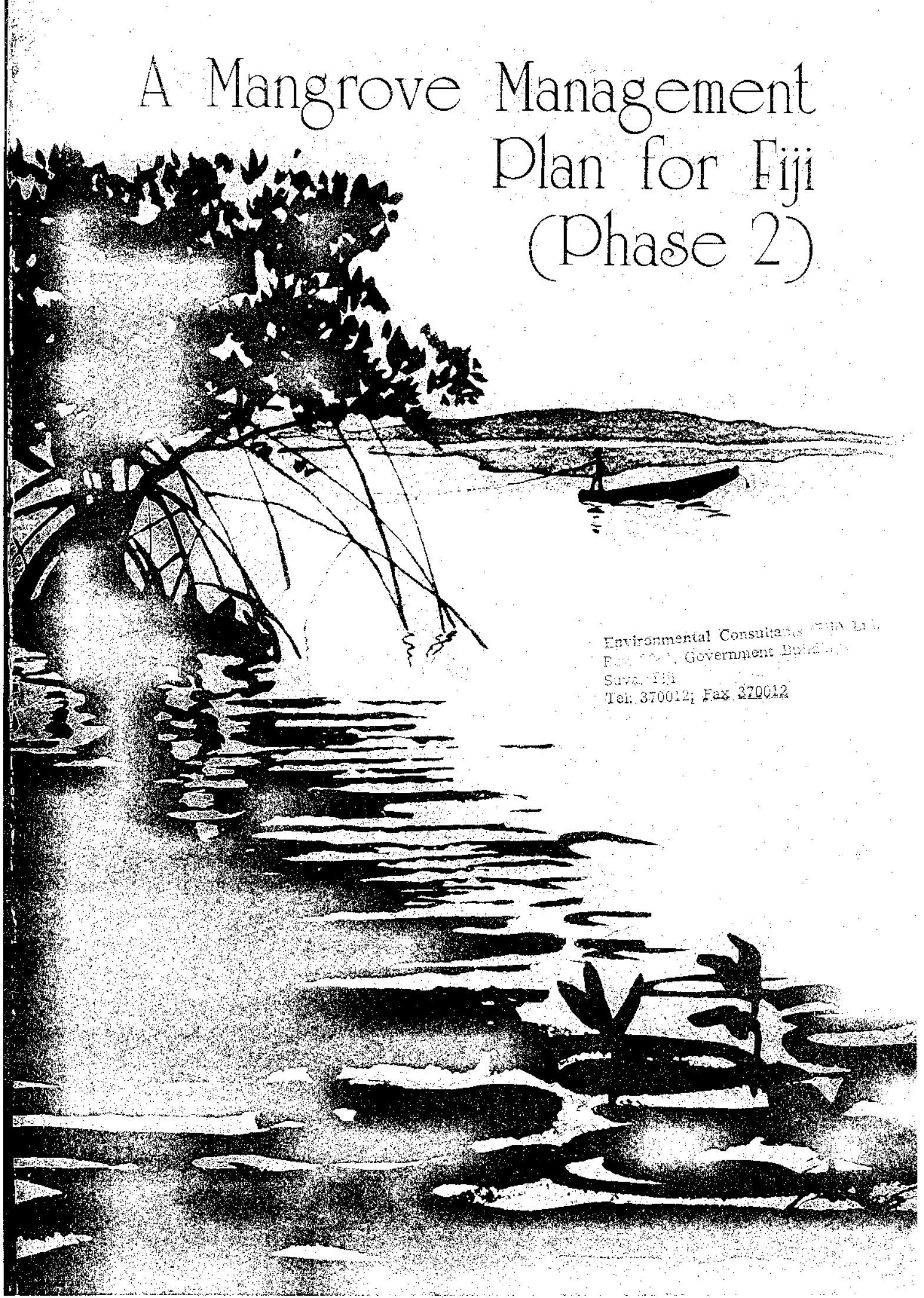


A Mangrove Management Plan for Fiji (Phase 2)



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A
MANGROVE MANAGEMENT PLAN
FOR FIJI

Phase II

A plan for the Mangroves of the Nadi Bay and
Suva-Navua Locales

Prepared for
The Mangrove Management Committee
by
Dick Watling



A joint project of the Fiji Government and the
South Pacific Commission

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I. INTRODUCTION

Phase I of the present project - A Mangrove Management Plan for Fiji established the basis of a broad zonation philosophy for Fijian Mangroves (Appendix 1). This was then applied to the mangroves of the Ba, Labasa and Rewa Deltas which comprise 10,686 ha, over a quarter of Fiji's Mangrove resource. In July 1986, the Cabinet of the Fiji Government endorsed the National Policy Plan for Fijian mangroves as proposed in Phase 1 of the project [Appendix 2].

While the mangroves of the Ba, Labasa and Rewa Delta are the major and most concentrated formations in the country, they are lightly affected by development pressures which threaten certain areas of Fiji's mangroves. In consequence, Phase II of the project examined two mangrove locales which because of their location and accessibility are considered the most threatened in the country:-

