: *Alstonia scholaris, Grewia glabra, Triumfetta* sp., *Sterculia foetida, Pittosporum moluccaum, Cassia siamea, Melaleuca leucadendra, Pipturus argenteus, Sesbania grandiflora, Timonius timon, Cassia fistula.*

b) Grasses: *Heteropogon contortus, Eleusine indica, Digitaria bicornis, Chloris barbata, Rhynchelythrum roseum, Panicum caudiglume, Eragrostis elongata, Dichanthium caricosum, Coelorhachis rottboellioides, Apluda mutica, Thelepogon elegans, Setaria laxa, Cenchrus brownii, Arthraxon lancifolius, Pennisetum polystachyum, Themeda australis.*
From M. de Castro (1964a): *Bothriochloa pertusa, Themeda intermedia, Panicum repens, Eragrostis tenella, Bragrostis cilianensis, Vignolo-Lutati, Sporobolus indicus, Tragne biflorus, Chloris gayana.*
From F.A. Soares (1963): *Cymbopogon procerus.*

4) Climate: See Baucau airport.

5) Soil: Red, calcareous soil from coral reef limestone (VR) and rai metan at swales where humic acids concentrate (e.g. Lequileuato); limestone outcrops are numerous, particularly in the northern half; almost level terrain, only slightly increasing in altitude from north to south (400-800 m).

6) Land use: Scattered single cropping to'os (bush fallowing) on reddish soil; some wet rice fields on rai metan of Lequileuato and in swales of ephemeral rivers (e.g. Uai Lacama). Permeable soil, limestone outcrops and shortage of water handicap agriculture. Shallow soils make fila rai the exception. Crop rotation, mulching, and corralling of sheep in fallowed fields help overcome shortage of organic matter. Little coffee in Cailubo Oli forest. Sisal planted in sinkholes under Administrator Pinto Correia in the 1930s thrives well, but remains largely unexploited owing to lack of commercial interest of the population.

7) Photographs: Plates 10, 40, 36.

E.Z. 5: Eastern and Western Escarpment of Baucau Plateau

1) Description: Escarpment zones of Baucau Plateau; covered by forest/savanna mosaic (patches of slightly deciduous forest); at water seepages: strongly deciduous forest and some *Eucaluptus alba* savanna. Sacred groves with huge *Ficus benjamina* trees are found near springs (e.g. Fatumaca de Cima).

2) Distribution: Escarpment zone east and west of Baucau Plateau; 300-600 m.

3) Flora:
Trees and shrubs: *Aleurites moluccana, Albizzia tomentella, Pterocarpus indicus, Zizyphus mauritiana, Schleichera oleosa, Sterculia* sp., *Psidium guajava, Santalum album, Cassia timorensis, Borassus flabellifer, Acacia leucophloea.*

4) Climate: See Baucau airport.

5) Soil: Red calcareous soil (VR) in upper portion (rai metan); some rai metan in swales derived from accumulation of humic acids from Plateau; mainly grey calcareous soil (derived from Viqueque Formation) (CMC).

6) Land use: Permanent to'os cultivation on rai metan at rim of plateau and near springs; double cropping natar near springs; bush fallowing on rai mutin.

7) Photographs: Plate 10.

E.Z. 6: Clay Zone of the Northern Lowland

1) Description: Heavy clay areas up to 300 m north of the central upland with *acacia leucophloea* savanna and patches of strongly deciduous forest conspicuous; grass cover very sparce and tussocky; as is common in all areas of Bobonaro Scaly Clay, huge rock outcrops believed to be allochthonous in origin - e.g. the Seiçal Formation on the west bank of the Seiçal River near its mouth - are included in this formation.

2) Distribution: All heavy clay areas up to 300 m north of the central upland, the lower parts of the escarpment east and west of the Baucau Plateau, lower parts east of Seiçal River, suco of Tequinamata and lower parts of posto of Quelicai.

3) Flora:
a) Trees and shrubs: *Tamarindus indica, Zizyphus mauritiana, Schleichera oleosa, Acacia leucophloea, Jatropha gossypifolia, Azima sarmentoso, Aegle marmelos, Cassia fistula, Pterocarpus indicus, Erythrina* sp., *Sterculia foetida, Bambusa blumeana, Vitex pubescens, Pipturus argenteus, Psidium guajava, Zizyphus timorensis, Acacia farnesiana, Dichrostachys cinera, Acacia oraria, Annona squamosa, Bauhinia acuminata, Salmalia valetronii, Melia dubia, Mallotus philippensis, Tetrameles nudiflora, Albizzia procera.*

b) Grasses: from FAO (1960): *Andropogon* sp., *Heteropogon compressus, Dichantium caricosum, Bothriochloa glabra, Setaria geniculata.*

4) Climate: See Vemasse and Laga.

5) Soil: Heavy textured clay soil (CN).

6) Land use: Of low agricultural value, very few single cropping to'os (bush fallowing); long rotation periods (1-2/20-25); a few wet rice fields (e.g. Hatodona, Badonau, Uai Laco Oli, Laco Mé at River Manoléden); some grazing during rainy season; water shortage and heavy texture of the soil are major handicaps for agriculture.

7) Photographs: Plate 4.

E.Z. 7: Clay Zone of the Central Upland and Southern Lowland

1) Description: Bobonaro Scaly Clay areas, moister than in E.Z. 6; supporting *Casuarina junghuhniana* savanna.

2) Distribution: All heavy textured clay areas of central upland above 300 m; in south starting from sea level.

3) Flora:

a) Trees and shrubs: *Casuarina junghuhniana, Tamarindus indicus, Zizyphus mauritiana, Schleichera oleosa, Pterocarpus indicus, Aegle marmelos, Psidium guajava, Acacia leucophloea, Alstonia spectabilis, Sterculia foetida, Litsea alutinosa, Cassia fistula, Mallotus philippensis, Premna corymbosa, Zanthoxylium rhetsa, Alstonia scholaris;*
Along rivulets: *Psychotria* sp., *Timonius timon, Xylosma luzonensis, Aleurites moluccana, Ficus* sp., *Bambusa spinosa, Pandanus tectorius, Pipturus argenteus, Psychotria* sp., *Eugenia* sp., *Maesa* sp.

b) Grasses: *Coelorhachis rottboellioides, Dichanthium caricosum, Eleusine indica, Digitaria argyrostachya, Apluda mutica, Capillipedium parviflorum, Chrysopogon aciculatus, Cynodon dactylon,*
From FAO (1960): *Themeda gigantea, Saccharum* sp., *Androgopon* sp.;
From M. de Castro (1964a): *Andropogon trispicatus, Chrysopogon aciculatus, Capillipedium assimile, Bothriochloa glabra, Themeda australis, Digitaria pertenuis* var. *glabra, Paspalum conjugatum, Paspalum orbiculare, Setaria pallide-fusca, Chloris dolycostachya.*
From F.A. Soares (1963): *Eragrostis zeylanica.*
Grasses along rivulets: *Saccharum spontaneum, Themeda intermedia.*
Sedges: *Fimbristylis dichotoma.*

4) Climate: Annual rainfall above 1000 mm.

5) Soil: Heavy textured clay soils (CN); erosion.

6) Land use: Livestock grazing throughout the year, particularly at elevations above 800 m. Some wet rice fields (mostly inundated); scattered to'os cultivation (rotation periods 2/20); the hard wood of the casuarinas which are frequently pollarded is esteemed for house construction as well as for tool making (e.g. ai suak).

7) Photographs: Plates 21, 42, 46.

E.Z. 8: Dissected Ridge north of Quelicai

1) Description: Ridge between 300 and 824 m (Mt Laualiu) of Triassic Aitutu Formation; deeply incised by erosion; covered by forest/savanna mosaic (relics of slightly deciduous forest in association with *Eucalyptus alba* savanna) on steep slopes; *Borassus flabellifer* savanna on less inclined slopes.

2) Distribution: Immediately north of administrative centre of Quelicai.

3) Flora: *Eucalyptus alba, Schleichera oleosa, Borassus flabellifer.*

4) Climate: See Quelicai.

5) Soil: Brown calcareous soil, from limestone from the Triassic associated to shales (PCX); covered with limestone fragments; at very steep parts bare rock or skeletal soils occur.

6) Land use: Permanent to'os cultivation (with ai suak kiik) on slopes of up to 20° gradient. To'os on more inclined portions are usually terraced. Tuak production from *Borassus flabellifer.*

7) Photographs: Plate 3.

E.Z. 9: Intermediate Foothill Zone of Loihuno

1) Description: Strongly dissected foothills south of Mt Mundo Perdido; mixed composition of Bobonaro Scaly Clay and allochthonous material primarily of volcanic origin (Barique Formation) and outcrops of autochthonous Atahoc Formation (Permian); these give rise to motley vegetation pattern of patches of *Eucalyptus alba* savanna on reddish skeletal soils, in between Casuarina savanna and slightly deciduous forest on heavy clay soils.

2) Distribution: Foothill zone of Loihuno 300 to 500 m, extending from River Bé Tuco (east) to River Cuha (west).

3) Flora:
   a) Trees and shrubs: *Casuarina junghuhniana, Grewia glabra, Bambusa blumeana, Albizzia lebbeck, Schleichera oleosa, Zizyphus mauritiana, Cassia fistula, Albizzia procera, Melochia umbellata, Melanolepis multiglandulosa, Toona sureni, Arenga pinnata, Ficus* sp., *Pipturus argenteus, Litsea* sp.

   b) Grasses: *Eleusine indica.*

4) Climate: See Ossu.

5) Soil: Reddish skeletal soils of volcanic origin on hills surrounded by heavy textured clay soil (CN).

6) Land use: Hardly any on reddish soil; extensive to'os cultivation on remaining soil, mainly along small creeks. Some grazing (buffaloes).

E.Z. 10: Moderately Steep Footslopes of Volcanic Origin

1) Description: Footslopes adjacent to fatus of Oligocene Barique Formation.

2) Distribution: Immediately west of Mt Mata Bian; at suco of Uai Oli (Venilale); northeast of Mt Laritame; and east and west of Mt Urubai (Liabala, Uato Có, Neo Hoo, Cai Male Hoo).

3) Flora: No natural vegetation left due to intensive cultivation.

4) Climate: See Venilale, Quelicai.

5) Soil: Greyish brown soil from non-calcareous material (from diorite) (CD); mixed with eluvial soil from adjacent fatu rock (PF).

6) Land use: Permanent to'os cultivation in Quelicai, terracing common; irrigated natar along springs (e.g. Uai Oli).

7) Photographs: Plate 37.

E.Z. 11: Floodplains

1) Description: Floodplain of major rivers; wide rubble beds; braided channels, sandbars and small islets; riparian forests; fringed by casuarina and locally by riparian forest.

2) Distribution: Floodplains of rivers of Manoléden, Seiçal, Bé Tuco, Cuha, Bé Bui.

3) Flora:
   a) Trees and shrubs: *Tamarindus indica, Corypha utan, Jatropha gossypifolia* var. *elegans, Calotropis gigantea, Hibiscus tiliaceus, Peltophorum pterocarpa, Pterocarpus indicus, Zizyphus mauritiana, Schleichera oleosa, Melia azedarach, Caesalpina pulcherrima, Casuarina junghuhniana, Pandanus tectorius, Terminalia catappa, Pithecellobium umbellatum, Sesbania grandiflora, Cassia siamea.*
   From Meijer Drees (1951): *Buchania arborescens, Saccopetalum horsfieldii, Terminalia mollis, Terminalia microcarpa, Bischoffia javanica, Calophyllum teysmannii, Dysoxylum acutangulum, Ficus ampelas, Ficus laeta, Eugenia microcymum, Pendanus* sp., *Parinarium corymbosum, Psychotria* sp., *Timonius timon, Wendlandia burkillii* var. *timoriensis, Palaquium* sp., *Planchonella obovata, Sterculia foetida.*

   b) Grasses: *Saccharum spontaneum, Brachiaria ramosa, Themeda intermedia, Eragrostis elongata, Coelorhachis rottboellioides.*
   From M. de Castro (1964a): *Saccharum arundinaceum.*

4) Climate: Primarily edaphically controlled.

5) Soil: Heavy textured non-calcareous modern alluvial soil (AP); medium textured calcareous modern alluvial soil (AMC).

6) Land use: Irrigated rice fields on lower terraces; coconut growing on light textured soils; to'os cultivation on upper terraces; after rice harvest natar are used for livestock grazing.

7) Photographs: Plates 7, 8, 13, 15.

E.Z. 12: Volcanic Ridges below 1000 m

1) Description: Steep ridges of volcanic (Barique Formation) or partly volcanic origin (Maubisse Formation); deeply incised by creeks; spurs covered with *Eucalyptus alba* savanna with tufted grass; ravines filled by slightly deciduous forest.

2) Distribution: Mt Ossoala (1024 m), Mt Birac (533 m) - near mouth of River Manoléden, Mt Ossoaque; Ai Bubur Laran (east of Mt Ossoala); northwest slope of Mt Mundo Perdido; small ridge of Dauboro Baha (Uabubo 2) northwest of Mt Laritame; near Uai Tuto Mata (Uaguia 3), east of Mt Laritame.

3) Flora:
   a) Trees and shrubs: *Eucalyptus alba, Zizyphus mauritiana, Schleichera oleosa.*
   In ravines: *Cassia javanica, Pterocarpus indicus, Alstonia scholaris, Arenga pinnata, Bambusa blumeana.*
   b) Grasses: from FAO (1960): *Sporobolus* sp., *Setaria verticillata, Cynodon dactylon, Panicum* sp., *Desmodium laxiflorum, Rhynchosia minima.*
   From F.A. Soares (1963): *Dichanthium caricosum.*

4) Climate: Primarily edaphically controlled, in a wide range of climates; annual rainfall is probably no higher than that of Venilale and Quelicai.

5) Soil: Red lithosolic soil due to downwash and high permeability. No A-horizon.

6) Land use: None, only some inundated natar at Dauboro Baha, in hollows where permeability is lower and accumulation of humic acids led to formation of some organic matter.

7) Photographs: Plates 1, 20, 28, 47.

E.Z. 13: Lowlying Limestone Outcrops of Nahareca and Uabubo

1) Description: Undulating limestone outcrops of Viqueque Formation, mostly cultivated; only remnants of slightly deciduous forest.

2) Distribution: Limestone areas of Nahareca and Uabubo 1:400-500 m.

3) Flora: No data.

4) Climate: See Ossu.

5) Soil: Greyish marly soil (from Viqueque Formation) (CMC).

6) Land use: Intensive to'os cultivation; rotation periods 3/3, locally even permanent cultivation; extensive coconut groves.

E.Z. 14: Volcanic Outcrops above 1000 m

1) Description: Volcanic outcrops (Barique Formation) above 1000 m covered with *Eucalyptus urophylla* between 1000 and 1200 m; hybrids of *E. alba* and *E. urophylla*, locally very steep hillsides; erosion due to overgrazing.

2) Distribution: North of Mt Mundo Perdido (suco of Builale) and Ossu de Cima, 1200 m; southern slope of Mt Mundo Perdido at Reo Bai (1000 m) and above Liaruca; at Dauboro Baha (Uabubo 2) and, though slightly outside our Area, on western slope of Mt Mata Bian.

3) Flora: *Eucaluptus urophylla, Elsholtzia pubescens, Eugenia acuminatissima, Vitex trifolia, Melastoma aculeatum, Rubus moluccanus, Rubus rosaefolius.*

4) Climate: Annual rainfall above 2000 mm.

5) Soil: Reddish lithosolic soils; only on more level grounds, e.g. at Builale, A-horizon has developed.

6) Land use: Grazing of big livestock; some to'os (lere rai) at Builale; lopping of *Eucalyptus urophylla* trees.

7) Photographs: Plate 19.

E.Z. 15: Medium Altitude Fatu Zone (1000-1500 m)

1) Description: Fatus covered with medium altitude moist evergreen forest.

2) Distribution: Between 1000 and 1500 m at Mt Mundo Perdido, Mt Laritame and Mt Builó, southward facing side of Mt Ossu about 800 m.

3) Flora:
   a) Trees and shrubs: *Elsholtzia pubescens, Maesa* sp., *Grewia glabra, Rhamnus nepalensis, Pittosporum moluccanum, Melochia umbellata, Elaeocarpus* sp., *Guioa* sp., *Ficus* sp., *Myrsine* sp., *Wiktroemia androsaemifolia, Toddalia asiatica, Decaspermum fruticosum, Daphniphyllum glaucescens* var. *timorianum, Glochdion* sp., *Evodia latifolia, Phaleria octandra, Cryptocarya* sp., *Canthium* sp., *Breynia cernua, Dysoxylum gaudichaudianum, Photinia notoniana, Wendlandia* sp., *Claoxylon* sp., *Ficus ampelas, Eugenia acuminatissima, Litsea* sp., *Dasminum* sp.
   From Meijer Drees (1951): *Acer laurinum, Actinodaphne velutina, Carallia brachiata, Casuarina Junghuhniana, Celtis wightii, Ehretia acuminata, Elaeocarpus petiolatus, Eugenia* sp., *Glochidion zeylanicum* var. *malayanum, Neolitsea cassifolia, Olea paniculata, Pithecellobium sapindioides, Planchonella obovoidea, Pometia tomentosa, Putranjiva roxburghii, Myrsine hasseltii, Santalum album, Tarenna pubiflora, Elattostachys verrucosa, Euonymus javanicus, Mallotus philippensis, Mischocarpus sundaicus, Pittosporum timorense, Timonius timon, Harrisonia perforata, Albizzia chinensis.*

4) Climate: Annual rainfall above 2000 mm.

5) Soil: Brown, calcareous soil from fatu limestone (PF); lithosolic soils (L) on steep escarpments and cliffs.

6) Land use: Hardly used because of lulik character (like E.Z. 17); some pastures have been hewn out of the forest.

7) Photographs: Plate 18.

E.Z. 16: Rounded Ridges of Larigutu Limestone

1) Description: Undulating open grassland with *Pandanus tectorius* along small creeks; some *Psidium guajava* at wind sheltered sites at Larigutu; lower ridge (800-900 m) covered with *Tecoma stans* scrubland and remnants of *Eucalyptus alba* which allegedly have accounted for the original vegetation.

2) Distribution: Larigutu limestone areas at Larigutu Pass (1000 m) and ridge northwest of it (800-1000 m).