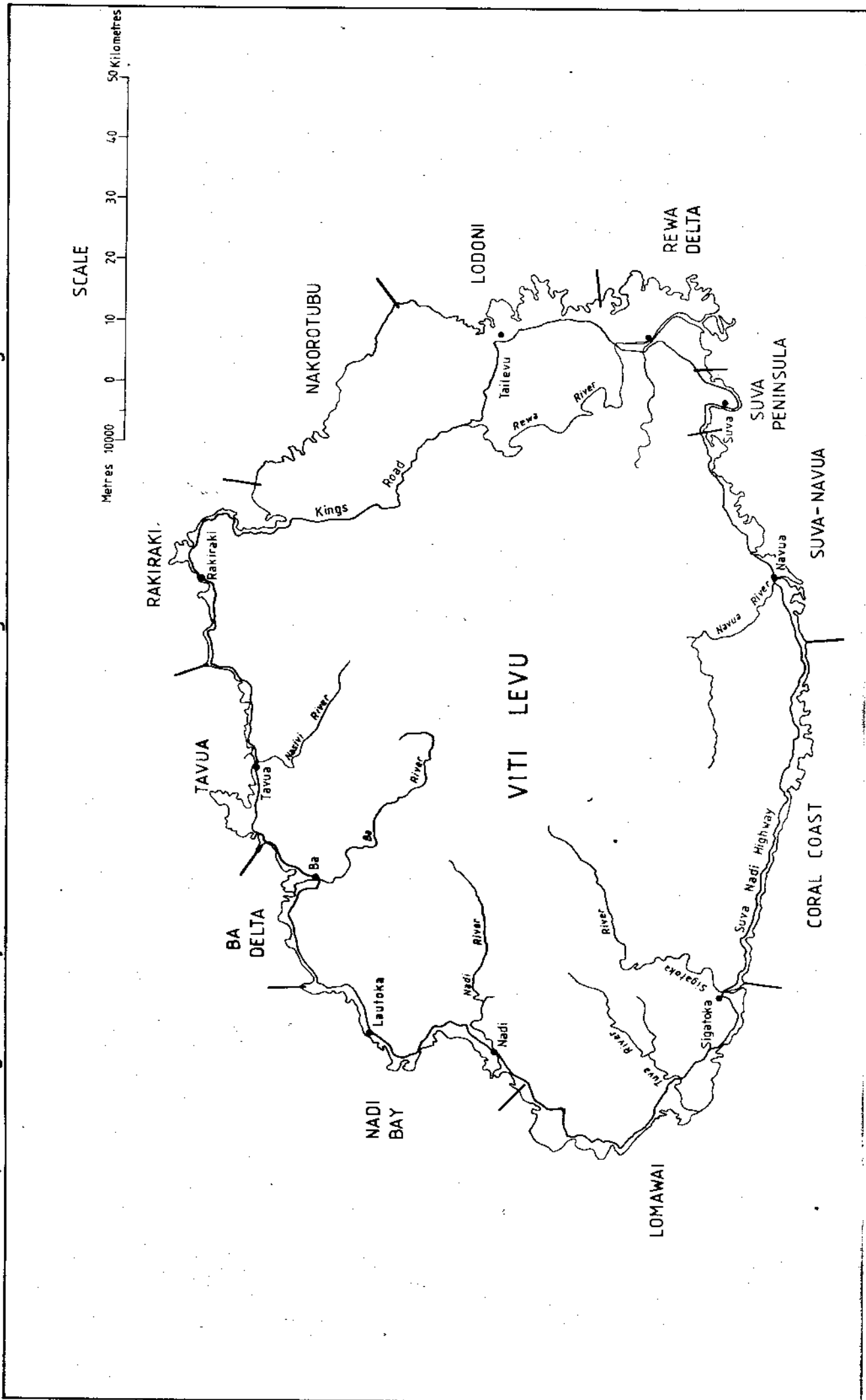
- The Suva-Navua Locale is a 60 km coastline of luxurious but essentially fringing mangroves (Fig.1); there is only a single major river estuary-the Navua. Being adjacent to Suva, Fiji's capital and largest concentrated population, the locale is under increasing pressure from diverse sectors including reclamation and uncontrolled utilisation.

- The Nadi Bay Locale contains a greater area of less vigorous mangrove along its 70 km coastline (Fig.1). The locale is the centre of much tourist associated development and its hinterland is a densely populated rural area of small-holder cane farmers. The locale is associated with two urban concentrations - Nadi/Nadi Airport and Lautoka.

Conditions and personnel for Phase II of the project (Jan-March 1986) were the same as for Phase I, with Dr Dick Watling assigned as Mangrove Consultant and working as Project Officer for the Mangrove Management Committee. The project continued to be overseen by the Fiji Government through the Mangrove Management Committee as a joint project between them and the South Pacific Regional Environmental Programme of the South Pacific Commission.

Figure 1 is a location map of Vitilevu showing the Nadi Bay and Suva-Navua Locales together with other Mangrove locales of Viti Levu.

FIG 1: Location Map showing Nadi Bay and Navua-Suva Localities together with other mangrove Locales of Viti Levu



2. DESCRIPTION OF THE MANGROVE LOCALES

2.1 Suva - Navua Locale

2.1.1. Boundaries

The Western boundary of the locale is the Qaranigio River at Pacific Harbour, with the eastern boundary being within Lami city, the Wailekutu Creek (Figure 1). The coastline of the locale is approximately 60km and includes two small offshore islands, Namuka (0.2km²) and Naqara (0.7km²) together with Rukunivutu I (0.3km²) which is joined to the mainland by mangroves.

2.1.2. Physical Features

The locale is within Vitilevu's wet climatic zone, experiencing a weakly seasonal annual rainfall averaging 320mm (figures for Suva - Laucala Bay).

The coastline lies so as to face directly the South East Tradewinds while the Barrier Reef, at a distance of 2-4km, is relatively close to the shore along the entire coastline. The two are separated by lagoons which form natural harbours at Namuka, Veivatuola and Naitonitoni.

The coastline is characterised by the large number of small rivers and creeks running down from the rugged hills which rise immediately behind the coast. Only to the west of the Vatuola R is the hinterland flat, this being the Navua floodplains and here Fiji's third largest river, the Navua runs to the sea at two mouths, the Navua and Deuba Rivers. The Vatuola is another major river of the coastline.

The eastern edge of the Navua alluvial plain is poorly drained and here forms the Melimeli freshwater swamp which adjoins the mangroves of the Toquru and Vatuola estuary. This swamp is of great scientific interest and national conservation importance (Ash and Ash 1984).

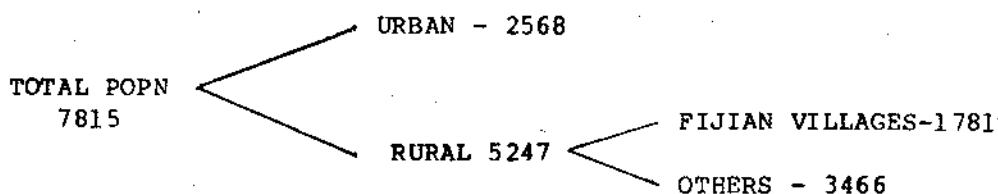
2.1.3 Population, Agriculture and Development

Immediately east of the locale is the Greater Suva area, Fiji's most densely populated region and active development centre (population - approx 75,000), while within the locale at the western extremity is Navua (population - 2,500) and the Pacific Harbour Tourist Development. These two population centres are joined by the Queens Road/Highway which gives access to many areas of mangroves, while from it spur roads lead to others. The highway is a development focus providing increasing access to the locale's mangroves with development pressure coming from the urban centres. (Table 1).

Between the urban centres, the locale is sparsely populated, there being only 10 Fijian villages or settlements. Their agricultural land apart, the essentially hilly terrain was, until recently, undeveloped and covered in forest. However over the past decade, developments on the coastline have increased markedly - agricultural (e.g. intensive goat farm at Vunisoco, chicken farm at Mau); residential (e.g. Wainidoi, Bible Centre). The headquarters of the Royal Fiji Navy has moved to Namuka Harbour, while an extensive residential area for Suva is planned for the Bilo peninsula. Less noticeable, but possibly more damaging is the increase in new settler-farmers clearing forest and settling in the area.

Drainage works have had a major but as yet invisible effect on the mangroves of the Toquru, Vunibau and Waikaloa R. Over 180 ha of very productive mangrove will be lost as a result of the construction of floodgates on these rivers.

Table 1.: Population breakdown for the Suva-Navua Locale



- Notes:
- 1) Greater Suva (Popn. 75,000) is east of the Locale, and excluded.
 - 2) 1976 Population Census
 - 3) Figures are for all 'Enumerated Areas' which have a coastal border.
-

2.1.4. Freehold Mangroves

A historical legacy is the presence of some mangroves of the Navua area being Freehold. While the constitutional legality of this is unclear and may yet be tested in the courts, the areas in question are utilised as Freehold land, (see Phase I Report pp4-5 for a summary of the Legal and Management Framework of Fijian Mangroves). The question of freehold ownership of Mangroves is not considered here but implications of private management of them are.

2.1.5 Historic and existing mangrove utilisation

Formerly, the mangroves as far as Navua were a source of fuelwood for Suva's industries and residents. As elsewhere, this use declined with the advent of convenient imported fuel oil. Today there are two active concessions in the Navua area, both working under Forestry Department Management control. Production figures are given in Table 2.

Table 2 Mangrove wood production from the Navua Concessions
(Forestry Department/Figures)

	<u>Concession</u>	<u>Locality</u>	<u>Production (m³)</u>	
			1984	1985
1.	H Wise	Lower Toquru R.	433	533
2.	I Valevatu	Upper Toquru R	-	144 (commenced in October)

Mangroves are also used for subsistence firewood needs, although this use is relatively light and sustainable. Illegal felling for other purposes (especially scaffolding poles) is commonplace and uncontrolled.

The mangroves of the locale help sustain an important coastal fishery of limited extent (limited by the proximity of the barrier reef). Direct evidence of this fishery is:-

- the number of Commercial Fishing licenses granted for these waters (Table 3)
- the density of fishtraps in the locale. 24 were counted on one aerial survey. 11 being in the Veivatuloa estuary area alone
- the amount of fish and crustacea sold daily on the roadside, Queens Highway.

Fish caught are predominantly sold in Navua and more specifically Suva. Production figures for the area cannot be given or estimated, since the supply is not distinguished from others reaching Suva or Navua markets. However, one can conclude that the waters adjoining the locale are very intensively fished providing an important source of income (and food) for the largely subsistence economy of the coastal villagers.

There are eight Customary Fishing Rights owners recognised for the inshore waters adjoining the locale (Map 8 Appendix 4).

Table 3: Commercial Fishing Licences (IDA) for 1986 in the Suva-Navua and Nadi Bay Locales. (Source - Fisheries Department)

<u>Areas</u>	<u>Indian</u>	<u>Fijian</u>	<u>Total</u>
<u>Suva-Navua Locale</u>			
Nadonumai	23	7	30
Navakavu	-	4	4
Navunisoco	-	1	1
Nabukebuke	2	5	7
Bativudj	-	3	3
Kalokolevu	1	-	1
Togalevu	-	1	1
Naikorolevu	8	1	9
Naikorokoro	3	-	3
Navugayago	-	2	2
Burenitu	-	5	5
Nakuraki	2	1	3
Wainitoguru	1	-	1
Total	<u>40</u>	<u>30</u>	<u>70</u>
 <u>Nadi Bay Locale</u>			
Vanua of Vitogo	15	3	18
Vidilo	2	2	4
Vanua of Vuda	24	3	27
Saunaka (Ua)	7	-	7
Nadi	3	-	3
Nakavacake	1	-	1
	<u>52</u>	<u>8</u>	<u>60</u>

The mangroves of the locale will continue to be an important resource base both for traditional uses and cash generating income for the essentially subsistence villages and Traditional Fishing Rights Owners. This function will not diminish but will be increasingly relied upon if their aspirations for development are to be fulfilled.

2.1.8. The Mangrove Alliances of the Suva-Navua Locale

The mangrove community of the locale is exceptionally vigorous and this is despite the absence of major estuarine formations and the exposure of the locale to the heavy seas generated by the Trade Winds. It is the presence of a large number of small rivers and creeks and high regular rainfall which sustains the mangroves.

Five Mangrove Alliances have been distinguished in the locale. (Maps 1-3, Appendix 4). Appendix 3 is a list of Principal species of Fijian mangroves with local names.

2.1.8.1. Coastal Fringing Alliance

This alliance dominates the coastline and occurs in all exposed situations where coarse, sandy substrates are found with little or no alluvial deposits, except towards the rear of the formation. The alliance exhibits a regular zonation but of varying extent.

On the exposed seaward edge is a closed canopy belt of R.stylosa of 3-5m canopy height, which increases upto 10m behind. R.samoensis and very rarely Selala can be found here but they never dominate. At the rear-landward edge of the formation Dogo of canopy height upto 14m are generally found, replaced occasionally as dominant by Saqali upto 18m canopy height. This formation occasionally merges into areas of Landward Alliance, which is not always sufficiently extensive to be distinguished on Maps.

Between the front and rear zones of this alliance, a zone of greater variability occurs. Most common is a closed canopy of R.stylosa with increasing R.samoensis and especially Dogo of 8-12m canopy height . In some localities this zone is a sparse open canopied, formation usually of Dogo but occasionally of either Tiri species and Selala. Small areas of stunted Tiri (<2m canopy) are found, but mudflats are absent.

Area 372 ha - 23% of the mangroves of the locale.

2.1.8.2. Mixed Coastal Alliance

The Mixed Coastal Alliance is restricted to sheltered localities associated with the larger creeks and rivers of the locale where there are substantial sediment deposits. The dominant species of the alliance is R.samoensis, sometimes forming a closed canopy 10-12m in height. Other formations include a more heterogenous open forest of variable and mixed composition with an uneven canopy height of 5-15m, R.samoensis, Dogo and Selala dominate with sapali being common. In some more elevated areas Sagali form pure emergent stands of 18m canopy height. Landward elements, principally Dabi and Sinu also occur with varying frequency.

The Mixed Coastal Alliance is a variant of the Mixed Alliance of the Rewa Delta, differing chiefly in the relative abundance of R.samoensis and Selala, greater occurrence of Sagali, and overall its more even canopy.

Area 538ha - 34% of the mangroves of the locale.

2.1.8.3. Dogo Alliance

The Dogo Alliance is the same closed, Basin Forest formation as described for the Rewa Delta. A uniform, closed forest of almost pure Dogo with a canopy height of 9-15m; well developed stands exceed 18m in height. Within the forest occasional Selala and large R.samoensis occur with Dabi and Sagali. Both the Landward and Mixed Coastal Alliances merge indistinctly with the Dogo Alliance, consequently mutual boundaries are difficult to discern.