3) Flora:
   a) Trees and shrubs: Along rivulets: *Arenga pinnata, Tecoma stans, Albizzia chinensis, Timonius timon, Pittosporum moluccanum, Psidium guajava, Elaeocarpus* sp., *Eucalyptus alba.*
   b) Grasses: *Saccharum spontaneum, Imperata cylindrica, Brachiaria paspaloides, Sporobulus indicus, Eleusine indica, Cynodon dactylon.*

4) Climate: See Ossu, Venilale; very windy (wind channel) at Larigutu Pass (1000 m) which also seems to prevent regrowth of trees and shrubs.

5) Soil: Shallow calcareous soil (AC-type), indicated on the soil map with Y; permeable and little organic matter.

6) Land use: Exclusively used for grazing; erosion scars due to overgrazing conspicuous; slopes riddled with a maze of animal paths; in deeply cut valleys of the lower ridge accumulation of humic acids gave rise to more fertile soils used for to'os cultivation (fila rai); at Larigutu in contact zone with clay complex two to'os crops of maize per year harvested.

E.Z. 17: Mundo Perdido Fatu Crest

1) Description: Fatu above 1500 m covered with typical montane cloud forest.

2) Distribution: Area above 1500 m at Mt Mundo Perdido.

3) Flora:
   a) Trees and shrubs: *Elastoma* sp., *Podocarpus imbricatus*, *Podocarpus amarus*, *Decaspermum fruticosum*, *Ehretia dichotoma*, *Melastoma polyanthum*, *Glochidion* sp. From Meijer Drees (1951): *Actinodaphne velutina*, *Artocarpus gomeziana*, *Celtis wightii*, *Cleistocalyx operculata*, *Drypetes* sp., *Elaeocarpus petiolatus*, *Elaeocarpus* sp., *Eucalyptus urophylla*, *Olea paniculata*, *Photinia notoniana*, *Putranjiva roxburghii*, *Euonymus japonicus*, *Viburnum cylindricum*, *Vaccinium* sp., *Pygeum* sp., *Palaquium* sp., *Planchonella* sp.

   b) Grasses: From M. de Castro (1964a): *Panicum undulatifolium*, *Artraxon quartinianus* on clearings in the Podocarpus forest.

4) Climate: Annual rainfall above 2000 mm.

5) Soil: Brown, calcareous soil from fatu limestone (PF); locally lithosolic soils (L).

6) Land use: None because of lulik character of the forest.

7) Photographs: Plate 17

E.Z. 18: Lower Altitude Fatu Zone (below 1000 m)

1) Description: All fatus below 1000 m covered with slightly deciduous forest.

2) Distribution: At Mt Urubai, Mt Venilale, Mt Hare Ana, lower portions of Mt Laritame, western section of Mt Builó, Mt Ossu (northern slope), Mt Ulohua, Mt Uatoréli, Mt Caileti Lale, escarpment zone northwest of Mt Mundo Perdido towards Laleia floodplain.

3) Flora:
   Trees and shrubs: *Maesa* sp., *Pipturus argenteus*, *Clerodendrum* sp., *Homalanthus populneus*, *Alstonia scholaris*, *Arenga pinnata*, *Acacia leucophloea*, *Jatropha curcas*, *Eugenia* sp., *Neolitsea javanica*, *Psidium guajava*, *Clochidion philippense*, *Cassia fistula*, *Timonius sericeus procera*, *Gossampinus heptaphylla*.

4) Climate: See Venilale, Ossu.

5) Soil: Brown calcareous soil from fatu limestone (PF) particularly at foot of fatus; lithosolic soils (L) on steep escarpments and cliffs.

6) Land use: Intensive to'os and locally also natar cultivation on rai metan, at foot of fatus; on more level ground (e.g. Mt Builó) to'os cultivation and grazing.

7) Photographs: Plates 11, 12.

E.Z. 19: Limestone Zone of Southern Foothills

1) Description: Southern foothills of Viqueque Formation; covered by *Corypha utan* savanna and relicts of slightly deciduous forest.

2) Distribution: Southern foothills below 400 m.

3) Flora:
   a) Trees and shrubs: *Jasminum* sp., *Maesa* sp., *Schleichera oleosa, Cordia dichotoma, Corypha utan, Timonium timon, Pithecellobium umbellatum, Zizyphus timorensis, Albizzia lebbeck, Premna corymbosa, Cassia fistula, Bridelia ovata, Acacia farnesiana, Millingtonia hortensis, Barleria prionitis, Trema cannabina, Fatoua pilosa, Erythrina* sp., *Solanum verbascifolium, Tamarindus indica, Leucaena leucocephala, Sterculia foetida, Pterocarpus indicus, Mischocarpus sundaicus, Dichrostachys cinera, Gossampinus heptaphylla, Pipturus argenteus, Melanolepis multiglandulosa, Hibiscus tiliaceus, Canarium indicum, Terminalia catappa, Leea* sp., *Annona muricata, Peltophorum pterocarpa, Wrightia javanica, Phyllantus reticulatus, Croton* sp., *Timonius timon, Xylosma luzonensis, Canarium vulgare, Alstonia scholaris.*

   b) Grasses: *Eleusine indica, Imperata cylindrica, Saccharum spontaneum, Chrysopogon aciculatus.*
   From M. de Castro (1964a): *Imperata koenigii* var. *major, Hyparhenia filipendula, Sorghum nititum, Erichloa procera.*
   From FAO (1960): *Sorghum plumosum, Panicum perakense, Bothriochloa glabra, Dichantium caricosum, Sporobolus virginicus, Eriochloa punctata, Capillipedium parviflorum, Rhynchosia minima, Cynodon dactylon, Setaria geniculata.*

4) Climate: See Uato Lari, Viqueque.

5) Soil: Greyish marly soil from Viqueque formation (CMC); modern calcareous alluvial soil (Amc) in valley bottoms; calcareous soil (from sandstone and coral reef limestone) CR in lower parts of coastal hills up to 200 m.

6) Land use: To'os cultivation; lere rai on slopes; fila rai on valley floors on which coconut growing is also common.

7) Photographs: Plates 14, 22.

E.Z. 20: Southern Beach Zone

1) Description: Typical pan-Malaysian beach vegetation on beaches, foredunes, outer beach ridge; wind-shorne coastal scrub of *Scaevola taccada, Pandanus tectorius, Hibiscus tiliaceus.*

2) Distribution: South coast.

3) Flora:
   a) Trees and shrubs: *Casuarina junghuhniana, Casuarina equisetifolia, Scaevola taccada, Pandanus tectorius, Calotropis gigantea, Desmodium umbellatum, Hibiscus tiliaceus, Cordia subcordata, Cynodon dactylon, Vigna marina, Vitex ovata, Thespesia populnea.*
   From Meijer Drees (1951): *Barringtonia asiatica, Mimusops elengi* var. *parvifolia.*
   From Gomes (1950c): *Calophyllum* sp., *Hernandia* sp., *Herietiera* sp., *Cerbera* sp.

   b) Grasses and herbs: *Spinifex littoreus, Ipomoea-pes-caprae.*

4) Climate: Principally edaphically controlled.

5) Soil: Calcareous psammitic regosols developed on or behind beach ridges.

6) Land use: None.

7) Photographs: Plate 24.

E.Z. 21: Swamp Zone

1) Description: Swamp forest with open irregular canopy; permanently high ground water.

2) Distribution: Along south coast.

3) Flora:
   a) Trees and shrubs: *Kleinhovia hospita, Metroxylon sagu, Corypha utan, Arenga pinnata, Antidesma* sp., *Xylosma luzonensis, Canarium vulgare, Macaranga tanarius, Desmodium* sp.
   From Meijer Drees (1951): *Leea sambucina* var. *sundaica, Oroxylum indicum, Canarium asperum, Claoxylon polot, Drypetes longifolia, Mallotus philippensis, Mallotus*

ricinoides, Omalanthus populneus, Garcinia dulcis, Planchonia valida, Albizzia lebbeck, Peltophorum pterocarpa, Pongamia pinnata, Hibiscus timorensis, Aglaia heptandra, Dysoxylum caulostachyum, Dysoxylum gaudichaudianum, Ficus callosa, Ficus fistulosa, Ficus flaveola, Ficus pisocarpa, Ficus benjamina, Ficus subglauca, Ficus variegata, Pisonia umbelliflora, Arenga pinnata, Parinarium corymbosum, Nauclea coadunata, Tarenna pubiflora, Casearia hexagona, Allophylus cobbe, Tristiropsis canarioides, Cordia monoica.
From Gomes (1950c): *Nauclea orientalis, Alstonia scholaris, Barringtonia* sp., *Sterculia foetida.*

b) Grasses: *Phragmites karka, Cymbopogon exaltatus.*

4) Climate: E.Z. mainly edaphically controlled.

5) Soil: Unconsolidated peat soil.

6) Land use: None; except at mouth of River Bé Bui where swamp forest gave way to wet rice fields.

7) Photographs: Plate 15.

E.Z. 22: Elevated Reefs on South Coast.

1) Description: Elevated coral reefs, limestone outcrops, solution cavities, covered with slightly deciduous forest.

2) Distribution: Bé Ro (east of Bé Aço); patches in plain of Uato Lari, max. 50 m above sea level.

3) Flora:
a) Trees and shrubs: *Albizzia lebbeck, Mallotus philippensis, Aglaia elaegnoidea, Tamarindus indica, Alstonia scholaris, Pterocarpus indicus, Sterculia foetida.*

b) Grasses: *Sorghum timorense, Eleusine indica, Chrysopogon aciculatus, Perotis hordeiformis, Scleria lithosperma.*

4) Climate: See Viqueque.

5) Soil: Red calcareous soil from coral reef limestone (VR) (or occurring in phases: VRd).

6) Land use: None, because of limestone outcrops.

E.Z. 23: Southern Back Plains

1) Description: Tall grassland with scattered stands of *Corypha utan*; patches of deciduous forest with periodically high ground water.

2) Distribution: Along southwest between River Bé Tuco and Cuha; between Cuha and Bé Ro forest; plain of Uato Lari (Fatun, Narequiçi a.o.).

3) Flora:
   a) Trees and shrubs: *Corypha utan, Schleichera oleosa, Bambusa blumeana, Albizzia lebbeck, Timonius timon, Ervatamia* sp., *Ficus* sp., *Pithecellobium umbellatum, Cordia dichotoma, Xylosma luzonensis, Desmodium umbellatum, Sterculia foetida, Tamarindus indica, Ixoro* sp., *Zizyphus timoriensis.*
   From Meijer Drees (1951): *Alstonia scholaris, Cordia monoica, Tetrameles nudiflora, Breynia cernua, Bridelia ovata, Claoxylon polot, Croton tiglium, Suregada glomerulata, Macaranga tanarius, Albizzia chinensis, Cassia timoriensis, Peltophorum pterocarpa, Strychnos muricata, Lagerstroemia* sp., *Aphanamixis grandifolia, Ficus hispida, Hymenodiction excelsum, Aegle marmelos, Euodia* sp., *Casearea moluccana, Homalium tomentosum, Exocarpus latifolius, Allophyllus cobbe, Erioglossum rubiginosum, Ganophyllum falcatum, Schleichera oleosa, Palaquium amboinense, Melochia umbellata, Pterospermum diversifolium, Phaleria octandra, Grewia eriocarpa, Grewia koordersiana, Schoutenia ovata, Celtis cinnamomea.*

4) Climate: See Viqueque.

5) Soil: Coastal lowland soil (Plc), high ground water table; locally Bobonaro Scaly Clay emerges at the surface.

6) Land use: Very scattered to'os cultivation (except near Bé Aço); wet rice fields at Uato Lari Plain; hazard caused to agriculture by scattered clay outcrops (sota-coconut plantation at Ra Tahu); some livestock grazing. Because of malaria, generally avoided by the Timorese.

7) Photographs: Plate 23.

E.Z. 24: Mangrove Zone

1) Description: Mangroves in sheltered inlets formed by seasonally ponded rivers caused by sandbars at river mouths made by wave action; also occurs in furrows in between beach ridges where water tends to stagnate during dry months of the year (locally known as coilão).

2) Distribution: Along south coast between Rivers Bé Tuco and Cuha; east of Bé Ro forest towards River Bé Bui.

3) Flora:
   Trees and shrubs: *Bruguiera cylindrica, Avicennia marina, Sonneratia* sp.
   From Meijer Drees (1951): *Dolichandrone spathacea, Cordia subcordata, Diospyros maritima, Glochidion obscurum, Mallotus ricinoides, Inocarpus fagiferus, Hibiscus tiliaceus, Thespesia populnea, Broussonetia papyrifera, Melaleuca leucadendra, Corypha utan, Pandanus tectorius, Acrostichum aureum.*
   From Gomes (1950c): *Bruguiera* sp., *Rhizophora conjugata, Sonneratia alba, Excoecaria agallocha, Aegiciceros corniculatum, Lumnitzera racemosa, Xylocarpus granatum, Heritiera littoralis, Acanthus ilicifolius, Caesalpinia* sp., *Cycas circinalis.*

4) Climate: Edaphically controlled E.Z.

5) Soil: Unconsolidated peat soils.

6) Land use: None.

7) Photographs: Plate 14.

E.Z. 25: Foho Manu Volcanic Outlier

1) Description: Small isolated hill of volcanic origin (Barique Formation) covered with slightly deciduous forest.

2) Distribution: Mt Foho Manu (247 m) near plain of Narequiçi (Uato Lari).

3) Flora: No data.

4) Climate: See Uato Lari.

5) Soil: Lithosolic soils.

6) Land use: None, too steep.

7) Photographs: Plate 15.

Appendix II

Alphabetical list of place names given in Fig. 3*

Ai Bubur Laran	C2	Bicaliu River	E3
Aidilalita	F3	Boro Uai	B4
Alas Oan	G1	Buanurac	E2
Aliambata	E5	Buareça	E3
Apanar	D2	Builai	B3
Assa Lai Tula River	D2/3	Builó	E3
Aubaca	B2	Bui Lua	E2
Audadan	G1	Caibada	C3
Badonau	B1	Cai Daua Lari	E3
Baha Bunac	F1	Cai Hae	D3
Baha Lata	E2	Cailato Lale	E2
Bahaneu	E1	Cailoi	G1
Baucau	A3	Cailoi Bere	F3
Baucau Airport	A2	Cailubo Oli	B2
Bé Aço	G3	Cai Male Hoo	C3
Bé Bui	D4/E4	Caisido	A2
Bé Laco	F1	Cai Uá	D1
Bé Nara	G3	Cai Uai Hoo	D2
Bé Ro	G3	Cajularan	F1
Bé Tali Tua	F1	Caravela	A1
Bé Tice	F2	Cassa Mau Cai Uada	A2
Bé Tuco River	D1/G1	Cassaquiar River	C3/4
Bia Issi	E3	Coilão Bé Sain	E4
Bibiluto	G2	Coilão Molic Oan	G1

* For suco names omitted on this map see Fig. 5.

Coilão Ué Ainfoan G1
Coilão Ué Turac G1
Cuha River E2/F2/G2
Culate F3
Cumo A2
Curacate E3

Dali Rissi D3
Dara Hoba D2/E2
Darasula B2
Darenau D3
Dauboro Baha D2
Derulo E3

Edemumo E4
Essa Issi E1

Fahi Berec F2
Fatoliana C2
Fatumaca de Cima B3
Fatun (Plain of Uato Lari) E4
Fatún E2
Festau B4
Futudu F2/E2

Gailata C3
Gômi Lari E3

Hai Bai C2
Hai Gala D2
Hainau C3
Hare Bé Oan F2
Has Abut F2
Hatodona B1
Hoi Né Uai C1

Lacôbi E2
Lacoto E1
Laga A5
Lai Soro Lé E3
Laleia River D1
Laliu F4
Lamac Laran F2
Larigutu D2
Lecrace Lale A4
Leo C3
Lequileuato B2
Lete Quisse E3
Liabala C3
Lianida D2
Liaró D2
Liasidi B3
Loho G2
Loibua B3
Loimé D3
Lua F2
Luca G1
Luli Heni A2

Macabu D3
Macadai de Baixo A2
Macadean F2
Macalosso F3
Mamulac F2
Mane Hat F2
Manolari (Ossoroa) E3

Manolari (Uma Quic) F1
Manoléden River A1/B1
Maubu C3
Maucali B3
Maurate D3
Mt Birac B1
Mt Builó E3
Mt Burluli F2
Mt Caicato Lale D5
Mt Caileti Lale E2
Mt Caitia D1
Mt Diribubo C5
Mt Fato Laran F3
Mt Foho Manu E4
Mt Hai Osso B1
Mt Hak Arat Lale D2
Mt Laritame D2
Mt Laualiu C4
Mt Loirubi D2
Mt Macadique D4
Mt Macalosso C4
Mt Mata Bian C5
Mt Mundo Perdido D1
Mt Ossoala C1
Mt Ossoaque D1
Mt Ossocou C3
Mt Ossu E2
Mt Uatolaua E2
Mt Uatoreli E2
Mt Ulohua E2
Mt Urubai C3
Mt Venilale C2
Narequici E4
Nourissi E2
Nunu Mé B1
Ossobei D3
Osso Coqui E3
Ossolata A2
Ossoliro C4
Osso Uá A2
Ossu E2
Plain of Luca G1
Point Bondura A2
Point Dailubun G3
Point Luca G1
Point Niqui G3
Quelicai C4
Rai Hun G2
Railá D3
Raimuti E2
Rai Sut G2
Ra Tahu G2
Reo Bai E1
Roliu River D4
Salele D1
Salubada River C3/4
Samalari E3
Sama Liurai E3
Saúma River E3/D3
Seiçal River D3/A4
Siralari F2

Tu Nihan D2
Tula Vaen E1
Uai Behe Ana C2
Uaibobo E3
Uaicana C3
Uai Heda E2
Uai Hura A3
Uai Lacama River B1/2/A1
Uai Laco Uli B1
Uai Lequi River D3/4/E4
Uailia D2
Uailili B3
Uai Múhi River B5
Uainoe B2
Uai Ono A2
Uai Reça (=Caibua Lori) River C2/3
Uairio D2
Uaisimo D2
Uaisuli D2
Uaisuli River C1/2
Uai Suli C3
Uai Tobono D2
Uaitutomata D2
Uala Uau E2
Uanisse C3
Uata Cau Issi E2
Uatalata B3
Uata Luca E3
Uatamuni F2
Uatobuti C3
Uato Co C3
Uato Dere E3
Uato Iro C2
Uato Ita (Ossu de Cima) D2
Uato Ita (Ossoroa) C2
Uato Lari E4
Uato Manotuco D2
Uatomissa D3
Uato Uá B3
Uhacae G1
Uitau D3
Uma Ana Ico D2
Uma Bere E2
Vemasse River C1
Venilale C2
Viqueque F2

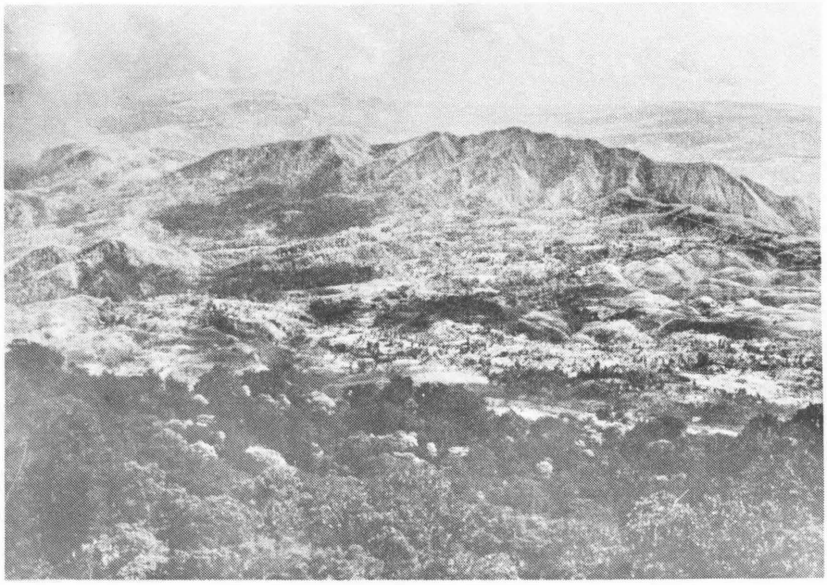


Plate 1 Ossoala Range, seen from Mt Mundo Perdido (1769m) looking north: knife-edged ridge covered with *Eucalyptus alba*; western escarpment of Baucau Plateau behind ridge.

14.9.69 9. a.m.

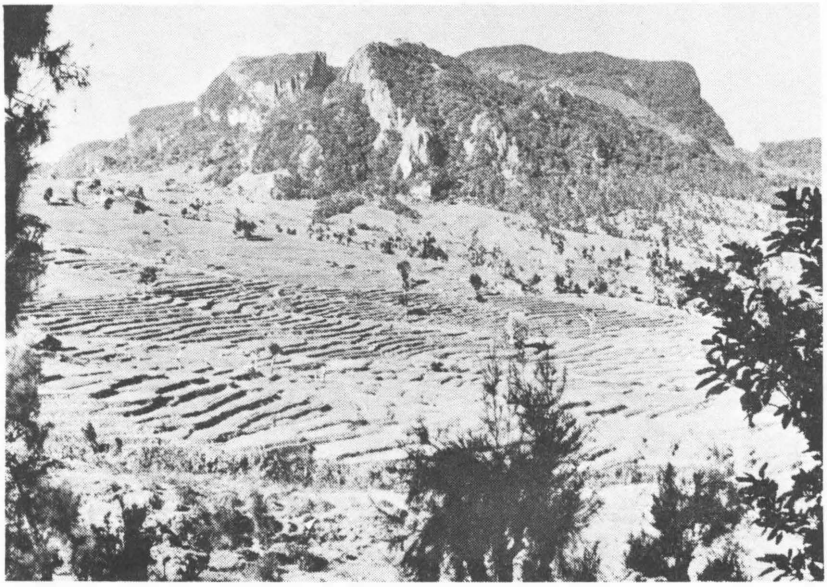


Plate 2 Central upland, fatu block of Mt Laritame (1417m) viewed from the south covered in upper reaches with medium altitude moist evergreen forest; *Casuarina junghuhniana* savanna reaching to the foot of mountain; low-yielding rice fields of Larigutu on heavy clay soil (CN) in foreground.

11.10.69 12 noon

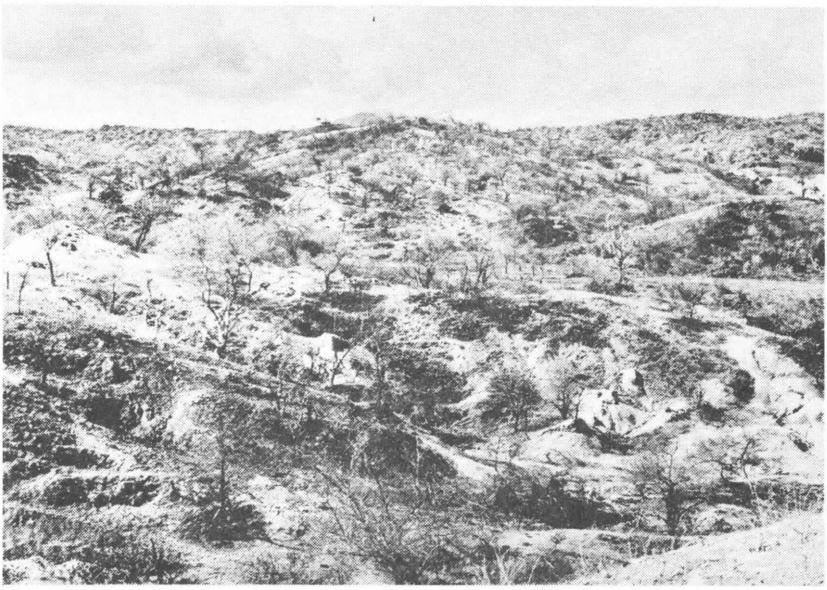


Plate 3 Quelicai, road to Baucau, north of Mt Laualiu (400m), looking north: *Borassus flabellifer* savanna on Aitutu Formation; brown calcareous soils (PCX); palms provide tuak and construction material for houses and household utensils.
19.11.70 6 a.m.



Plate 4 North coast, near mouth of River Seiçal, looking south: Seical Formation, complete soil deterioration; xerophytic vegetation consisting of *Zizyphus mauritiana* trees and *Azima sarmentosa* (Macassai: sehe); deforestation due to excessive cutting of wood required for salt production.
16.12.69 10 a.m.



Plate 5 Baucau Plateau, eastern rim, suco Gari Uai, near Maucali (500m), looking north: peasant with bundled maize cobs earmarked for planting.
13.12.69 4 p.m.



Plate 6 Southern slope of Mundo Perdido Range (750m): hunter with blowpipe (au hu) and killed monkey; secondary vegetation on abandoned to'os as indicated by *Psidium guajava* bushes behind man.
10.5.70 8 a.m.

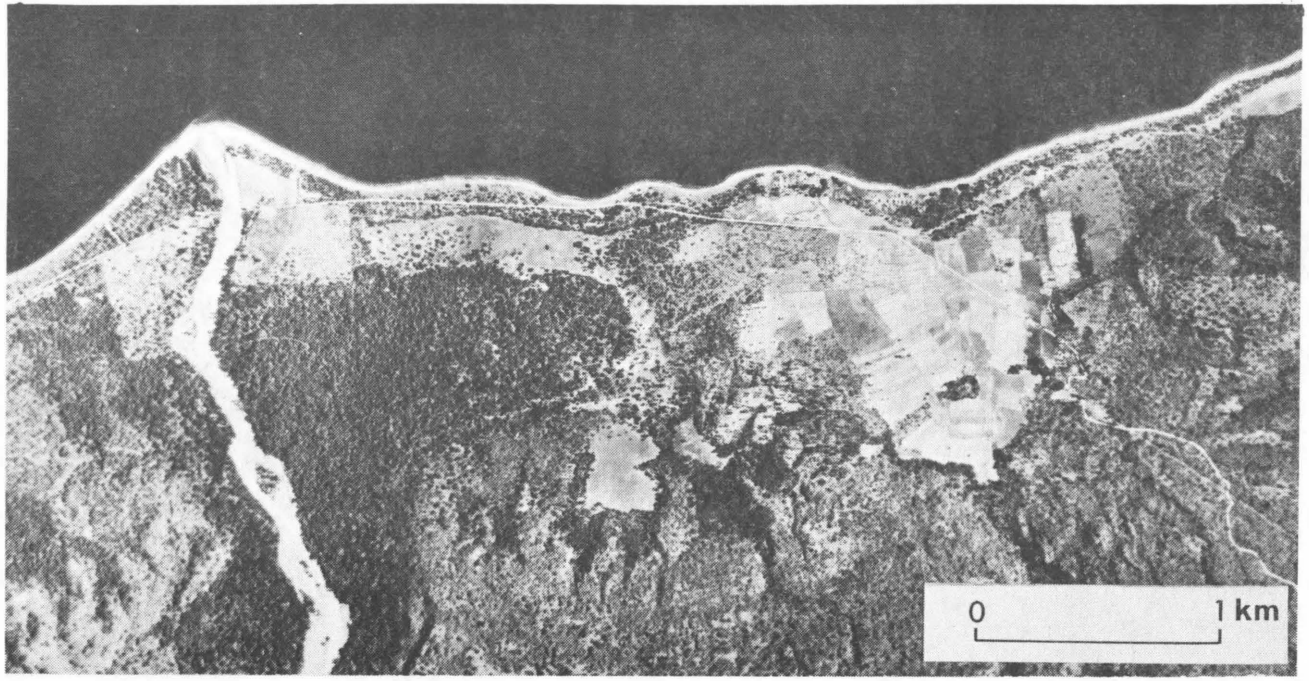


Plate 7 Mouth of River Manoléden, north coast, forming the northwestern limit of the Area. Dense riverine forest of chiefly *Corypha utan* fringe the wide rubble bed of the river. Back plains of Caravela between beach and lower slopes of Baucau Plateau are used for natar cultivation (largely rainfed) and scattered coconut growing. Abandoned coconut plantation belonging to a Chinese of Baucau is seen on both embankments of River Manoléden at river mouth.

H: 4900m, T: 8.15 a.m., D: 15.8.1962, No: F7/08



Plate 8 Mouth of River Seiçal. Instability of flood-plain is evidenced by wide scrolls, oxbows, oxbow lakes and levees. Wherever possible riverfed natar cover the lower lower terrace. Mud flats north of Baucau-Lautem road remain uncultivated because of salinity hazard due to incoming seawater during the northwest monsoon. Heavily deforested and eroded hills of Seiçal Formation are seen in lower left hand corner.

H: 4710m, T: 9.05 a.m., D: 15.8.1962, No: F9/31

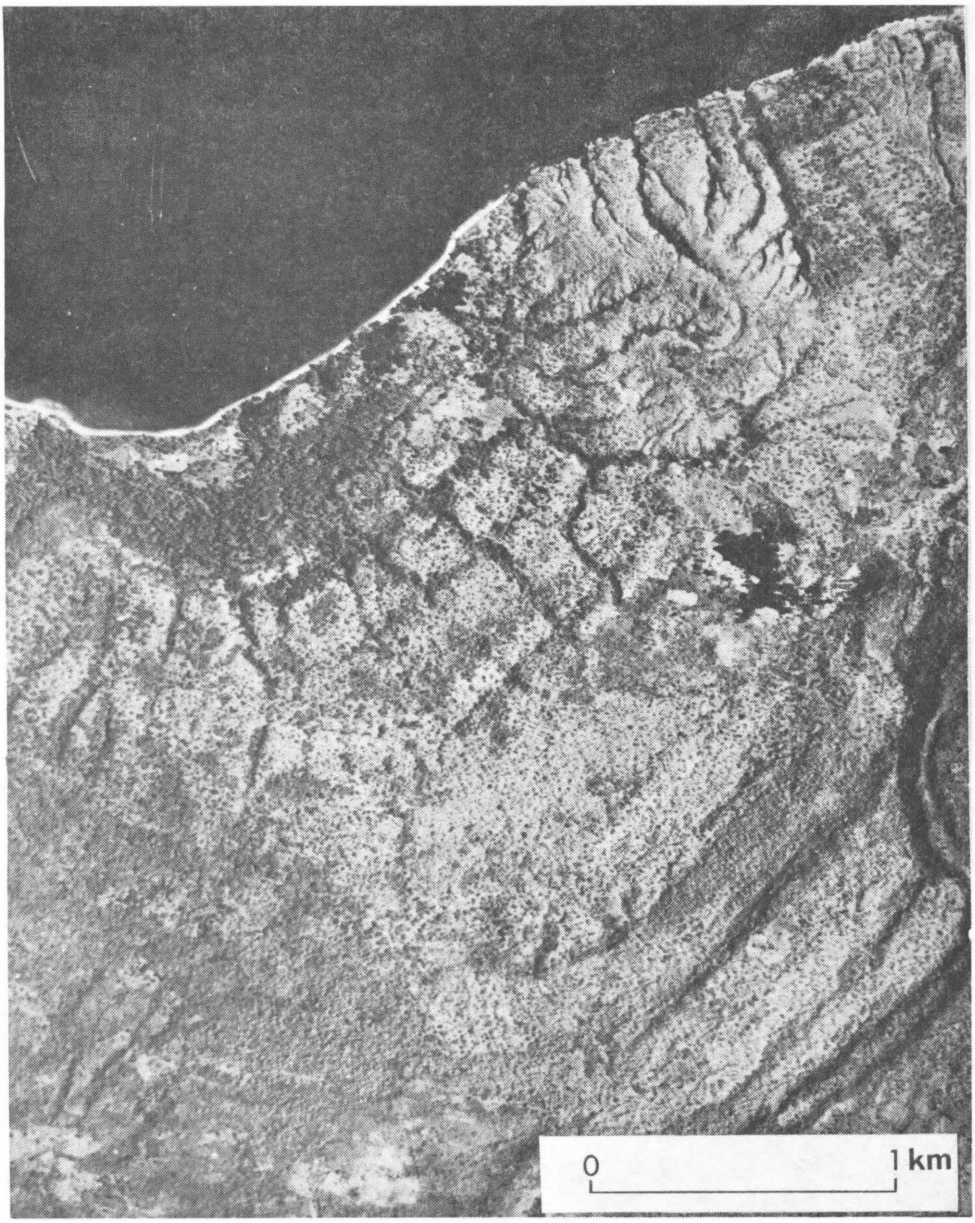


Plate 9 Series of elevated marine terraces of Baucau Plateau, covered with *Eucalyptus alba* (light patches). Strongly deciduous forest with predominantly *Tamarindus indica* at left (dark mottled). At seafront: mud flat of Uai Ono studded with *Borassus flabellifer* palms receiving surface downwash from surrounding hills. Note water seepage at lower terrace. Hamlet Ua Sa at spring indicated by cluster of dark trees.

H: 4900m, T: 8.15 a.m., D: 15.8.1962, No: F7/04

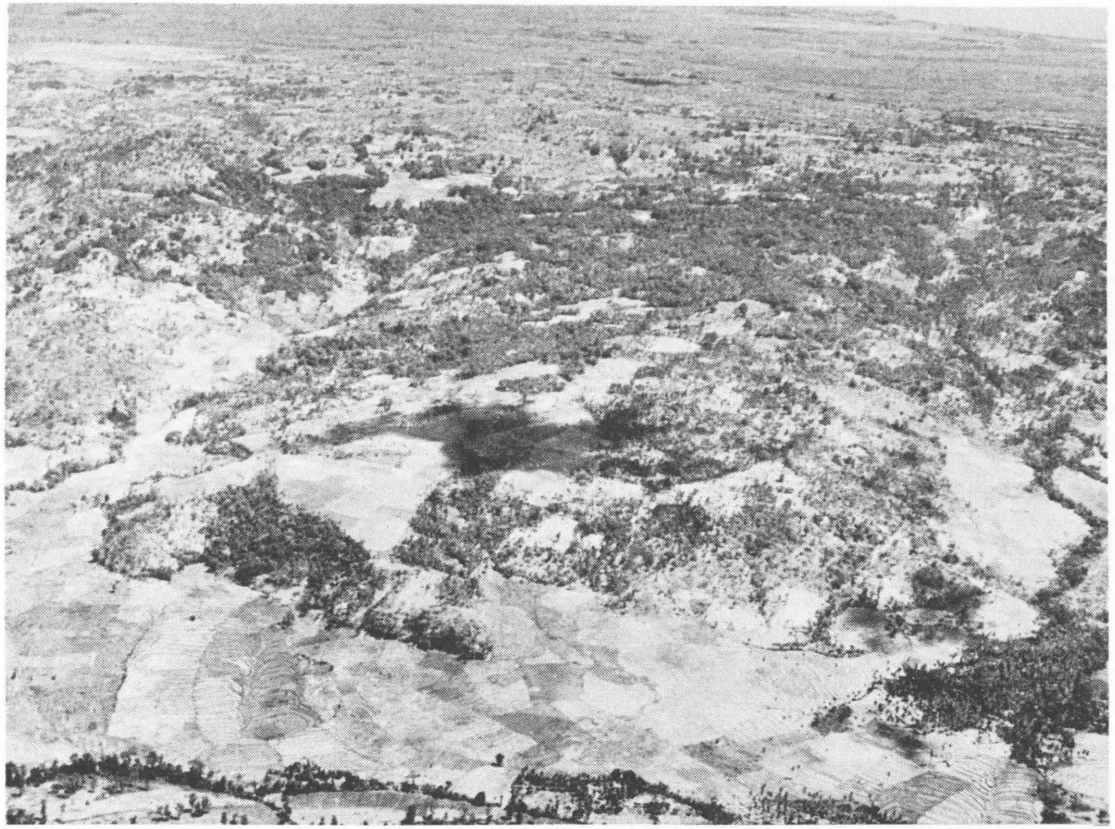


Plate 10 Baucau Plateau, eastern escarpment, looking west from Fatumaca de Cima (400m) down to floodplain of Seical River at lower margin of photograph (100m); springfed rice fields along escarpment.