Some areas of Dogo, perhaps the majority of accessible locations are more densely wooded with taller, thinner trunks. It seems likely that such areas were formerly clear felled and are regenerated, but have not been managed.

Area 537ha - 34% of the mangroves of the locale.

2.1.8.4 Landward Alliance

The Landward Alliance has been described for the Rewa Delta -

'A heterogenous closed forest of mixed composition forming the floristically most diverse mangrove alliance. Found only in the least exposed situations, the presence of an extensive epiphytic and climbing flora indicates that the alliance is stable, well drained and well protected from storm damage.

The most common tree species are Dabi, Dogo and Sinu with a canopy of 10-12m. R.samoensis and Selala occur more rarely and on creek banks. Other common trees are Terminalia litoralis, Heritiera littoralis, Inocarpus fragiferus, Ficus obliqua, Hibiscus tiliaceus, Pandanus pyroformis and Cocos nucifera'.

In this locale the Landward Alliance is essentially a transitional alliance with truly terrestrial vegetation. It is not extensive.

Area 136 ha - 9% of the Mangroves of the locale.

2.1.8.5 Boreti Alliance

A small area of pure Boreti the fern Achrostichum aureum is found in the locale. As in the Rewa Delta it is restricted to poorly drained, slightly elevated flats.

Area 8 ha - 0.5% of the mangroves of the locale.

2.1.9. Soils of the Suva - Navua Locale

No soil map for the mangrove soils of the coastline east of Navua has been prepared, but the soils are believed to be the same as those described for the Rewa Delta (see Watling 1985; in press).

A 1:25,000 soil map was prepared for the 'Navua Pre-investment Study' by Hunting Technical Services (Land Use Section, Ministry of Primary Industries). The Mangroves of the Navua plains are comprised of 'saline gleys' of the Soso and Doqo series, (see Watling in press).

2.2. Nadi Bay Locale

2.2.1 Boundaries

The southern boundary of the Nadi Bay Locale is the headland north of Yako village; the northern boundary is Nacilau Point. The coastline of the locale is approximately 70km and the offshore islands of Yakuilau (0.2km²), Via (0.02km²), Bekana (0.2km²) and Yawalau (0.02km²) are included in the locale, (Fig 1).

2.2.2 Physical Features

The locale lies in Vitilevu's dry climatic zone and experiences a strongly seasonal annual rainfall averaging 165 mm (figures for Nadi Airport).

Situated in a protected bay on Vitilevu's leeward coast, the locale is unaffected by the South East Tradewinds. However the locale is exposed to cyclones which normally arrive from the north-west quarter. The barrier reef is many kilometres distant from this coastline.

The locale has four principal features:

- . the protruding, mainly mangrove delta of the Nadi River
- . Nadi Bay and the Sabeto River delta within it
- . Vuda headland
- . Vitogo Bay with its large protruding mangrove formation.

The locale's hinterland is an extensive alluvial plain, drained by few but substantial rivers, in strong contrast to the many creeks and rivers of the Suva-Navua locale. The protected situation of this coastline has resulted in the retention of alluvial sediments allowing the formation of extensive deltas, and the formation of extensive fringing mangroves.

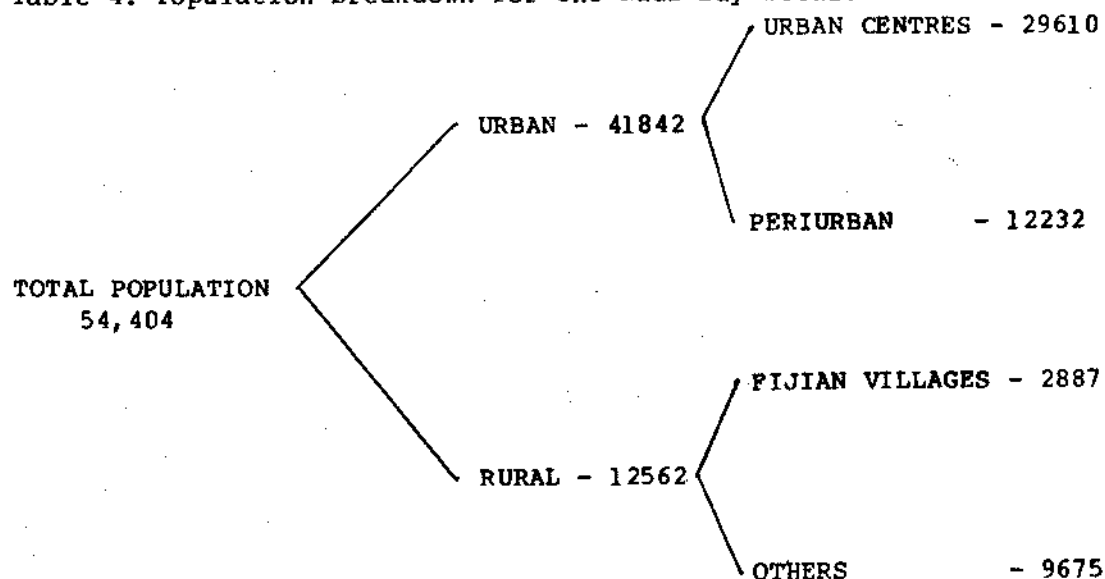
2.2.3. Population, agriculture and development

In contrast to the Suva-Navua locale which is sparsely populated except for two urban concentrations, the Nadi Bay locale borders a dense rural population of smallholder cane farms along its entire length, encompasses Lautoka City (population 29,000) and is closely associated with another urban concentration - Nadi-Nadi Airport environs (population 13,000), the centre of the Tourist Industry.

The locale, therefore is associated with Fiji's two major industries tourism and sugar both of which have made considerable reclamation demands of the locale's mangroves in the past.

Population Figures are presented in Table 4

Table 4: Population breakdown for the Nadi Bay Locale



- Notes:
- 1) 1976 Population Census
 - 2) All Enumerated Areas with a coastal border are included
 - 3) Urban Fijian Villages (8) are included in 'Urban' as per 1976 Census.

2.2.4. Historic and existing Mangrove utilisation

Formerly the mangroves were used for fuelwood by light industry and bakeries etc in Nadi and Lautoka and especially by the Cane Crushing Mill at Lautoka. Following the national trend this practice declined in the 1950's and today there are no mangrove fuelwood concessions for industrial purposes. However, between 1983-1986 23 Mangrove Cutting Licenses were issued by the Divisional Forestry Office Western for domestic fuelwood. All licensed sites were in remnant mangrove areas behind recently rehabilitated seawalls (see below).