12.8.69 12 noon

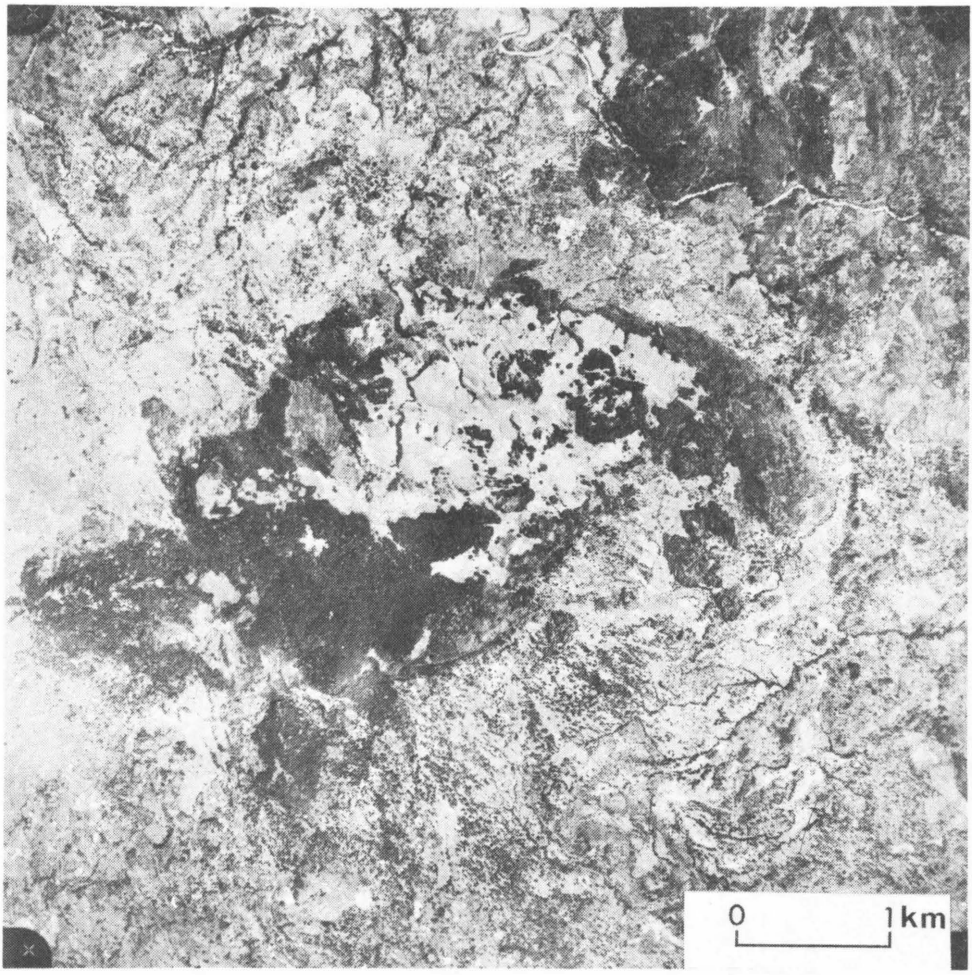


Plate 11 Mt Laritame fatu block in centre; Assa Lai Tula River in the north winding through gorge between Mt Laritame and Mt Venilale (seen in upper right hand corner).

H: 4999m, T: ?, D: Aug 1963, No.: F12/13/26

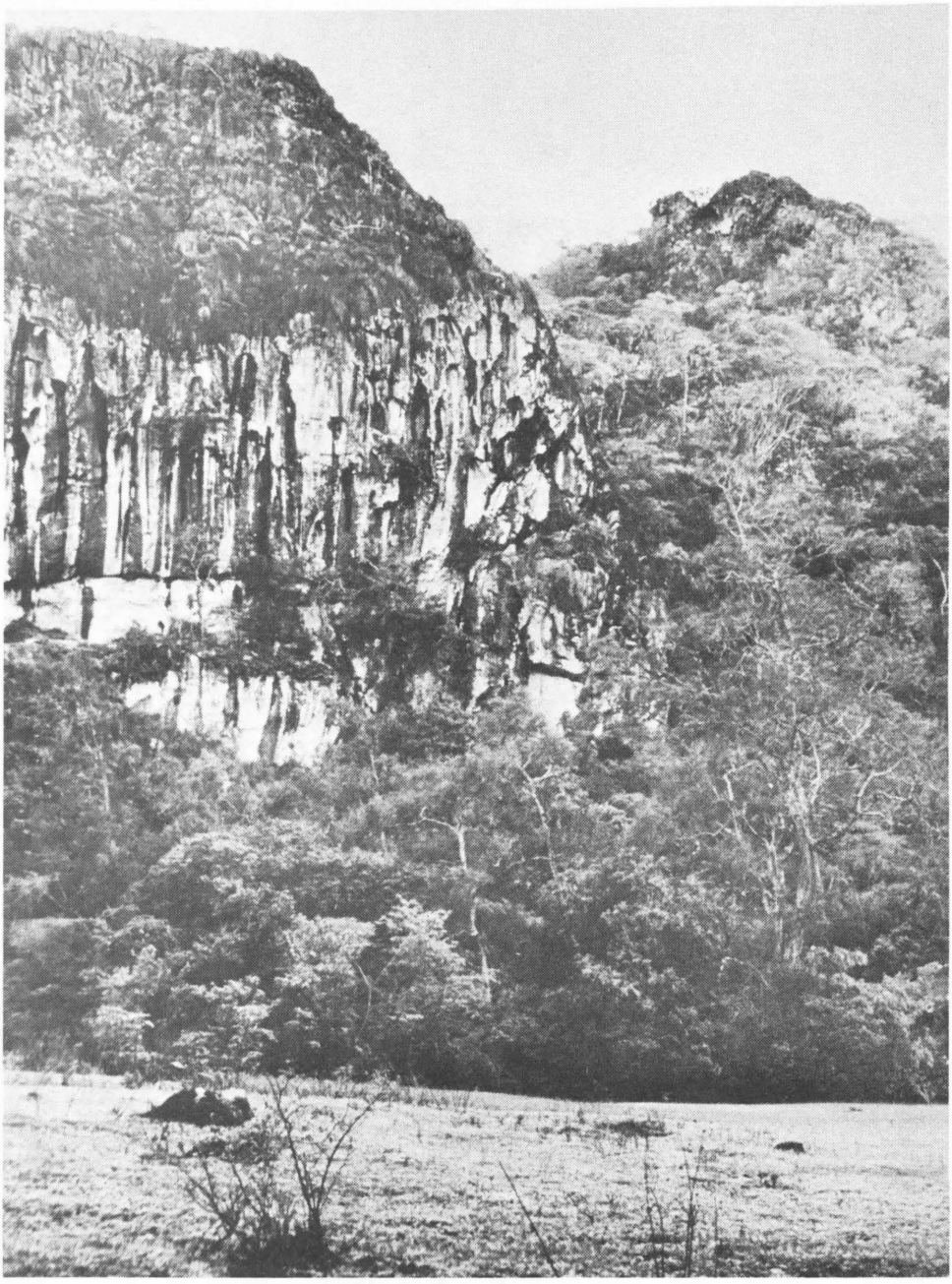


Plate 12 Mt Hak Arat Lale, part of Mt Laritame-Mt Venilale fatu block: gorge of River Assa Lai Tula (600m), looking south from river; karst features; slightly deciduous forest. 22.12.69 10 a.m.

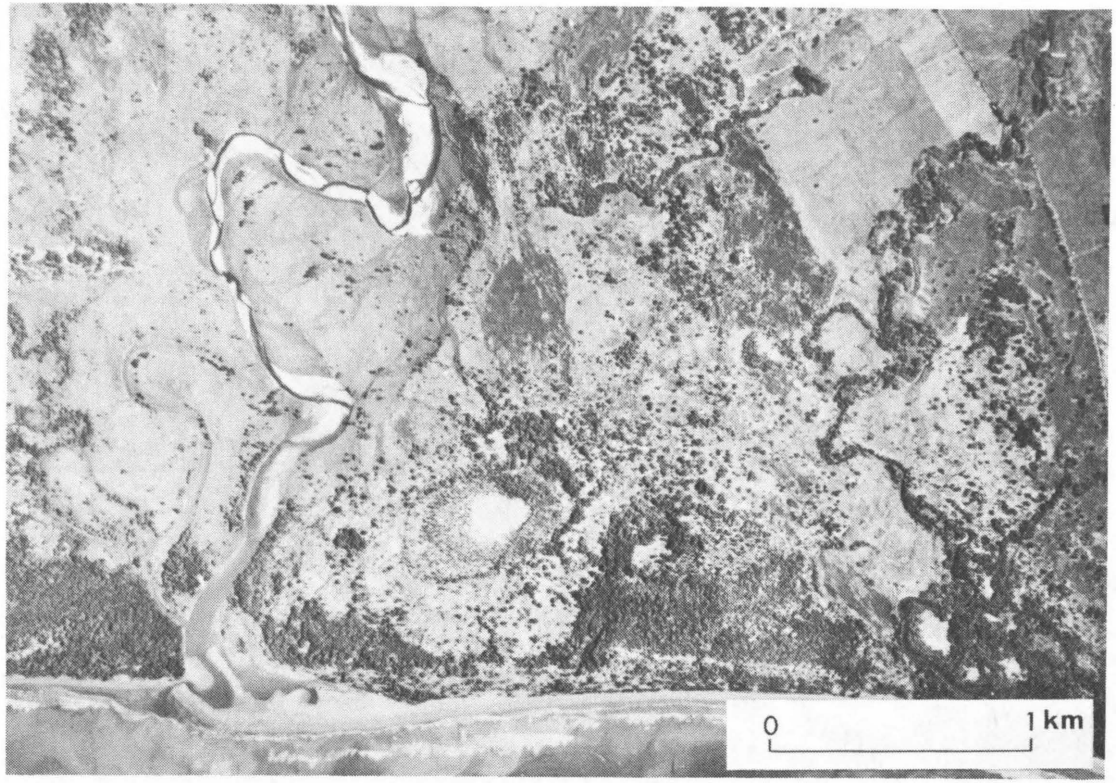


Plate 13 Mouth of perennial River Cuha (south coast): scrolls and cut-off meanders bear witness to the dynamics due to highly variable rainfall. Rai Sut mud volcano fringed by *Casuarina junghuhniana* amidst *Corypha utan*, tall grass savanna is recognized by whitish tones. In upper right hand corner parts of Ra Tahu coconut plantation (SOTA, Dili) are visible. River mouth almost completely blocked by sand spits due to tidal action.

H: 4605m, T: 8.00 a.m., D: 15.8.1962, No.: F18/06

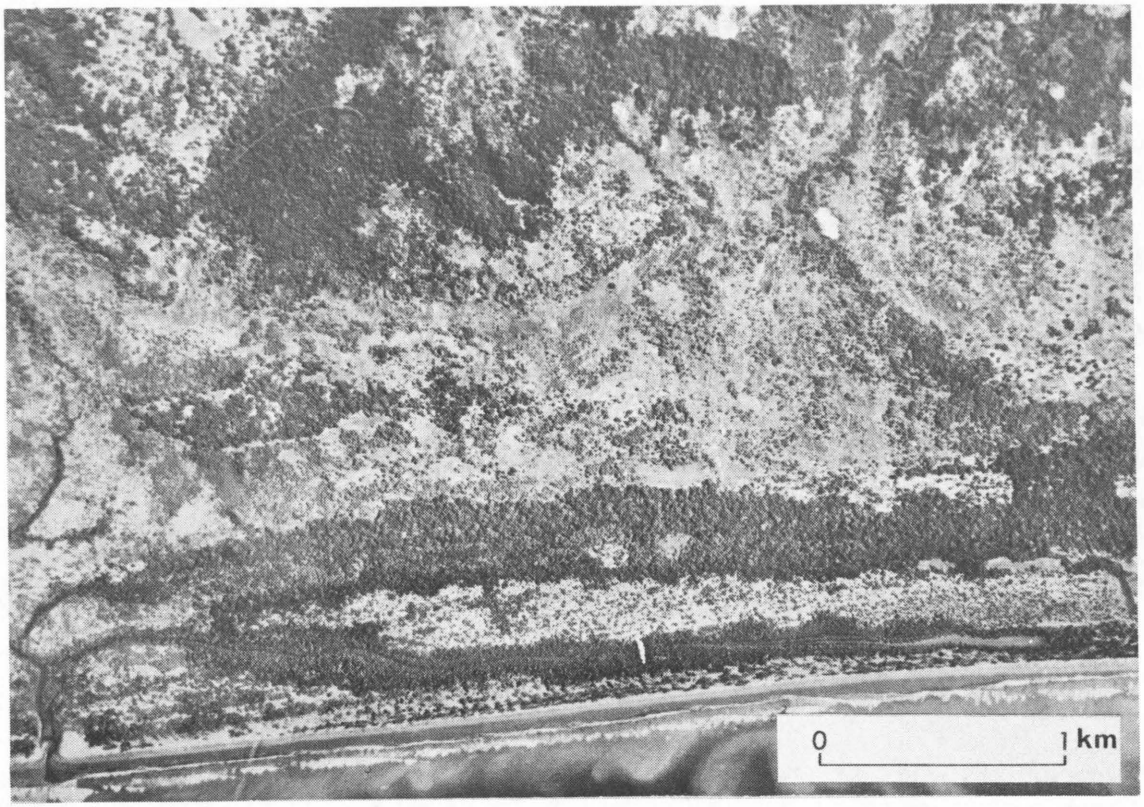


Plate 14 Southern Littoral Plains Zone with adjacent Southern Foothill Zone. Coilao Molic Oan and Coilão Ue Turac running parallel to the coast in swales and flanked on both sides by mangrove. Coastal Plain covered with tall *Saccharum spontaheum/Imperata cylindrica* grass savanna.

H: 4605m, T: 8.35 a.m., D: 15.8.1962, No.: F18/08

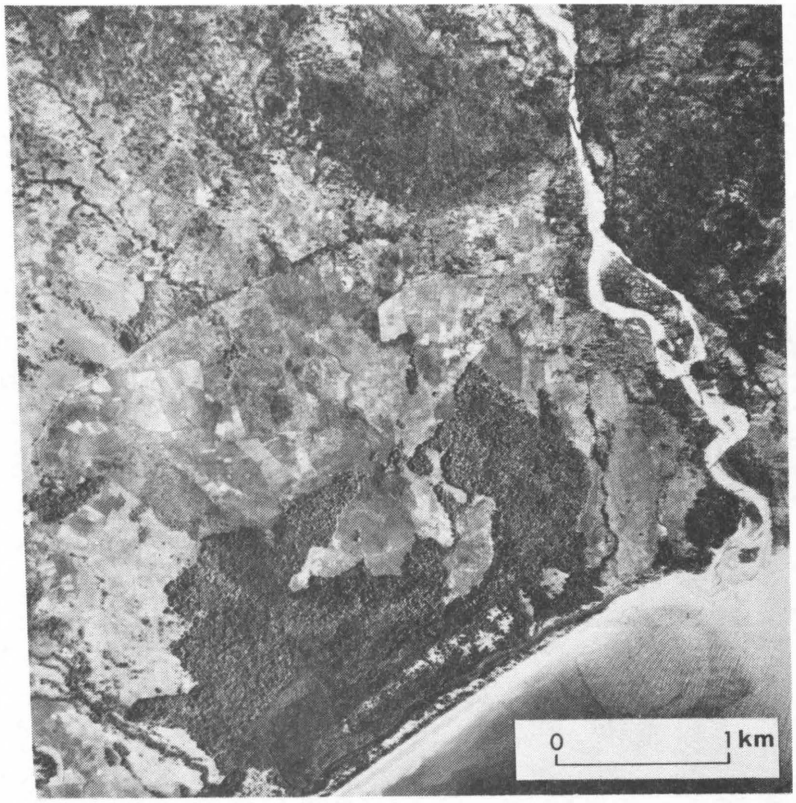


Plate 15 Plain of Uato Lari (Plain of Narequici at right and Plain of Fatun at left). The extent of the tall swamp forest that still covered the lower half of the plain in 1962 when the aerial survey was taken had shrunk by 1970 as more land was needed for natar cultivation. Coilão Bé Sain, running parallel to the coast in between beach ridges till it breaks through to the sea, is fringed by mangrove. Mt Foho Manu (247m) is seen above (centre).
H: 4695m, T: 8.45 a.m., D: 15.8.1962, No: F.F/19



Plate 16 North coast, suco Seiçal, eastern escarpment of Baucau Plateau (100m): heavy clay soil (CN); deep cracks during dry season; *Jatropha gossypifolia* bushes. 10.12.69 3 p.m.

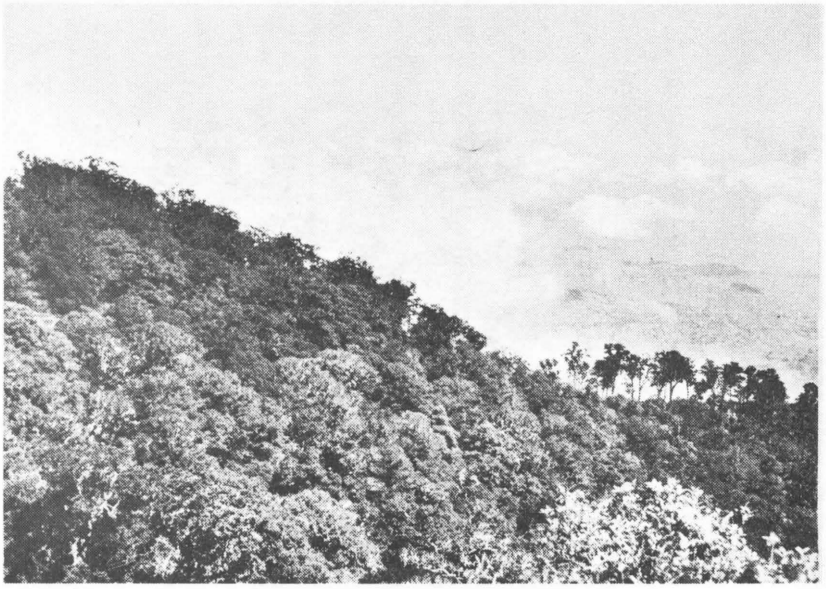


Plate 17 Mt Mundo Perdido (1769m) north slope, looking west: tropical cloud montane forest; at lower left *Podocarpaceae* festooned with beard mosses.

14.9.69 9 a.m.

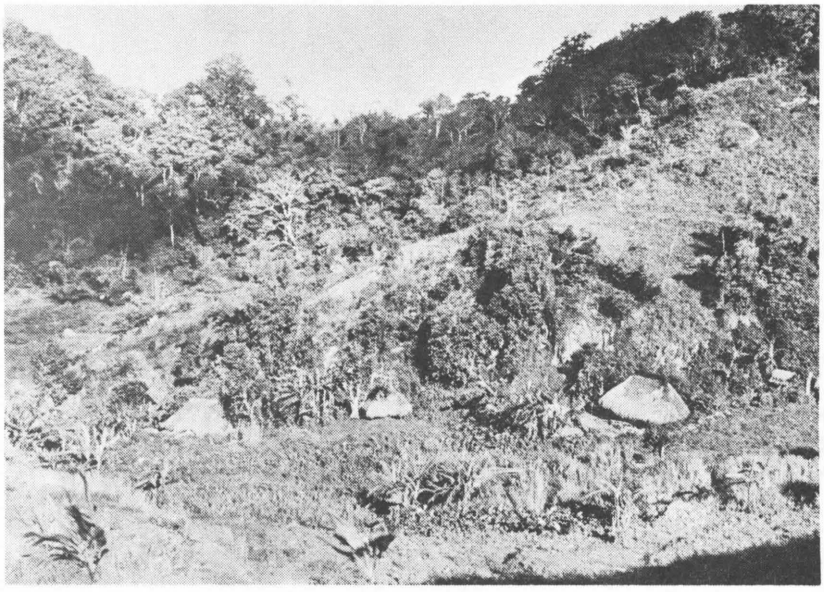


Plate 18 Mundo Perdido Range, north slope (1300m), Tu Nihan hamlet (to village Uairio, suco Ossu de Cima), highest permanent settlement in the Area, surrounded by medium altitude moist evergreen forest. Taro in stagnating water near houses; bush fallowing practised on slope.

15.6.70 3 p.m.



Plate 19 Mundo Perdido, northern slope (1200m): *Eucalyptus urophylla* woodland.
15.6.70 12 noon



Plate 20 Mt Ossoala, northern slope, suco Ossoala (500m), looking west: ***Eucalyptus alba*** savanna, skeletal soils, sheet erosion due to periodic buring for grazing purposes.
11.10.70 2 p.m.

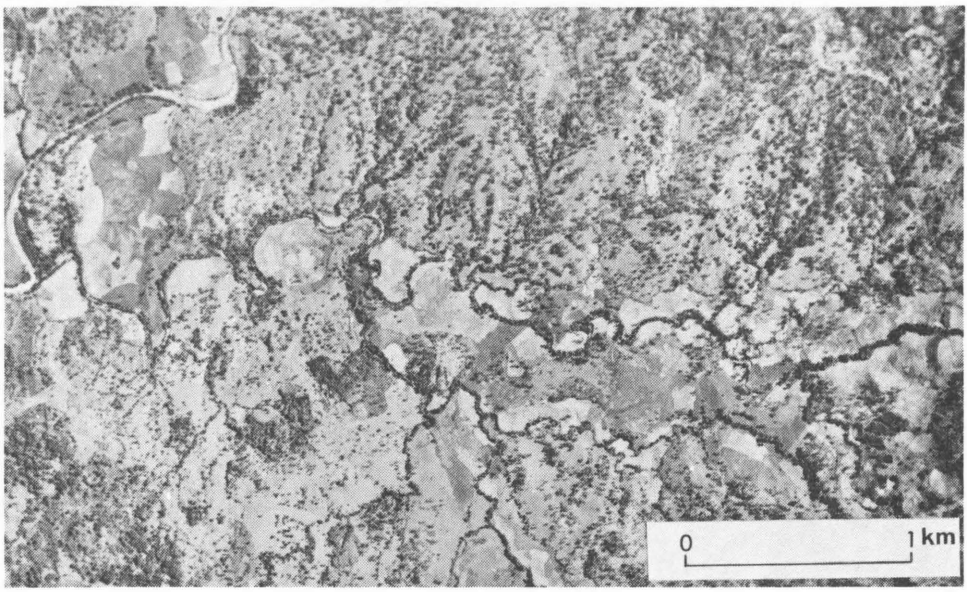


Plate 21 Floodplain of River Bicaliu, tributary of Cuha, which is seen on the left. Heavy clay soils (CN) covered with *Casuarina junghuhniana* savanna are not cultivated. Here livestock grazing is common.

H: 4900m, T: 8.30 a.m., D: 15.8.1962, No: F15/39



Plate 22 Southern foothills, southeast of Viqueque (100m): *Corypha utan* savanna. 24.3.70 11 a.m.



Plate 23 South coast, littoral plains zone, south of Loho, looking west: *Corypha utan* and tall *Saccharum spontaneum* grass (soco), *Imperata cylindrica* (duut manu lain) in foreground; at left swamp forest grading into mangroves along Coilão Uê Turac.
3.4.70 11 a.m.

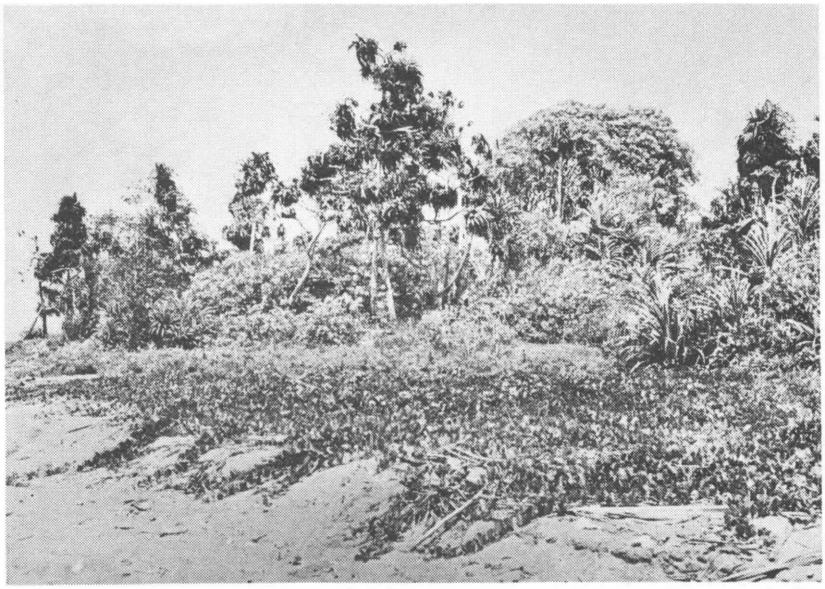


Plate 24 South coast, west of Bé Aço: in foreground *Impomoea-pes-caprae* creepers, behind which are *Spinifex littoreus* and *Calotropis gigantea* (fuka); wind shorn spray-burnt wall of *Scaevola taccada* (ai hudi) in association with *Pandanus odoratissimus* (heda). The crown of the large tree behind the beach belongs to swamp forest.
11.10.69 9 a.m.

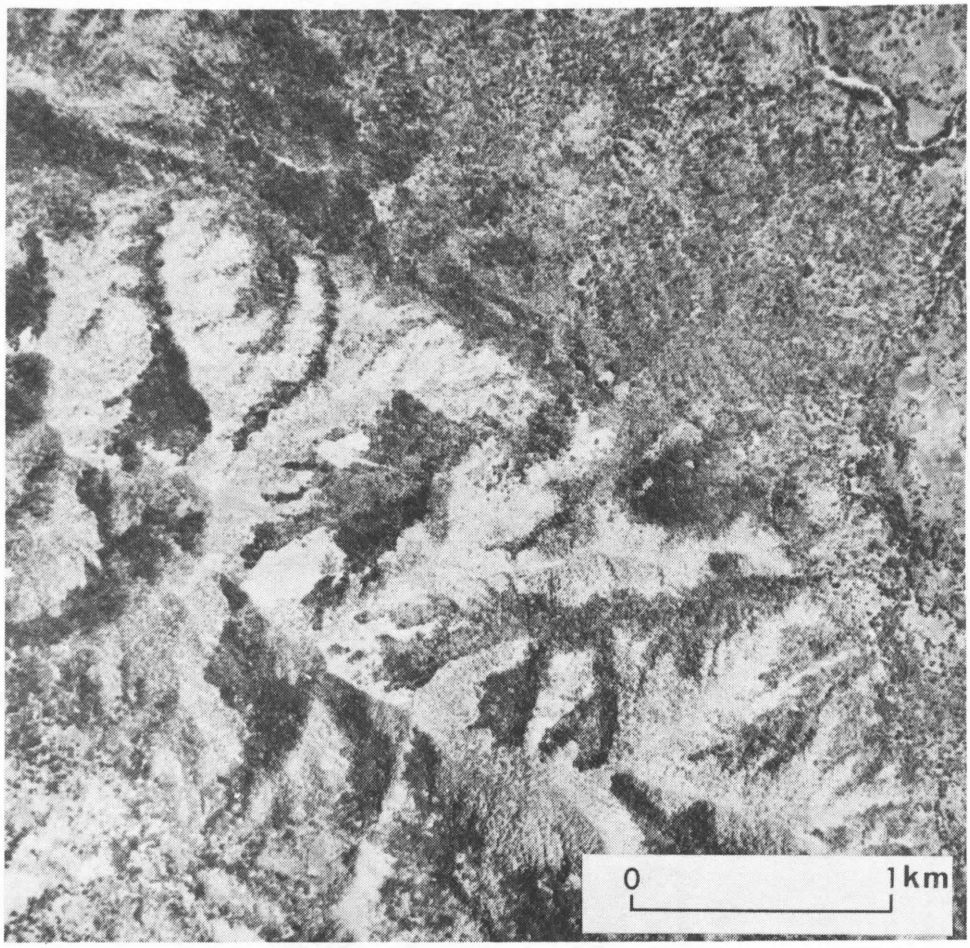


Plate 25 Mt Ossoala ridge of volcanic Barique Formation covered on its knife-edged crests with *Eucalyptus alba*, while semi-deciduous forest fills the ravines. The juxtaposition of Australian and Southern Asian vegetation types is here clearly visible. Some natar along River Vemasse (upper right corner) and River Uai Suli (right margin).

H: 5865m, T: 9.40 a.m., D: 15.8.1962, No.: F11/33



Plate 26 Mundo Perdido Range (1400m): hunter with spear and catana (on shoulder), and head of wild boar in left hand. Medium altitude moist evergreen forest (lulik) in background.

28.11.69 3 p.m.

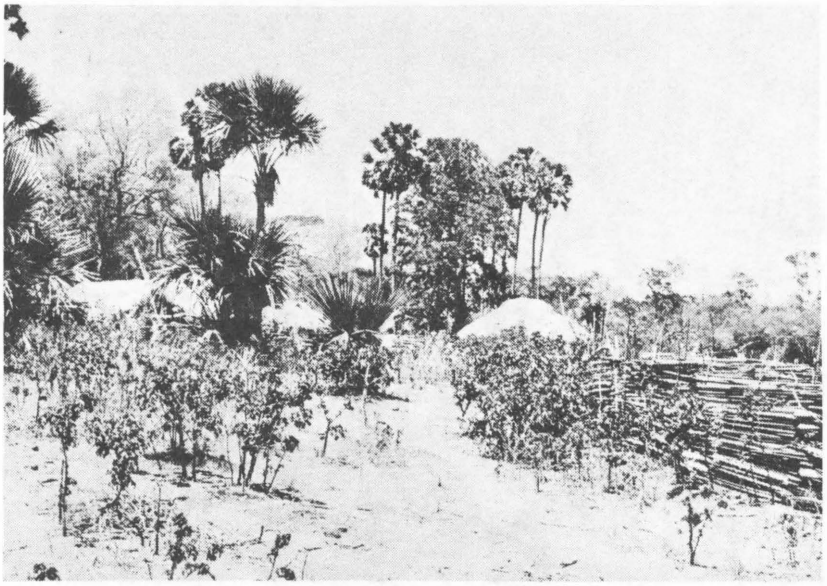


Plate 27 North coast, west of River Manoleden (50m): to'os fenced in with leaf stalks of *Corypha utan; Jatropha gossypifolia* scrub in foreground.

5.12.69 2 p.m.

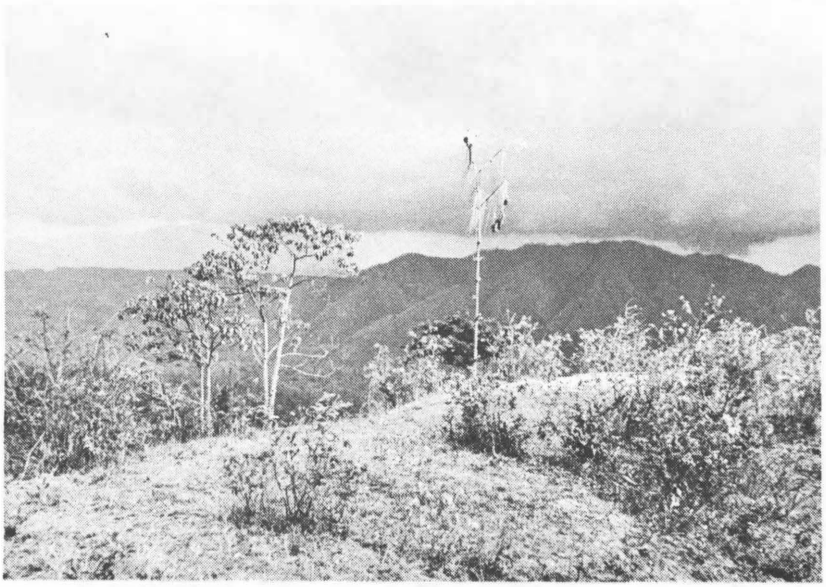


Plate 28 Baucau Plateau, soco Loilubo (650m), looking south: bando pole reminding suco members of taboos; in background Ossoala Range (right) and Mt Mundo Perdido (left); *Psidium guajava* in foreground.

4.12.69 3 p.m.



Plate 29 South coast, suco Maluro, north of Macalosso (100m): tilling (fila rai) on alluvial soil by means of digging sticks (ai suak); fence made of bamboo.
20.10.69 10 a.m.



Plate 30 Southern Foothill Zone, near Uala Uau, suco Loihuno (100m): drilling holes with planting stick (ai suak) for dryland rice in tilled to'os (fila rai).
12.5.70 12 noon

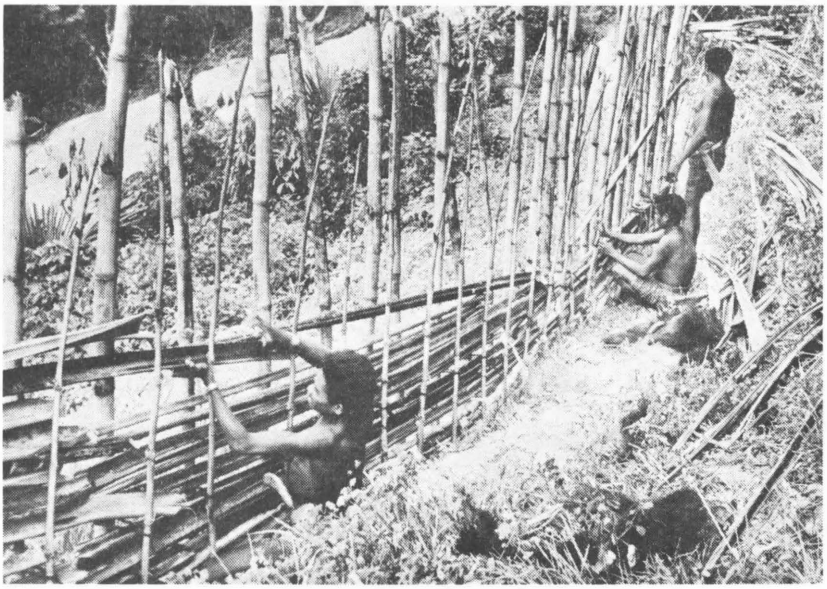


Plate 31 South coast, near Mt Burluli (300m): fence construction (halo lutun) with bamboo and leaf stalks of *Corypha utan.*

5.5.70 10 a.m.



Plate 32 Western escarpment of Baucau Plateau, suco Bucoli (300m), looking north: trampling of irrigated rice field by buffaloes (sama natar).

23.2.70 2 p.m.



Plate 33 Baucau Plateau, eastern rim, Uainoe, suco Gari Uai (500m), looking west: bund repair (halo kabubo) on rice field with digging sticks (ai suak).

7.1.70 12 noon



Plate 34 Venilale, near Fatuliana, suco Fatulia (800m): threshing of rice by foot (tuku hare).

3.7.70 4 p.m.



Plate 35 Venilale (800m): winnowing of rice.
28.6.70 4 p.m.

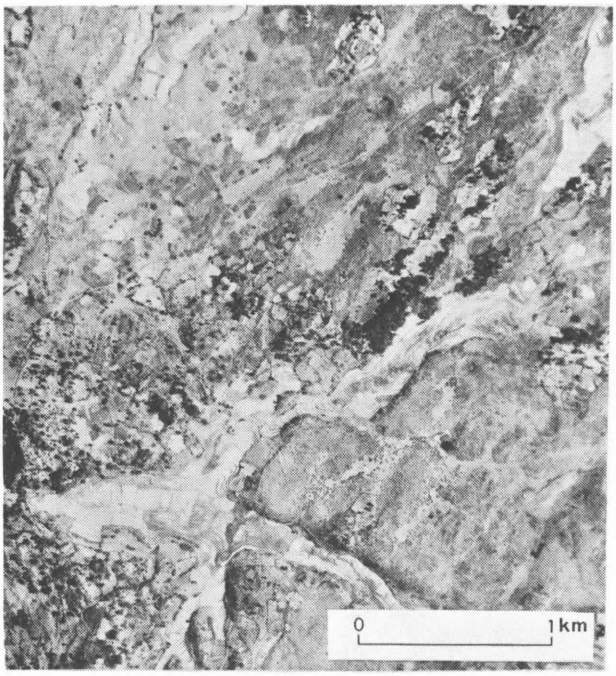


Plate 36 Suco Loilubo; Uai Behe Ana rainfed paddy field on southern rim of Baucau Plateau.
H: 5865m, T: 9 a.m., D: 15.8.1962, No: F10/30



Plate 37 Quelicai (700m), looking south from administrative centre: terraced rainfed rice fields in foreground; coconut palms and candlenut trees *(Aleurites moluccana)* in centre of photograph; at horizon Mt Builó (1247m).