At the turn of the century the Colonial Sugar Refining Company (CSR) constructed seawalls at several places in the locale but most extensively north of Lautoka on the Lovu-Drasa-Vitogo flats. It is unknown how much mangrove was lost following their construction but it is doubtful if it exceeded 100 ha (see Watling 1985 pp45, 60).

These seawalls required very heavy maintenance because they were poorly constructed (Pepper 1983). Gradually all of them fell into disrepair and were abandoned; those at Lovu-Drasa following a severe hurricane in 1930. The areas behind these abandoned walls quickly reverted to mangrove and it is perhaps logical to assume that this area of mangrove colonisation was approximately equivalent to the original area reclaimed by CSR.

Between 1976-83, these seawalls were reconstructed, flood gates installed and the mangroves behind are presently dying or have already been removed. Some new seawalls have also been constructed - Maqalevu, Vitogo and parts of Lomolomo with the resultant loss of mangroves and foreshore (72ha).

However, these mangrove areas were for the most part stunted Tiri with large areas of mudflat - relatively unproductive, while the seawall rehabilitation programme has resulted in over 1,000 ha of caneland 'benefitted' Table 5 (Note figures given for 'Protected' and 'Benefitted' areas are not consistent. Compare Table 5a and Ernest (1983) for the same sites)

Table 5a : Recalamation of Mangroves in the Nadi Bay Locale
I - Seawall Rehabilitation Programme (1976-83)

Locality	Area (ha) ¹		Mangrove lost ²
	Benefitted	Protected	
Teidamu	30	15	-
Drasa-Vitogo	139	76	73
Lovu	102	101	35
Lomolomo	243	93	45
Nasoso	311	142	-
Navakai	153	61	63
Maqalevu	72	44	17
TOTAL	<u>1050</u>	<u>532</u>	<u>233</u>

Notes: 'Benefitted' - 'all area behind the seawall upto which cane has been grown and to which main drains have been dug' (Ernest 1983)

'Protected' - 'area below the 2m contour interval - the level of the seawall' (Ernest 1983)

1. - Department D&I figures. File DI 6/3/1 - III Folios 126-128.
2. - Lands & Survey Department Figures. D0560. (Represents mangroves invading areas behind breached seawalls).

Table 5b: Reclamation of Mangroves in the Nadi Bay Locale
 II - Reclamation other than through Seawall Rehabilitation

Locality	Area (ha)	Purpose	Remarks
Lautoka-Namoli	6	Garbage Dump	Developed
Lautoka Namoli	40	Industrial	Application-final processing
Lautoka	4	Urban	Developed
Vulani I	53	Tourism	Awaiting Development
Saweni Beach	23	Tourism	Awaiting development
Vuda	3	Tourism	Developed-abandoned
Vuda	c. 3	Agriculture	(T.O.L.)-failed
Denarau	155	Tourism	Under development
Saru/Navutu	c.20	Industrial	Under development
Natabua	10	Urban-sewerage	Developed
Wairabetia	49	Industrial	Awaiting development

Another major cause of mangrove reclamation in the locale has been for the tourist industry, Table 5b. While recently permission has been granted or applications are in process for large reclamations for industrial requirements. Reclamation (either developed or approved) of approximately 600 ha of the locale's mangroves constitutes over 15% of the original resource in the locale. This is approximately three times the national average.

There is an almost complete absence of forest or even scrub cover in and around the cane farms adjoining the locale, consequently it is inevitable that the mangroves are heavily utilised for domestic fuelwood requirements and they are thus a most important resource. In certain areas the demand is exceeding sustainable yield and mangroves are being completely removed. This is a conspicuous and increasing problem. The majority of the mangroves of the Nadi locale are far less vigorous than those of the Suva-Navua locale as a result of climatic factors and are far less able to withstand heavy and continual cropping. They are thus quite easily destroyed.

The mangroves of the locale help sustain the inshore fisheries of the Nadi Bay which is very intensively fished Table 3. Fish and crustacea are commonly sold at the roadside and supply the Nadi and Lautoka markets, production figures are given in Table 6.

Table 6 Nadi and Lautoka Municipal Market Fish Sales
(Source - Fisheries Division, MPI)

Market	1982		1983		1984		1985	
	Weight (tonnes)	Value (\$)	Weight (tonnes)	Value (\$)	Weight (tonnes)	Value (\$)	Weight (tonnes)	Value (\$)
Lautoka	290.09	591,784	260.13	509,855	252.91	533,844	272.00	535,840
Nadi	83.02	161,889	80.63	186,256	86.00	138,460	97.00	181,390

2.2.5 Future trends

It appears clear that Nadi Bay will continue as an important focus of the tourist industry. Further mangrove sites will almost certainly be considered for reclamation for the industry. It is essential that such applications be thoroughly scrutinised as to viability and necessity given the already considerable loss of mangroves to the industry.

The sugar industry is unlikely to consider further mangrove areas for development given the present policy to consolidate within the existing cane perimeter. The latter is well defined where it borders mangroves in the locale by the presence of the seawalls.

The recent acquisition of foreshore for industrial development near Lautoka has been dramatic and unprecedented in Fiji (Wairabetia 49 ha; Navutu 30 ha; Namoli 40ha). Given the presence of much unutilised land at Lautoka further reclamation would appear hard to justify.

Dredging of the Nadi R. for flood mitigation is in the early planning stages. The location of dredge spoil disposal is crucial and should be carefully planned and preceded with a detailed impact assessment.

The Nadi locale has suffered more foreshore and mangrove reclamation than any equivalent area in Fiji. The remaining mangroves help sustain a very intensively fished inshore fisheries for a large rural population. The intensity can only increase and the continued productivity of the remaining mangroves is of increasing importance.

The locale will inevitably lose more mangroves. It is essential that the rate of loss be acceptable to all communities, in the national interest. Of major concern should be ill conceived, planned and financed small scale, 'private' reclamations. The futility of such schemes is conspicuous at the mouth of the Vuda R where a 'Leisure Park' (Ruggero) and a T.O.L. reclamation for agriculture have failed. In each case the mangroves have been removed and a productive ecosystem and replaced by a barren wasteland.

In view of the locales exposure to, and long history of cyclones and storm surge, reclamation is a very risky procedure. It requires careful planning and considerable capital and even then is vulnerable to cyclones and storm surge. This should be a major consideration when scrutinising reclamation applications.

2.2.6. The Mangrove Alliances of the Nadi Bay Locale

Three substantial rivers flow to the sea in the Nadi Bay locale - the Nadi, Sabeto and Vitogo and all three have a mangrove dominated delta which together contain the majority of the locale's mangroves. An extensive stand of fringing mangroves stretches along the coast from the Vuda headland to Lautoka.