22.10.70 10 a.m.



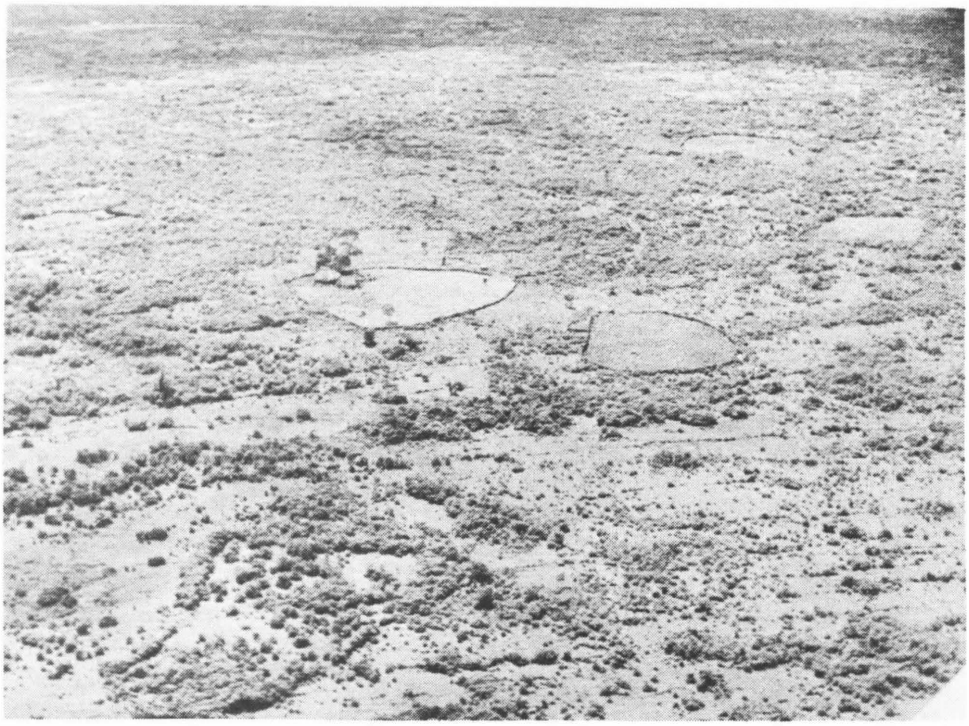
Plate 38 Baucau Plateau, eastern escarpment, looking east towards Mt Urubai (background): irrigated maize (batar bé) on terraced rice fields as a second crop.

15. 9.69 11 a.m.



Plate 39 Quelicai, near administrative centre (fila rai) with dibble (ai suak kiik) on terraced field, permanent dryland cultivation.
22.10.70 3 p.m.

Plate 40 Baucau Plateau (500m): to'os fenced in with coral limestone blocks; field on right under fallow; only a portion of field on left being tilled (fila rai); *Tecoma stans* scrub surrounding to'os.
30.1.70 11 a.m.



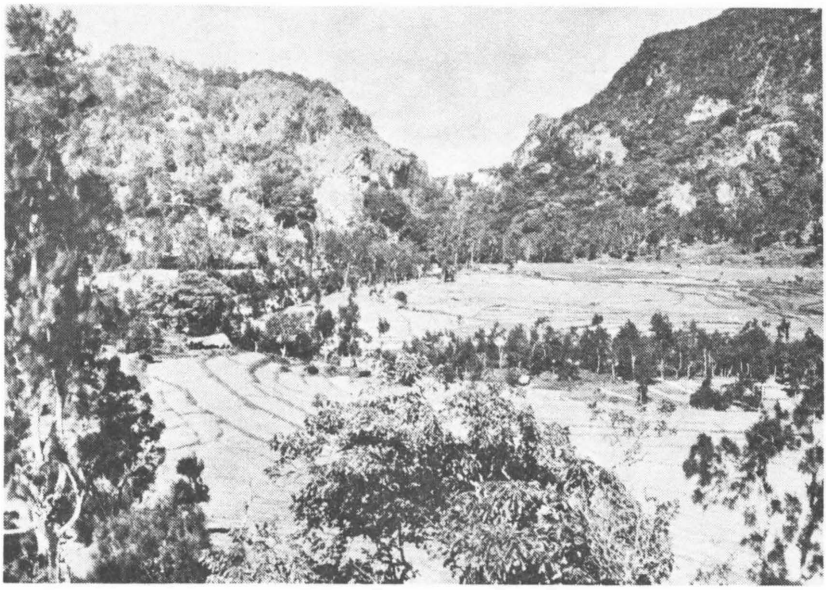


Plate 41 Venilale, Assa Lai Tula River, valley floor 650m, looking east: casuarina-fringed river winds through gorge betweetn Mt Loirubi, 812m (left) and Laritame fatu block (right). 29.6.70 12 noon

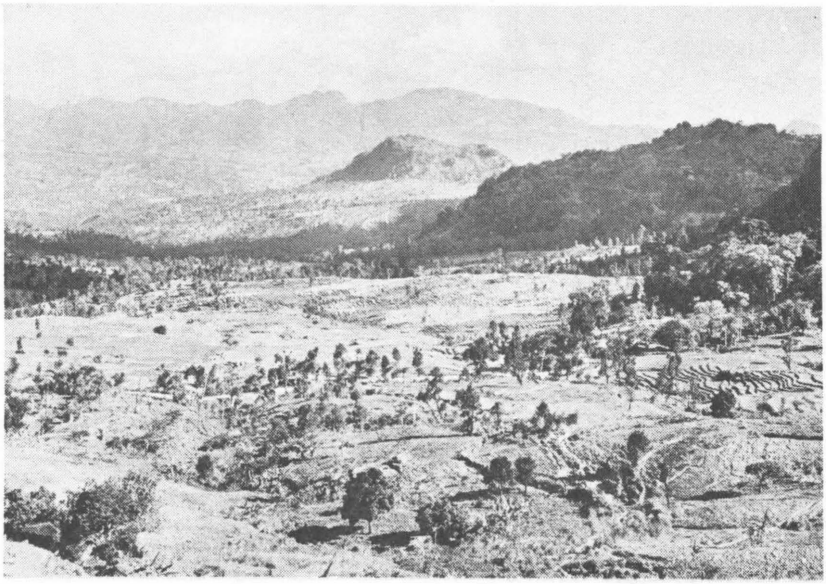


Plate 42 Central upland, viewed from Larigutu (1200m), from above village Cai Uai Hoo, looking southeast: Builó Range at horizon; Mundo Perdido Range at right; foreground Baucau —Viqueque road. 28.11.69 12 noon



Plate 43 Southern Foothill Zone, near Mt Burluli (300m): to'os clearing in slightly deciduous forest on steep hillside 30° slope gradient; stilted huts with overhanging roofs typical of Viqueque region. 20.10.69 10 a.m.



Plate 44 Ossu (650m), administrative centre, looking southeast: administrator's residence on top of hill in former fort; fortification seen left of the house; administrative building in front of residence; market hall with roof supported by pillars; three partly hidden Chinese shops (cantina) at left of picture, Builó Range on horizon. 10.5.70 10 a.m.

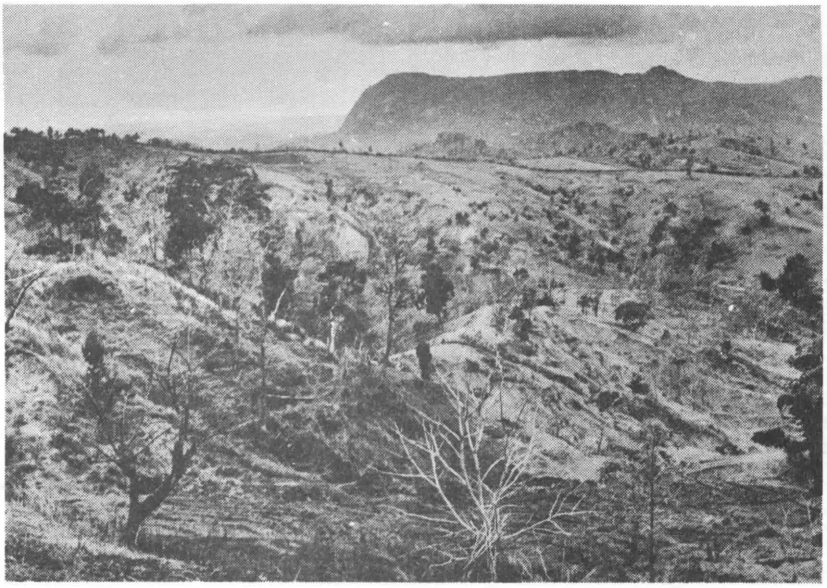


Plate 45 Quelicai, suco Maluro (400m), looking west: heavy clay soil (CN) severely eroded due to to'os cultivation; Mt Urubai in background.
21.10.70 1 p.m.



Plate 46 Venilale (800m), seen from Baucau – Viqueque road, looking west: *Casuarina junghuhniana* savanna, heavy clay soils, scarred by guiilies.
20.5.70 12 noon

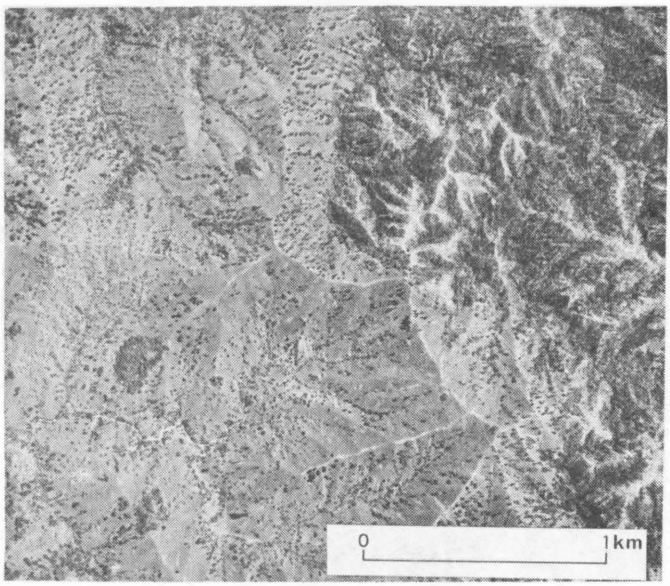


Plate 47 Heavy clay soils west of Mt Ossoala ridge (seen on the right), severely deforested and stripped of its topsoil. Parts above 300m (lower right and upper centre) covered with scattered casuarina trees. Only used for livestock grazing. Note that foot and bridle paths follow crests of hills.
H: 5865m, T: 9.45 a.m., D: 15.8.1962, No: F11/36

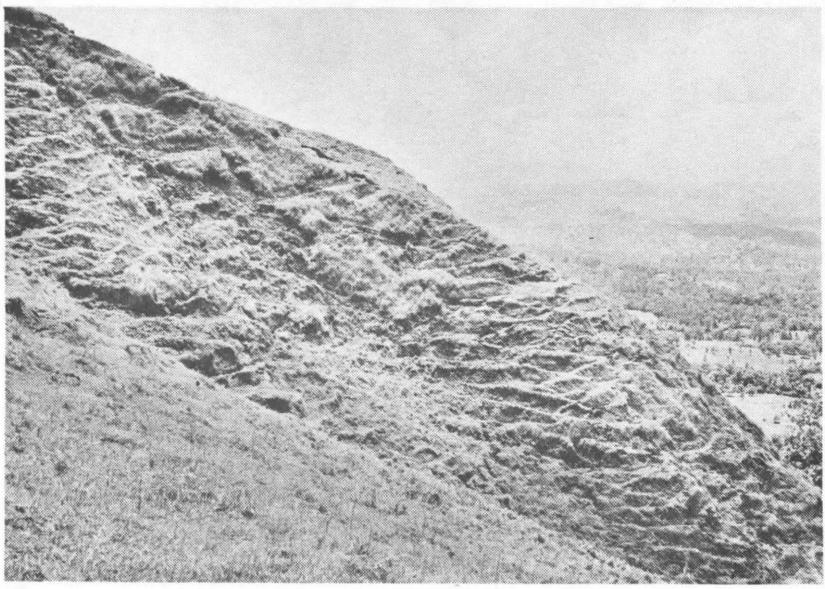


Plate 48 Mundo Perdido Range, southern slope, above Liaruca (900m), looking south: Barique Formation; scarred by erosion caused by livestock, *Casuarina junghuhniana* savanna on heavy clay soils (CN) along foothill zone.

23.11.70 9 a.m.

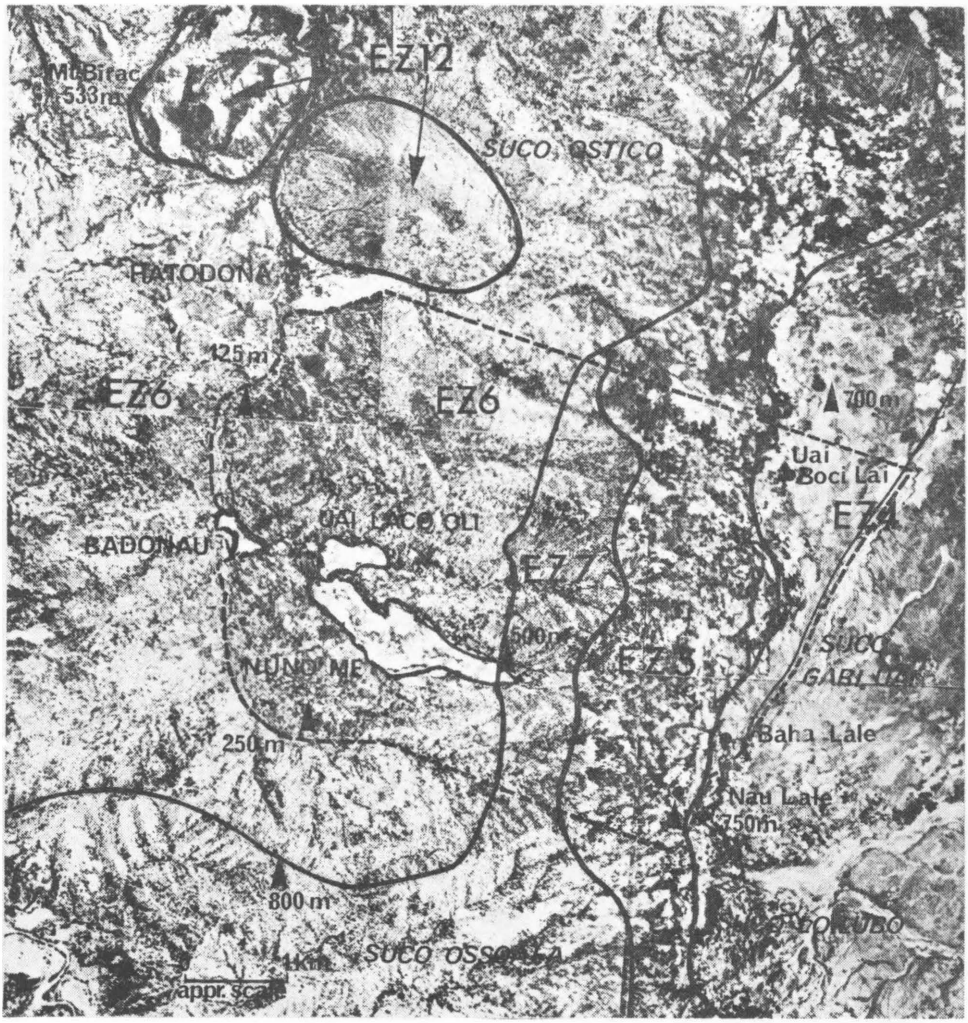


Plate 49 Western escarpment of Baucau Plateau: suco Vato Lari (Vemasse) (in dotted lines). (See Table 42).

Resumo

A ilha de Timor, a mais oriental das ilhas do arquipélago da Pequena Sunda, ocupa uma posição de passagem em virtude da sua situação entre a costa asiática e o continente australiano. Este facto está visivelmente expresso no revestimento vegetal, na fauna, na composição racial da população e na forma de exploração da terra.

Em comparação com outras partes do arquipélago, apresenta Timor condições geográfico-naturais muito mais desfavoráveis. Não obstante, subsistiu também aqui uma espécie de equilíbrio entre a população e o meio ambiente até à pacificação da ilha, no princípio deste século, pelas potências coloniais - Portugal a leste e Holanda a oeste. Epidemias e guerras tribais permanentes limitaram o crescimento da população. Só com a pacificação e introdução da medicina moderna, efectuadas pelas autoridades coloniais, se acelerou o crescimento da população. Este aumento não foi acompanhado por equivalente subida da produção agrária. O desequilíbrio daí resultante teve efeitos devastadores em consequência do encurtamento do ritmo de rotação na agricultura itinerante, do deflorestamento e da decrescente produção agrária, culminando com as actuais fomes sazonais.

Perante esta situação, pareceu ao autor ser uma tarefa particularmente útil analisar mais profundamente este desequilíbrio - se possível também quantitativamente - e, seguidamente, constatar em que medida a população se adaptou à nova situação. Por fim, devem ser apresentados pontos de partida para uma planificação regional que sejam capazes de estabelecer um novo equilíbrio entre o homem e o meio ambiente nesta parte do arquipélago.

Quanto ao método, foi, para esse fim, escolhida uma perspectiva geo-ecológica. O autor limitou-se à análise da região de Baucau-Viqueque, uma faixa com 30 kms de largura e 60 kms de comprimento, orientada na direcção norte-sul, que, devido à grande variação de altitudes nela existente, oferece uma diversidade ecológica suficiente para esse efeito. Como houvesse carência de literatura, foi de importância decisiva

a cedência, por parte das autoridades portuguesas, de fotografias aéreas e de pormenorizadas cartas topográficas.