Hypersaline mudflats are a characteristic feature of the locale, they are a consequence of the seasonal climate with a distinct and often severe dry season. Stunted Tiri Mangrove areas are also extensive and are generally associated with the mudflats.

Two Mangrove Alliances have been identified in the locale (Maps 4-7. Appendix 4) and they are considered the same as those found and described for the Ba Delta. Raj et al (1982, 1984) provide descriptions of the mangroves of the Saweni Bay area and the Sabeto Delta/Vulani.

2.2.6.1. Tiri Alliance

This alliance is a closed shrub forest overwhelmingly dominated by R. stylosa. Raj et al (1982) found R. stylosa to form 90-100% of the cover in random 10m² quadrants of this alliance at Saweni Bay. The canopy height varies. At the seaward edge it is 2-4m rising to 5-7m in the most vigorous stands. In poorly drained areas, stunted Tiri formations appear down to 1m in height, the latter invariably adjoin hypersaline mudflats.

Occasional Selala are found and even fewer Dogo. The occurrence of R. samoensis varies greatly being associated with fine, soft sediment substrates and fresh water. Along some creeks it can become dominant.

Area 464 ha 29% of the mangroves of the locale, which includes 95 ha of stunted Tiri, 6% of the locale's mangroves.

2.2.6.2. Selala Alliance

This is an open forest alliance dominated by the Selala hybrid. The canopy is uneven, varying between 4-12m, reflecting the emergent growth form of the hybrid. Also found are Tiri species, more commonly R. samoensis and occasional Dogo. In the more elevated areas landward species such as Dabi, Sinu, Xylocarpus granatum, Scaevola taccada and Hibiscus tiliaceus appear. In the Nadi and Sabeto deltas, extensive levees have been formed, some of these are of considerable size and have been cultivated, others have a typically terrestrial flora with Cocos nucifera, Leucaena leucocephala, Morinda citrifolia, Tamarindus indica, Cordia subcordata, Thespesia populnea, Calophyllum inophyllum, Samanea saman, Xylocarpus moluccensis being common trees.

Area 1158 ha 71% of the mangroves of the locale.

2.2.6.3. Mudflats

Mudflats are extensive in the locale. Lack of rainfall and a severe dry season enables salt concentrations to build up following evaporation, leading to hypersaline 'salt pans'.

Area 118 ha 7% of the combined mangrove and mudflats area in the locale.

2.2.7. Soils of the Nadi Bay Locale

No soil maps of the Mangrove in the locale have been prepared. However, the soils are believed to be the same as those described for the Ba delta (Watling 1985; in press).

3. AREA OF MANGROVES

3.1. Nadi Bay and the Suva-Navua Locales

The area of mangroves in both locales has been measured on mosaic aerial photograph maps (scales between 1:10,000 and 1:15,000). In Table 7 these areas are compared with those of the Lands & Survey Department estimate based on 1:50,000 map series (DO 560-62).

There is a considerable discrepancy with the official Lands & Survey Department underestimating the mangrove cover by 1760 ha (34% of the present project's estimate). The greater discrepancy (42%) is found in the Suva-Navua locale but this is in part a result of cartographical errors in the 1:50,000 Map series. Four separate areas of Mangroves were not identified as such and these total 271 ha (Toquru R - 147 ha; Deuba R - 48ha; Navua R - 47ha, Waimate Creek - 29 ha). Another source of error lies in the use of a photocopy for Map 19 - Mau in DO 560, on this the seaward limit of mangrove coverage is often poorly defined and sometimes invisible.

Table 7: Mangrove areas (ha) in the Suva-Navua and Nadi Bay Locales

Locale	Lands Dept 1:50,000 (a)	Present estimate (b)	Lands Dept underestimate (a-b)	Reclaimed Mangroves (c)	Mangroves remaining (b-c)
Nadi Bay	2530	3614	-1084 (30%)	546	3068
Suva-Navua	915	1591	- 676 (42.3%)	188	1403
Total	3445	5205	-1760 (33.8%)	709	4496

3.2. Estimate of Fiji's total Mangrove Resource

The Lands & Survey Department official estimate of the original mangrove resource is 45,288 ha (LD 33/41) based on the 1:50,000 Map series (DO 560-2). Phase 1 of this project revealed an apparent 11% over-estimate in the official figure of the mangroves of the Ba, Labasa and Rewa Deltas. The present work reveals an apparent underestimate in the mangroves of the Suva-Navua and Nadi Bay Locales of 34%. Combined, these estimates indicate a possible 3.5% underestimate of the official Lands Department figure for the national Mangrove Resource, Table 8.

In the circumstances it would be wisest to retain the official Lands & Survey Department figure of 45,288 ha with the knowledge that it is only very approximate. (Phase 1 Report - Appendix 3).

This highlights the need for an accurate estimation of the National Mangrove Resource, which should also include the mangrove of those islands not covered by the 1:500,000 map series.

Table 8: A comparison of the Mangroves areas of Locales covered in the present project and the area estimates of the Lands & Survey Department 1:50,000 series (Hectares)

Locale	Lands Department 1:50,000 series	Present Project estimate	Difference from Lands Dept estimate	
Rewa Delta	5492	5130	+362	7.1%
Ba Delta	4487	3714	+773	20.8%
Labasa Delta	1549	1473	+ 76	5.2%
Nadi Bay	2530	3614	-1084	30.0%
Suva-Navua	915	1591	- 676	42.3%
<u>Combined</u>	14,973	15,522	- 549	3.5%

3.3 Specific Management Consideration.

- A more accurate estimation of the National Mangrove Resource is required, and this should include the mangroves of islands for which there is no present estimation.

4. ZONATION

4.1. Suva-Navua Locale (Map 8, Appendix 4)

4.1.1. Port of Suva

The western boundary of the Port of Suva is Muaviso Point. A small portion of the locale is thus within the Port of Suva, most importantly the mangroves of the Veisari Creek. Within the Port, foreshore development is under the jurisdiction of the Ports Authority of Fiji.

4.1.2. National Reserve

No mangroves within the locale appear to be of sufficient scientific interest to warrant National Reserve status. However, this conclusion may be modified following a more exhaustive survey than this project has been able to carry out.

The accessibility of some areas of mangroves in the locale make them suitable as a National Reserve for educational or recreation requirements. First to be considered for this should be the mangroves of the Vatuloa estuary which appear to be the richest and most diverse of the locale. Indeed these mangroves if combined with the adjacent Melimeli Freshwater Swamp would form an area of outstanding scientific interest and of national conservation importance.

4.1.3. Resource Reserve

The Mangroves of the Vatuloa estuary have an intensive associated fishery (2.1.4) and continued sustenance of this is of greater importance now that the adjacent Toguru mangroves have been lost through seawall construction by D&I, and the precarious future of other major mangrove formations of the Navua-Deuba delta because of their inclusion in freehold titles.