Os habitantes das regiões estudadas vivem debaixo de difíceis condições físicas. Estas são caraterizadas pela extrema diversidade do relevo e, por conseguinte, por uma diminuta percentagem de terra plana e própria para fins agrícolas; por uma grande parte de terreno argiloso, compacto e pouco azotado que os nativos só com grande dificuldade podem trabalhar, com as suas técnicas agrárias simples; sobretudo por uma desfavorável distribuição das chuvas, com até sete meses de seca na costa norte. Além disso, tem o agricultor de lutar contra uma enorme variabilidade das chuvas que, no actual baixo nível de desenvolvimento, não pode, muitas vezes, dominar eficazmente. A influência de factores edáficos e, sobretudo, climáticos, reflecte-se na vegetação do território. Esta compõe-se, no máximo, de 10% de vegetação primária. Quinze formas vegetais foram diferenciadas e representadas em cartas com base numa valiosa colecção de plantas na qual savanas pouco espessas (eucaliptos, palmeiras (Corypha e Borassus) acácias, casuarinas), atribuídas a queimadas regulares efectuadas pelo homem, ocupam a maior parte do território sob estudo.

O homem aprendeu a submeter de várias maneiras às suas necessidades o meio ambiente atrás esboçado. A forma mais corrente de aproveitamento da terra é a agricultura itinerante que se transforma, em alguns sítios, devido à pressão demográfica, em permanente cultura de sequeiro. São utilizados, em larga escala, paus para cavar e plantar. A paisagem agrária é caracterizada além disso, pela cultivação do arroz, em campos alagados ou em sequeiros, que é efectuada em planícies litorais e encostas na forma de socalcos. Os arrozais não são lavrados, mas pisados até que a lama adquira a consistência desejada. Os resultados obtidos nos sequeiros e nos arrozais são muito baixos em consequência das técnicas muito rudimentares aí empregadas. O gado é mantido pela população, tanto por motivo de prestígio como para ser utilizado no acto da compra da noiva. O seu aproveitamento económico é diminuto. Assim, por exemplo, os búfalos são apenas utilizados durante algumas semanas para a cultivação dos arrozais. Durante o resto do ano pastam livremente e, afim de evitar os prejuizos por eles causados, é necessário levantar cercas em volta dos campos cultivados, o que exige até um terço do trabalho dos camponeses.

O concurso destes factores num sistema ecológico encontra a sua expressão visível, espacialmente, na estrutura da paisagem agrária, assim como, temporalmente, nos calendários agrícolas averiguados em determinados lugares. O sistema ecológico existente já está profundamente marcado pelas medidas da administração europeia que introduziu, principalmente a partir do começo deste século, várias culturas (cauchu, café, camim (Aleurites molluccana), óleo de palma, algodão, sisal, etc.). Estes esforços para incitar os nativos a passar de uma economia de subsistência para uma economia agrária de mercado só tiveram êxito quanto ao côco e ao camim.

Um dos principais obstáculos que o desenvolvimento agrário do território sob estudo apresenta é o desequilíbrio do povoamento. Ao lado de uma montanha central sobrepovoada encontram-se, na costa sul, regioes quase despovoadas, apesar de férteis. É razão para isto, em primeira linha, a aparição maciça da malária nas regiões costeiras.

A concentração demográfica, seguida por paralela concentração do gado, provocou um processo de destruição nas montanhas centrais. Uma planificação regional eficaz tem de se basear, segundo a opinião do autor, em sólido conhecimento das relações ecológicas. Por isso se procuraram representar cartográficamente as relações ecológicas conhecidas, baseadas tanto na vegetação natural como no aproveitamento da terra - representação sob a forma de 'zonas de meio ambiente' (environmental zones). Estas 'zonas de meio ambiente' constituiram a base para o cálculo da capacidade de absorção populacional da região. Da relacionação da densidade populacional actual com a potencial pode-se obter um índice que expressa em que medida já foi atingida ou até ultrapassada, essa capacidade numa determinada região sob estudo. Com base neste índice e na diversa evolução das regiões prèviamente estimada, pode-se avaliar quantitativamente o desequilíbrio entre o homem e o meio ambiente e, assim, dosear as medidas de correcção necessárias. O equilíbrio ecológico deve ser atingido por três vias: 1. Protecção da paisagem 2. Melhoramento da agricultura baseada na economia de subsistência 3. Estabelecimento de uma cultura orientada para o mercado. A última parte deste estudo é dedicada à discussão das medidas consideradas necessárias e em propostas concretas diferenciadas segundo zonas de planificação.

Ringkasan

Pulau Timor yang letaknya di ujung timur kepulauan Nusatenggara merupakan daerah peralihan antara benua Asia dan Australia. Posisi ini sangat ditegaskan oleh vegetasi, fauna, susunan bangsa bangsa penduduk dan cara penggunaan tanahnya.

Dibandingkan dengan bagian bagian lain di kepulauan Indonesia keadaan fisis-geografis kurang menguntungkan kehidupan di pulau Timor. Namun disini juga terdapat semacm keseimbangan antara penduduk dengan lingkungan alamnya sampai pulau ini didamaikan oleh kekuatan penjajahan Portugis di bagian timur dan Belanda di bagian barat pulau itu pada awal abad ini. Penyakit penyakit menular dan perang perang antara suku membatasi jumlah penduduk. Baru setelah perdamaian dan penyebaran ilmu kedokteran yang modern oleh kekuatan penjajahan jumlah penduduk meloncat keatas. Pertumbuhan ini tidak diiringi dengan kenaikan yang sama pada bidang produksi pertanian. Akibat perkembangan ini ialah ketidakseimbangan yang dibuktikan dengan pembasmian hutan dan kemunduran hasil pertanian yang sekarang memuncak sampai kelaparan musiman. Tanda tanda perkembangan ini disebabkan oleh cara pertanian yang sangat merusakkan lingkungan alam karena di bidang pertanian berpindah-pindah jumlah tahun giliran dikurangi jauh kebawah minimum.

Mengingat keadaan ini pengarang beranggapan bahwa satu penelitian baik kwalitatif maupun kwantitatif tentang ketidakseimbangan itu sangat berguna. Dianggap penting dalam rangka penelitian ini menguraikan sejauh mana para penduduk telah menyesuaikan diri dengan keadaan baru itu. Pada achirnya akan diberikan dasar bagi perencanaan daerah yang patut demi pencapaian keseimbangan baru antara manusia dan lingkungannya di bagian ini kepulauan Indonesia.

Guna mencapai tujuan ini metode geoekologis yang dipilih. Pengarang membatas analisanya pada wilayah antara Baucau (pantai utara) dan Viqueque (pantai selatan), bagian timur pulau Timor. Wilayah ini, lebarnya 30 km dan panjangnya 60 km, menunjukkan diferensiasi ekologis yang cukup besar karena ketinggian tempat yang sangat berbeda. Sebab ketiadaan

publikasi apapun tentang wilayah ini riset cuma bisa dilakukan berkat kesanggupan administrasi Portugis menyediakan baik potret potret udara maupun peta peta topografi yang bersekala besar.

Para penduduk di wilayah ini hidup dalam keadaan fisis yang sangat berat; inilah dibuktikan melalui topografi yang terjal yang tidak patut untuk tujuan pertanian; apalagi tanah sebagian besar terdiri dari tanah margalit; sifatnya kekurangan nitrogen serta sulit pengolahannya - apalagi melihat alat alat pertanian yang amat sederhana. Pertanianpun sangat terganggu oleh distribusi hujan yang tidak merata sampai mencapai tujuh bulan kering di pesisir utara. Halangan lain ialah ketidaktentuan curah hujan yang besar; petani belum dapat mengatasi masalah itu mengingat taraf perkembangan pertanian masih rendah. Pengaruh faktor tanah dan terutama iklim tercermin melalui pola tumbuh-tumbuhan wilayah ini. Paling tinggi hanya 10% dari luas wilayah ini terdiri dari tumbuh-tumbuhan primer. Atas dasar suatu kumpulan tumbuh-tumbuhan dibedakan limabelas lingkungan vegetasi yang langsung dipetakan. Akibat pembakaran tahunan sebagian besar wilayah penelitian merupakan sabana pohon-pohonan (Eukalyptus, Akazia, cemara, gebang (Corypha) dan lontar (Borassus)).

Manusia berhasil mempergunakan lingkungan yang tersebut diatas itu sesuai kebiasaannya yang berbeda-beda. Cara penggunaan tanah yang paling umum ialah pertanian berpindah-pindah; akibat tekanan penduduk cara pertanian tsb. mengalih menuju ke pertanian kering dan tetap pada tempat tempat tertentu. Alat pertanian yang paling lazim ialah tugal yang dipakai baik untuk mengolah tanah maupun untuk menanam. Selain daripada itu wilayah pertanian ditentukan oleh persawahan berpengairan dan tadahan yang terdapat baik di beberapa dataran pantai yang sempit maupun di lereng gunung yang bertingkat-tingkat. Sawah tidak diluku melainkan dirincah oleh satu kelompok kerbau sampai tanah menjadi lumpur. Sesuai dengan cara pertanian yang sederhana sekali, hasil pertanian yang dicapai di ladang dan di sawah rendah sekali. Ternak yang dipelihara oleh penduduk terutama dipakai untuk menambah kemuliaan (prestige) dan sebagai belis. Guna ekonominya rendah. Umpamanya kerbau dipergunakan untuk pengolahan sawah untuk beberapa minggu setahun saja. Lain waktu dilepaskan di padang secara liar sehingga biasanya ladang dan sawah harus dipagari. Sering sampai sepertiga dari seluruh waktu kerja sitani dibutuhkan untuk pembuatan pagar itu.

Pengaruh timbal-balik faktor faktor ekologis ini dalam satu sistim ekologis dicerminkan baik dalam pola geografis wilayah pertanian maupun melalui beberapa penanggalan pertanian yang ditetapkan oleh pengarang untuk tempat tempat tertentu. Sistim ekologis yang ada telah sangat dipengarhui oleh tindakan tindakan pemerintahan penjajahan yang memasukkan beberapa tanaman (kelapa, karet, kopi, kelapa sawit, kapas, serat, kemiri dll.) pada awal abad ini. Usaha usaha ini bertujuan memberi semangat kepada para penduduk guna mengubah cara pertanian dari pertanian tradisionil kearah pertanian komersil; akan tetapi usaha ini hanya berhasil tentang kelapa dan kemiri.

Salah satu rintangan pokok yang menghalangi perkembangan pertanian di wilayah penelitian ialah penyebaran penduduk yang tidak merata: Daerah pegunungan di bagian tengah berpenduduk terlalu padat, tetapi daerah pesisir selatan yang subur berpenduduk rendah sekali akibat malaria masih hebat.

Konsentrasi manusia sejajar dengan konsentrasi ternak di daerah pegunungan membangkitkan permusnahan wilayah. Menurut penilaian pengarang, perencanaan daerah hanya berhasil kalau berdasarkan atas pengertian yang dalam tentang hubungan hubungan ekologis. Oleh karena itu pengarang berusaha memetakan hubungan hubungan itu atas dasar baik tumbuh-tumbuhan maupun penggunaan tanah dalam rupa 'lingkungan ekologis' (environmental zones). Lingkungan lingkungan ini merupakan unit untuk perhitungan kapasitas tampung wilayah terhadap para penduduk. Melalui perbandingan angka angka riil dengan angka angka potensil para penduduk didapatkan suatu indeks yang menunjukkan sejauh mana pada daerah tertentu kapasitas tampung sudah dicapai atau dilampaui. Mengingat indeks ini bersama perkembangan demografis untuk satu wilayah tertentu pada masa depan, maka ketidakseimbangan antara manusia dan lingkungannya dapat ditentukan secara kwantitatif. Tindakan tindakan untuk memperseimbangkan kembali bisa ditentukan juga. Menurut penilaian pengarang keseimbangan ekologis seharusnya dicapai melalui tiga jalan: 1. Perlindungan alam 2. Perbaikan cara pertanian tradisionil 3. Pembangunan pertanian komersil. Penelitian disudahi dengan pertimbangan strategi strategi bersama saran saran yang nyata dan dianggap penting untuk daerah daerah perencanaan masing masing.

Zusammenfassung

Die Insel Timor, östlichste der Kleinen Sunda Inseln, nimmt aufgrund ihrer Lage zwischen dem asiatischen Festland und dem australischen Kontinent eine Übergangsposition ein. Diese findet ihren sichtbaren Ausdruck im Pflanzenkleid, in der Fauna, in der rassischen Zusammensetzung der Bevölkerung und in der Landnutzung.

Im Vergleich zu anderen Teilen des Archipels weist Timor sehr viel ungünstigere naturgeographische Bedingungen auf. Dennoch bestand auch hier bis zur Befriedung der Insel durch die Kolonialmächte - Portugal im östlichen, Holland im westlichen Timor - Anfang dieses Jahrhunderts eine Art Gleichgewicht zwischen der Bevölkerung und ihrer Umwelt. Seuchen und permanente Stammeskriege hielten die Bevölkerungszahl in Grenzen. Erst mit der Befriedung und Einführung moderner Medizin durch die Kolonialmächte schnellten die Bevölkerungszahlen in die Höhe. Diese Zunahme war nicht begleitet durch entsprechende Steigerungen in der Agrarproduktion. Das daraus resultierende Ungleichgewicht manifestierte sich in verheerender Form als Folge verkürzter Rotationszeiten in der Landwechselwirtschaft, Entwaldung und sinkenden Agrarerträgen, die schließlich heute in regelmäßigen saisonbedingten Hungersnöten gipfeln.

Angesichts dieser Situation erschien es dem Autor eine besonders lohnenswerte Aufgabe, das bestehende Ungleichgewicht näher - wenn möglich auch quantitativ - zu analysieren und dabei fest zustellen, wieweit sich die Bevölkerung bereits der neuen Situation angepaßt hat. Schließlich sollten regionalplanerische Ansätze aufgezeigt werden, die geeignet sind, ein neues Gleichgewicht zwischen Mensch und Umwelt in diesem Teil des Archipels herzustellen.

Methodisch wurde dabei der geoökologische Ansatz gewählt. Der Autor beschränkte sich auf die Analyse des Baucau-Viqueque Gebietes, eines 30 km breiten und 60 km langen Nord-Süd Streifens, der aufgrund seiner Höhenerstreckung ausreichende ökologische Differenzierung anbot. Angesichts des Fehlens von Literatur war jedoch die Überlassung von Luftbildern und

großmaßstäbigen topographischen Karten durch die portugiesischen Behorden von entscheidender Bedeutung.

Die Bewohner des Arbeitsgebietes leben unter harten physischen Bedingungen. Diese sind gekennzeichnet durch die Zerrissenheit des Reliefs und damit einen geringen Anteil an ebenem, für landwirtschaftliche Zwecke geeignetem Land; durch einen hohen Anteil schwerer stickstoffarmer Tonböden, die die Einheimischen nur mit großer Mühe mit ihren einfachen Agrartechniken bearbeiten können; vor allem durch eine ungünstige Niederschlagsverteilung mit bis zu sieben Monaten Trockenzeit an der Nordküste. Der einheimische Bauer hat darüber hinaus mit einer enormen Niederschlagsvariabilität zu kämpfen, der er beim gegenwärtigen niedrigen Entwicklungsstand oft nicht wirksam begegnen kann. Der Einfluß edaphischer und vor allerm klimatischer Gegebenheiten spiegelt sich im Vegetationskleid des Gebietes wider. Dieses besteht höchstens noch zu 10% aus Primärvegetation. Fünfzehn Vegetationsformationen wurden aufgrund einer unfangreichen Pflanzensammlung unterschieden und kartiert, wobei lichte, auf regelmäßiges Brennen durch den Menschen zuruckzuführende Baumsavannen (Eucalyptus, Akazien, Casuarina und Corypha) den größten Teil des Arbeitsgebietes einnehmen.

Der Mensch hat die so skizzierte Umwelt für sich im vielfältiger Weise zu nutzen verstanden. Die vorherrschende Form der Landnutzung ist die Landwechselwirtschaft, die lokal infolge des Bevölkerungsdruckes in permanenten Trockenfeldbau übergeht. Grab- and Pflanzstöcke finden dabei weitgehend Verwendung. Die Agrarlandschaft wird weiterhin durch den bewässerten und unbewässerten Naßreisanbau geprägt, der in Küstenhöfen und an terrassierten Berghängen zu finden ist. Die Reisfelder werden dabei nicht gepflügt, sondern durch eine Herde von Büffeln so lange zertrampelt, bis der Schlamm die gewünschte Konsistenz hat. Den sehr einfachen Agrartechniken entsprechend sind die auf Trockenfeldern und auf Naßreisfeldern erzielten Erträge sehr gering. Vieh wird von der Bevölkerung vor allem aus Gründen des Prestiges sowie als Brautpreis gehalten. Seine wirtschaftliche Nutzung ist gering. So werden z.B. Wasserbüffel für einige Wochen im Jahr für die Bestellung der Naßreisfelder eingesetzt. Für den Rest des Jahres grasen sie frei im Gelände, so daß die Errichtung von Zäunen um die Felder notwendig wurde, eine Tätigkeit, die bis zu einem Drittel der Arbeitszeit des Bauern verlangt.

Das Zusammenwirken dieser Ökofaktoren in einem Ökosystem findet räumlich seinen sichtbaren Ausdruck im Gefüge der Agrarlandschaft sowie zeitlich in für mehrere Orte ermittelten Landwirtschaftskalendern. Das bestehende Ökosystem ist bereits nachhaltig durch Maßnahmen der europäischen Verwaltung geprägt, die insbesondere seit Anfang dieses Jahrhunderte mehrere Kulturpflanzen (Kokos, Kautschuk, Kaffee, Ölpalme, Baumwolle, Sisal, Aleurites moluccana, etc.) einführte. Erfolgreich waren diese Bemühungen, die auf Subsistenzwirtschaft ausgerichtete einheimische Bevölkerung zu einer marktorientierten Agrarproduktion anzuregen, lediglich bei Kokos und 'candlenut tree' (Aleurites moluccana).

Eines der Haupthindernisse, die der Entwicklung der Landwirtschaft im Untersuchungsgebiet entgegenstehen, ist die ungleiche Verteilung der Bevölkerung. Einem überbevölkerten zentralen Hochland stehen fast menschenleere, aber fruchtbare Gebiete an der Südküste gegenüber. Grund dafür ist in erster Linie das massive Auftreten der Malaria in den Küstengebieten.

Die Bevölkerungsballung - und die damit parallellaufende Konzentration des Viehs - im zentralen Hochland hat einen Prozeß der Landzerstörung ausgelöst. Eine erfolgreiche Regionalplanung muß nach Meinung des Autors auf einer soliden Kenntnis der ökologischen Zusammenhänge beruhen. Es wurde daher der Versuch unternommen, die erkannten ökologischen Beziehungen auf Grundlage der natürlichen Vegetation als auch der Landnutzung in Form von Unweltzonen (environmental zones) zu kartieren. Diese Umweltzonen bildeten die Grundlage für die Berechnung der Tragfähigkeit des Landes in bezug auf die Bevölkerung. Aus dem Verhältnis der gegenwärtigen zu der potentiellen Bevölkerungszahl läßt sich ein Index ermitteln, der angibt, wieweit bereits die maximalmögliche Auslastung in einem betreffenden Teil des Untersuchungsgebietes überschritten ist. Unter Berücksichtigung dieses Index und der zu erwartenden regional differenzierten Bevölkerungsentwicklung lassen sich Ungleichgewichte zwischen Mensch und Umwelt quantitativ bestimmen und die erforderlichen Korrekturmaßnahmen dosieren. Das ökologische Gleichgewicht sollte nach Auffassung des Autors auf drei Wegen erfolgen: 1. Landschaftsschutz 2. Verbesserung der auf Subsistenzwirtschaft beruhenden Landwirtschaft 3. Aufbau einer marktorientierten Landwirtschaft. Die Diskussion der als notwendig erachteten Strategien und konkreten Vorschläge, differenziert nach Planungsräumen, bilden den Abschluß der Untersuchung.

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Index

abolition of kingdoms, 5
abrasion platforms, 25
administrador, 5
administration, development, 5
administrative division, 4.7
agricultural calendar, 204-10
agricultural extension, 19, 281
agricultural fragmentation, 17
agricultural school, 14n.
agriculture, subsistence, improvements, 271
ahi matan, 3
ai café, see *Leucaena leucocephala*
Aidassa, 239
ai suak, 46, 118; ai suak boot, 46, 118, 121, 123, 170; ai suak kiik, 170, 177
aldeamentos indigenas, 19
Aleurites moluccana, see Candlenut
Allan, W., 260
Amarassi, 272
annual census, 5; see also Tax census
anthropological research, 1
archaeological research, 1, 25n.
areca, 181
Arenga saccharifera, 139n.
Aroki plain, 121
arrolamento, see Tax assessment
ash fertilizer, 135
ata, 4
Atahoc Formation, 21
Ataúro, 4n.
Atoni, 116
Atsabe, rainfall, 63
Audley-Charles, M.G., 20, 40

badlands, 114
bai loro boot, 65
bai loro kiik, 65, 182, 210
baldio, see land, communally owned
bando, 149
Barique Formation, 21, 28, 33
barlaque, see bride price
batar boot, 175, 176, 177, 179
batar kiik, 175, 179, 180
batar lalais, 205
batar udan, 182
beach barriers, 35
beach ridges, 24, 34, 35
beans, 123-4, 125, 126, 176, 178, 179, 180, 182
bee hives, 148
Belu, 116, 145
Benain Plain, 3
Betel nut, 137
Bobonaro Scaly Clay, 17, 21, 28, 32, 34, 36
Borassus flabellifer, 24, 107-8
botanical research, 93-4
boundaries, see suco boundaries
bride price, 140, 184, 239
bridle paths, 39
Brookfield, H.C. and Brown, P., 260
buffaloes, 185-6, 189, 191-3, 196; distribution, 185-6; numbers, 193, 195; policy, 291; recommendations, 277; shortage, 132, 189, 192; slaughter, 193; social distribution, 189, 191-2; trade, 238-9.
Bunak, 1
bunds, see Kabubo
burnings, cultural, 100, 101, 102
bush fallowing, 117-27, 170; lower elevation, 176-7; medium altitude, 177-9

Cablac Limestone, 28
Cairui, 10, 14, 29n.
Câmara, Filomeno da, Governor, 141, 211, 216, 217
candlenut, 138, 177, 180, 181, 183, 216
canteiro, 162
cantina, 138, 168, 213, 214, 231, 281, 285
Carneiro, R.L., 260
cash production, 216-7
cashew nuts, 126
cassava, 125, 176, 177, 180, 249n.
castor-oil plant, 126, 288
Castro, A.O. de, 94
Casuarina junghuhniana, 28
cattle, 199, 200; Bali, 142, 224, 278; centres, 143; policy, 143, 291
Central Upland Zone, 28-9, 32
chefe de posto, 5
chefe de povoação, 149
chefe de suco, 5, 10, 149
chick pea, 178, 291
Chinese, 14, 16, 213, 231, 237; farmer, 26; shops, see Cantina
circunscrição, 4, 5
claystone, 27
climate, 61-91; along profile, 90; and landscape, 87, 89, 91
cnua, 3n., 16
coast, regularized, 24, 35
coastal plains, 22
cock fighting, 238
coconut, 177-8, 181, 183, 221-3, 279, 287-8; development, 234n.; experimental stations, 225; interplanting, 221; introduction, 217; nurseries, 218, 234; Ra Tahu plantation, 36, 147
coffee, 142-4, 235-6, 279; growing areas, 238

coilão, 110
commercial production, 277-81
commercialization, 167n., 210-39
communal plantations, 4
communication, 215
composting, 273
concelho, 4, 5
Conklin, H.C., 260
contribuinte, see taxpayers
copra, 217-9
coral benches, 24
coral limestone, 26
coral reef, 34; uplifted, 26
Corypha utan, 108
cotton, 289
cow pea, 125
Cretaceous deposits, 21
crops, introduction of cash, 211-2; root, 116, 124; rotation, 177, 273; to'os, 123-6; tree, 279
cropping pattern, 175-83
cucumbers, 126
cyclones, 87

Dagadá, 3
dams, brushwood, 135, 274n.
Dampier, W., 124
dato, 3
dato rai, 145-6
dato uain, 3, 5
deforestation, 253
density of occupation index, 259-68
digging stick, see ai suak boot
drainage channels, 170, 205
drainage subsurface, 26
Dutch control, 3
duut manu lain, see *Imperata cylindrica*

Eastern Foothill Zone, 32-3
education, 232
ema, 3
ema foho, 14n
ema rai, 4
ema tasi, 14n., 161n.
ema uma laran, 156
employment, 211
enclosure, 126-7
environmental zones, 295-315
Eocene deposits, 21
erosion, 28, 201, 251, 253, 254
escarpments, 26
estilo, 239
Eucalyptus alba, 26
Eucalyptus urophylla, 29, 103-4

fatu, 22, 28, 29, 32, 33, 59, 60, 169, 180
feasts, 239
fencing, 126-7, 148, 202
fertilizer, 233
feto fuan, 3
field preparation, 118
fila rai, 46, 117, 118, 121-3, 172
finta, 211n.
fire, 92, 93, 148, 253-4
fishing, 289, 290
floodplains, 27
fodder, 204, 277
Fontoura, Governor, 19
food shortage, 259
Forbes, H.O., 94
foredunes, 34
foré mungo, see beans
foré tali, 176, 178
forest, destruction of, 251; largely deciduous, 102-3; lulik, 251; medium altitude moist evergreen, 100-1; riparian, 111-2; savanna mosaic, 103; semi-deciduous, 26, 100-2; swamp, 111; tropical montane cloud, 98, 100
forester, see makleat
forestry, 236
Fox, J.J., 156n.
French bean, see beans
fronteira, 5
fruit cultivation, 291
fruit trees, 137
furniture factory, 236

Galoli, 10
gamuti, 139n.
Garcia, J.S., 39, 42
gardening, interplanting, 137; permanent, 136-9
girdling of trees, 118
goats, 145, 199
Gomes, R.C.V.M., 93, 94
Gonçalves, L.d.C., 145
grassland, 108-9, 114, 253; management, 277
grazing, 140-5, 183-204, 277; see also livestock
groves, sacred, 92, 114; see also lulik

hare lalais, 163n.
hare natar, 128, 155-62
hare to'os, 180, 181
head tax, 5, 6, 149, 211-2, 215
head hunting, 4, 16
health centre, 156, 229, 246
Hemileia vastatrix, 236n.
Hicks, D., 5, 156, 238
Hippobosca, 196
horses, 142, 196-7, 199; trade, 238-9; treading of rice fields, 142
hospitals, 242
house garden, see gardening, permanent
humidity, 86-7

Imperata cylindrica, 122, 224
imposto domiciliario, see head tax
indirect rule, 5
inheritance, land, 147
Inner Arc, 21, 39
intercropping, 279-80

intergrazing, 280-1
International Rice Research Institute, 167
Intertropical Convergence Zone, 61
irrigation, 160, 208, 274, 275

Jaco, 4n.
Japanese occupation, 5
Jatropha gossypifolia, 24
Jurassic deposits, 21

kabo bé, 135
kabubo, 129, 130, 151, 166
kare hare, see rice cultivation, broadcasting
karst springs, 27
keladi, 116n.
kero, 146
kidney beans, see beans
Kohler, K., 145

labour, contracts, 167n., 192, 230-1; forced, 38, 215, 216; input, 120, 121, 122; joint, 121, see also socio; migrant, 230-1; remunerated, 121, 215, 216, 257; statute, 38, 215, 216; supply, 216
Lains e Silva, H., 121, 130
Laivai, rainfall, 63
land, communally owned, 148; conservation, 269-71; degradation, 248, 249; individually owned, 148; ownership, 136, 145-50; quarrels, 147-8; scarcity of, 249, 252-3; (owing to tree crops), 279
land use zoning, 271
landing craft, 231
landslides, 28
languages, 3n., 10, 13
Larigutu Limestone, 32
Lata, 129n., 166n.
Lautem, 5
Leendertz, A.C., 121
Lekkerkerker, C., 116, 124
lere rai, 117, 118, 119-21
lere rai boot, 176
lere rai oan, 176n.
Letefoho, rainfall, 63
Leucaena leucocephala, 122, 270, 272, 287
limestone, 25; blocks, see fatu
lingua franca, 14
Linguistic composition, 12
liurai, 3, 4, 145, 210
livestock, and landscape, 199-203; carrying capacity, 255; census, 183; death figures, 198; densities, 185, 188; development, 255; disease, 196; for export, 277-9; grazing, 140-5, 183-204, (control of), 277; numbers 184, 185, 187, 188, 190, 194, 255, 258; possibilities, 287; production, 277-9; quality, 204; slaughter, 198, 278; social significance, 140; stocking density, 255; tax, 5, 215; trade, 240
lopping, of trees, 135, 277n.
lulik, 19, 92, 98, 246, 251, 270

Macair fukum, 3, 5
Macassai, 3, 10, 14, 156n.
maize, see batar boot, batar kiik, batar lalais, batar udan; irrigated, 135, 161-2, 209
major, 148-9
makleat, 39n., 148, 270
maksaba, 148
malaria, 17, 156, 192, 229, 232, 239-48, 283; ecology, 247-8; effect of, 242; endemicity, 245-7; fatalities, 241n.; spleen rate, 241, 245; native treatment of, 242; reported cases, 243; studies of, 245
Mambai, 22n.
Manatuto, 5; rainfall, 63
mane fuan, 3
mangrove, 24, 110-1
manure, 273; green, 280
Marine Terrace Zone, 25-6
market, creation of, 238; orientation, 137; place, 213-4
marl, 27
Marques, E., Governor, 211
Maubisse, 16
meat consumption, 203
MEAU (Missão de Estudos Agronómicos do Ultramar), 39
mechanization, 276n.
Meijer Drees, E., 94, 270
Meneses, F.X.A.S., 145
Middelkoop, P., 116
Midique, 10
migration, 230, 233, 283; seasonal, 257
military commands, 4
missions, 14n.
Moluccas, 127
money, circulation, 212-3
monsoons, 35, 61
mud flats, 24
mud volcano, 34n.
mung bean, see beans
mutual help, 17, 132

nai boot, 145
natar, see cultivation
Nau Eti, 10, 156n.
New Guinea, 127
Northern Coastal Zone, 24-5
nutrition studies, 257

Oécussi, 5
oil palm, 235
Oligocene deposits, 21
onions, 126, 135, 161
Ossoala ridge, 28

Outer Arc, 21
overgrazing, 202

pacification, 4
Pacific mountain type, 21
paddy fields, see rice fields
palm, see *Arenga saccharifera; Borassus flabellifer; Corypha utan*
Palu, 63n.
pardau, 140, 239n.
pataca, 212n.
Pax-Lusitana, 149
peanut, 125, 176, 288n., 289
pepper, 126
Permian deposits, 21
physiography, 2, 20, 22-3
pigs, 144-5, 199
plains of Uato Lari, 33, 229
plain of Viqueque, 34
planning regions, 281-91
planting stick, see ai suak
plantação, 147
Pleistocene deposits, 21
ploughs, 141
ploughing, 203n., 235, 276
Podocarpaceae, 100
political structure, 4
population, active, 211; and environment, 248-59; carrying capacity, 259-68; census, 10; changes, 252; density, 10, 11; development, 250; distribution, 18; figures, 6, 8-9; increase, 249; non-indigenous, 14, 15; pressure, 222; trends, 248-59
posto, 5
posto sanitário, see health centre
potatoes, 126, 180
potatoes, sweet, 125, 135, 161-2, 176
povoação, 3n., 10
precipitation, see rainfall
price control, 220n.
prices, regional differences, 220
protein gap, 291
proteins, 203
puddling of rice fields, see sama natar
pumpkins, 126

Ra Tahu, 14
rai malirin, 166n., 179, 181n.
rai mean, 59, 60, 173, 174
rai metan, 59, 173, 174, 180
rai mohate, 60
rai mutin, 60, 174
rai tahu manu tem, 60, 170, 174
rai teen, 145
rai udan, 205
rainfall, 62-75; diurnal variation, 75-6; distribution, 65, 67-8; intensity, 72, 74; mean annual, 63-4; monthly, 66, 69; probability, 72-3; stations, 63; variability, 70-2; zones, 65-7
rattan, 236; factory, 289
rebellion, 4
reino, 145
Reinwardt, C.G.C., 93
resettlement, suggestion for, 281
rhinoceros beetle, 223
rice, dryland, 180, 181; exports, 226-8; harvest, 130-1, 167; high yielding varieties, 167, 226, 232, 275; huller, 131, 226; income from, 232n.; nursery bed, 132; pests, 167, 276; price, 233, (stabilization) 233; seed, 129, 131; terraces, 136; transplanting, 131-3, 167; varieties, 162-6, (indica) 127, 162; yields, 127, 131, 142, 166-8, 276
rice cultivation, 127-36; broadcasting, 128-31, 204; regional distribution, 157-62; risk, 134; wet, 128, 155-62
rice fields, double cropping, 135, 161-2; inundated, 133-4; irrigated, 134-5; ownership, 229n.; rainfed, 157, 160; riverfed, 160; single cropping, 157; springfed, 160; transplanting, see sama natar; waterlogging, 136
roads, 214-5; construction, 38; maintenance, 38-9; repair, 216
rootcrops, 116, 124
rubber, 218, 235
run-off, 80, 83, 84

Saccharum spontaneum, 122
salinization, 39
salt making, 237
sama natar, 46, 128, 134, 141, 162, 189, 204n., 235; labour input, 128-9; with horses, 128, 129
sandalwood, 148
sandstone, 27
São Domingos, 5
savanna, 104-8, 119; *Acacia leucophloea*, 106; *Casuarina junghuhniana*, 33, 107; *Corypha utan*, 33; *Eucalyptus alba*, 26, 105-6; palm, 107-8
schools, 232, 284n.
Schweinfurth, U., 117
scrub, 108
Septicaemia haemorrhagica, 196
serviço hamutuc, 121
sesame, 126
settlement pattern, 16-9
sheep, 145, 199, 290
silage, 204, 277
siltstone, 27
Silva, J.C., Governor, 4, 211, 216, 217
Slatyer, R.O., 76
slope, classes, 36; map, 37

socio, 167n., 192, 257, 284n.; see also labour, joint
soil, 39-61; creep, 251; fertility loss, 248; moisture storage, 78-80; overworking, 248, 249; research, 39, 42
solution cavities, 26
sorghum, 138
Sota coconut plantation, 14, 61, 223
Sousa, J.P.A.d.A., Governor, 235
Southern Foothill Zone, 33
Southern Littoral Plain Zone, 33-4
sowing, 124
Steenis, C.G.G.J.v., 112
stocking density, 202
Suai Formation, 24
suco, 3, 4n., 5; boundaries, 6, 149, 281; size, 6, 10
sugar cane, 126
Sunda Mountain System, 21
sunu rai, 118
swamp, 34, 35; forest, 111
sweet potatoes, see potatoes, sweet

taro, 116, 125
Tata Mai Lau, 22
tau karau hamutuc, 192
tax, assessment, 183; census, 149; evasion, 184; head, 5, 6, 149, 211-2, 215; livestock, 5, 215
taxpayers, 5, 6
teak, 237
temperature, 82-3, 85-6; diurnal, 86
terraces, marine, 24
terracing, indirect, 272; to'os, 170
Tetum, 3, 10, 14, 14n.
Teysmann, J.E., 93
tilling, see fila rai
tobacco, 177
to'os cultivation, 169-83; double cropping, (at high elevation) 179-80, (at lower elevation) 180-1, (with dryland rice) 181-3; intensity, 169-75; permanent, 170; rotation periods, 171, 248
topography, 20
transhumance, 189
transit certificate, 217, 230
transport, cost, 220n.; maritime, 231, 285
Treaty of Lisbon, 4
trees spared from felling, 118n.
Triassic deposits, 21
tribal war, 4
tripanosomiasis, 196n.
tuak, 130, 139n.
tubers, see root crops
Turiscai, rainfall, 63
Uaima'a, 10
undergrazing, 202
usufruct, 146, 148
vegetation, beach, 109-10; fire resistance, 253; Lesser Sunda Islands, 112-4; present, 96; primary, 92, 98; profile, 99
villages, 16, 19
Viqueque Formation, 27, 28, 34
volcanic deposits, 21

wages, 216
Wallace, A.R., 93
Wallace Line, 93
water availability, 35, 76-83; balance, 76-83; percolation impeded, 141; seepages, 25
wave-cut notches, 25
weeding, 118
Wehale, 3
wheat, 178, 179, 291
wind, Föhn-like, 67; speed, 87
World War II, 5

yams, 125, 180n., 182

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