The mangroves of the Veisari creek form the closest major mangrove formation west of Greater Suva which is sufficiently undisturbed and unpolluted to be of major importance in sustaining the fisheries of Suva Bay. However, signs of abuse of these mangroves are increasing - illegal felling and squatters. If these mangroves, are to function as a Resource Reserve they will need active conservation management in the near future.

Mangroves of the Nabukavesi estuary constitute another important mangrove formation of the locale which were considered for Resource Reserve status but because of their rather heavy utilisation by the large village of Nabukavesi are more appropriately zoned for Traditional use.

4.1.4. Traditional Use Zones

The majority of the mangroves in the locale are zoned for Traditional Use thereby ensuring their continued role in sustaining the locale's coastal fisheries whilst providing the many other sustainable necessities of the essentially subsistence-living coastal communities.

4.1.5. Wood Production Zones

All applications for mangrove fuelwood should be scrutinised carefully and should not be granted indiscriminately given the abundance of wastewood in the many sawmills of the Greater Suva area. Any concessions should be located behind the seawalls at Toquru, Waikaloa and Vanibau - if appropriate non-freehold mangroves can be located. Since mangroves will not regenerate in these areas, normal mangrove management techniques are not appropriate, this should be replaced by an alternative form of management.

After these areas have been felled, no new Wood Production Zones should be assigned to the locale. Initially all applications should be directed to any 'Freehold' Mangroves for negotiations with the title owners. Applications are presently made to Forestry/Lands & Survey Department because Royalties and Licensing Fees are outdated and non-commercial, (this is an important area for review - Phase I Report p28, 5.2.2.) A high end-cost for mangrove wood is a necessary objective to help counter indiscriminate use and wastage of mangrove fuelwood.

If, in the future, there is a need for Mangrove Fuelwood, a need which under the present circumstances of wastewood availability, cannot be justified, then a single well-managed operation should be located in the Rewa Delta's Production Zone (Phase I Report). This single location should be designed to serve all the needs of the Greater Suva area and adjacent locales.

4.1.6. Shoreline Protection

Mangroves on the seaward side of the seawalls at Toguru and Waikaloa should be maintained to protect the seawalls and are zoned for this purpose. H.Wise's concession is partly outside the seawall and this part should be re-located inside.

The Queens Road and Highway have been constructed adjacent to a Mangrove-fringed foreshore in parts of Namuka Harbour. These mangroves should be retained and managed for Shoreline Protection.

4.1.7. Development Zones

The mangrove areas behind all the seawalls constructed in the locale should initially be considered Wood Production Zones but in the longer term should be developed for agriculture or Forestry plantations.

The construction of the Highway created several small islands of mangrove remnants on its landward side between Lami and Veisari. These should be developed appropriately as they are serving little useful purpose.

Certain mangrove areas in the Tradewinds Bay are zoned for Development specifically for Conservation and 'Open Space'. Reclamation applications for these mangroves have already been rejected for this purpose.

4.2. Nadi Bay Locale (Maps 9-10, Appendix 4)

4.2.1 Ports Authority of Fiji

The Port of Lautoka-Vuda includes the entire coastline from the north of Lautoka to the south of Vuda Point (map 10). Foreshore development within the Port boundary requires approval from the Ports Authority of Fiji.

4.2.2 National Reserve

No mangroves of the locale appear to be sufficient scientific interest to warrant National Reserve status though this must be regarded as a provisional assessment which may be altered by a more exhaustive study. An area of the Selala Alliance in the Ba Delta has been proposed as a National Reserve, being a particularly vigorous and accessible example of this widespread mangrove alliance of Vitilevu's western coasts. (Phase I Report - Appendix 8, Map 8). Its accessibility makes it particularly suitable for educational purposes.

4.2.3 Resource Reserve

In the north of the locale, the mangroves north of the Waibitu Creek and across through the Vitogo mangrove complex, should be protected as a Resource Reserve. The landward side mangrove, are here heavily utilised for domestic fuelwood gathering, and are not suitable for Resource Reserve.

Included in the Resource Reserve should be the mangrove overwash island of Yawalevu. Overwash islands are a distinctive mangrove formation with special fish breeding and nursery habitats. They should be protected wherever possible despite their generally stunted stature.

The mangrove of the Dreketi Inlet is an important Resource Reserve of the central section of the locale, first identified as such by Baines (1979). It is presently being subjected to excessive fuelwood collection, protective measures are required. (Map 10, Appendix 4)

The mangrove of the Nadi R delta are under considerable pressure for two reasons. Firstly, a large tourist development - Denarau is sited there, increased population and fringe activities are inevitably affecting the mangroves. Secondly the fragmented nature of the delta mangrove formation with many elevated islands of terrestrial vegetation, the majority of which are either cultivated or at produce copra, has resulted in much of the mangrove area being accessible for both legitimate and illegal utilisation. In addition the extensive salt pans and areas of stunted Tiri indicate that the overall productivity of the delta is likely to be low by comparison with the more luxurious mangroves of the eastern coasts.

In consequence a Resource Reserve to help sustain the fisheries of the Nadi Bay is all the more important, and is made more urgent by the enormous loss of mangrove in the locale to date. Given the fragmented nature of the delta's mangroves, the ready access and existing associated developments, there is no natural location for a Resource Reserve. Hence the two areas proposed have no natural boundaries but contain the best remaining mangroves in the delta, (Map 9, Appendix 4).

The overwash mangroves adjacent to Yakuilau I are included as Resource Reserve.

4.2.4 Traditional Use Zone

The majority of the mangrove in the locale is zoned for traditional uses.

There is no doubt that the present unrestricted use of mangroves for fuel, even for only domestic needs is resulting in the gradual (and in some places, rapid) loss of mangrove cover in many accessible sites. The stunted Tiri community which is often closest to the shore and hence accessible, is the least able of all the mangrove alliances to withstand heavy cropping. Growing near the limit of its physiological tolerance, stunted Tiri soon disappears leaving bare mud flats when under sustained cropping. This problem which results from the high rural population density in the locale combined with the widespread use of mangrove for domestic firewood requirements, is a serious one. It will only be resolved by a combination of mangrove protection and the availability of other firewoods. The prospect at present is a steady and possibly increasing loss of mangrove cover at most accessible sites throughout the locale, with a resultant steady, increase in the area of relatively unproductive mudflat.

4.2.5 Wood Production Zones

The mangroves of the western coasts are not suitable for firewood production zones. While the more vigorous formations of the Selala Alliance do contain trees of sufficient size to be useful firewood, there are many unresolved problems in its management. At present the silviculture and management requirements for a hybrid mangrove such as Selala are completely unknown ; there is no certain knowledge of what will replace a felled stand of Selala.

Until such research is undertaken, mangroves of the western coasts should not be considered for Wood Production Zones. These should be restricted to areas where Dogo is the dominant, a species whose management is adequately known (Marshall, undated).

There will be pressure for Wood Production Zones in the Nadi Bay and neighbouring locales but this should be resisted. There is an abundance of wastewood from sawmills around the country at present and this should be fully utilised first. Mangrove wood is favoured for cremations but this use is over-rated. An inspection of 5 cremation, has shown that other woods are extensively and in certain cases exclusively used for cremations. The use of mangrove wood is as much a function as its availability and cheapness, as its suitability for the purpose.

Road communications on Viti Levu are now sufficiently good to enable any specific mangrove wood requirements to be serviced from an efficient wood production zone in the Rewa Delta or elsewhere.

Firewood plantations for both domestic and light industrial requirements are needed in the west. The Forestry Department should investigate the possible use of reclaimed land behind seawalls for this purpose.

4.2.6 Shoreline Protection

Small areas of mangrove which help protect the FSC Railway line in exposed situations should be retained and managed for this purpose.

Mangroves are also important in protecting seawalls where they are exposed to the sea. A 'Buffer zone' of mangroves should be maintained on the seaward side of the wall and should be as wide as possible, 100m at least (Rabanal 1981). The serious breaching of the Raviravi seawall (Phase I Report . p13) might have been mitigated or avoided if a realistic 'Buffer Zone' had been retained on the seaward side of the wall.

4.2.7 Development Zones

Areas behind the locale's seawalls are zoned for agricultural use, but nowhere is agriculture actually being attempted and it might be appropriate for such areas to support fuelwood plantations (4.2.5).

All mangroves remaining on the Lautoka City foreshore are zoned for development, but consideration for some of these to remain as 'Open Space' should be made by the council, similarly those on Vio I.

Other mangrove areas zoned for urban development are on sites already planned for, or operating as industrial subdivisions - Namoli, Saru/Navutu, Wairabeta and the Natabua Sewerage Plant. With the exception of Namoli where the mangroves are vigorous and productive the other areas are principally mudflat and/or stunted Tiri.

Mangroves zoned for Tourist Development are those of the Denarau I complex which is already developed and Vulani I and Saweni Bay, which are still in the planning stage.

Judicious landscape planning, utilising mangroves can certainly enhance a tourist development and mangroves therefore can be managed as an interesting visitor attraction.

Tourist developments which encompass mangroves 'in situ' will certainly infringe traditional usage of such sites by Customary Fishing Rights Owners and hence such sites should be included in compensation payments to Fishing Rights Owners. This precedent was set by the arbitration of the Vananiu Resort.

At Vulani, road construction to the island across mangroves must be properly surveyed and engineered to ensure that drainage patterns to and from surrounding mangroves are not affected.

Specific Management Considerations, Suva-Navua and Nadi Bay
Locales

- The mangroves of the Vatuloa estuary when combined with the adjacent Melimeli Freshwater Swamp form an area of national conservation importance.
- Any dredging in the Nadi, Navua or Deuba deltas which would effect mangroves should be preceded by a thorough impact assessment, adequately budgeted for.
- Abuse of mangroves through squatting and/or illegal felling is of mounting concern in both locales. It can only be countered by active management and law enforcement.
- Heavy firewood collecting in the vulnerable mangroves of the Nadi Bay Locale is, in certain localities, leading to the clearance of mangroves. This requires active attention.
- Wood Production Zones of the Suva-Navua locale should, once clearing of mangroves behind the seawalls is complete, be relocated in the Rewa Delta.
- The Tiri and Selala Alliances of the western, dry coast are not suitable for Wood Production Zones.
- Royalties and License Fees for Mangrove Wood are outdated and non-commercial. These should be reviewed and replaced by Fees ensuring a high end-cost for mangrove wood.

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Zonation Philosophy for Fijian Mangroves (From Phase 1 Report)

Background

Mangrove distribution within Fiji is not uniform and the mangrove vegetation itself varies from one locality to another. This is most marked between the mangroves of the dry, leeward coasts and those of the wet, windward coastlines. Recognising this and since the benefits that mangroves provide are received either in situ or in adjacent or offshore waters, management of the mangrove resource should be directed at a local, rather than a broad national level.

Initially, Fiji's coastlines should be divided into management 'locales' and a suitable framework already exists in the 1:50,000 Map series but demarcation between locales should be by natural features approximately defined by the 1:50,000 grid. The goal should be to balance management activities especially conversion between locales, thus preventing localised disruption to the resource becoming too severe.

The mangrove vegetation should be classified in alliances. For the present the alliances are characterised by an assessment of their standing biomass which is considered to be the best gross estimate of their productivity. A conventional vegetation map would be too detailed and of limited management use. The alliances are intended as practical management units which are sufficiently broad and therefore few in number to enable any mangrove area to be characterised and therefore be compared with any other.

When preparing a zonation plan, the alliances should provide the basic mapping unit, on which a consideration of potential and existing uses and threats are superimposed. At present the alliances are subjectively characterised, empirical data on their productivity status is urgently needed.

A hierarchial designation of zones is proposed so as to allow a degree of flexibility within the 'Managed' and 'Development' scheduled zones whilst affording maximum protection for the majority of the resource. Table A illustrates a Use-Compatibility Matrix for the proposed zones.

It must be emphasised that the scientific data base on which this suggested zonation system is formulated is very limited and in its present form is a guideline which will require refining. Any development application whether for conversion or managed harvesting of a renewable resource should still be considered on its own merits with reference to National Policy.

PRIMARY DESIGNATION - MANGROVE RESERVES

Resource Reserve

Mangrove areas identified as being of primary importance specifically in the sustenance of the capture fisheries, but for other reasons too which would become known on completion of detailed research. Areas selected on the basis of suspected high productivity or diversity, generally rather little used and with limited access. The objective is to prevent any activities which might deleteriously affect the resource. This should include appropriate zoning of adjacent land and coastal areas to ensure the integrity of the area.

Primary Mangrove Reserve	DESIGNATION		MAJOR USES						
	Secondary Managed Resource	Tertiary Development Zone	TRADITIONAL USE	CAPTURE FISHERIES	WOOD PRODUCTION	PRESERVATION	SHORELINE PROTECTION	SEWAGE PROCESSING	CONVERSION
RESOURCE RESERVE			P	1	X	2	2	X	X
NATIONAL RESERVE			X	2	X	1	2	2	X
	WOOD PRODUCTION (Potential) (in use)		P	2(1)	1	2	2	2	X
	TRADITIONAL USE		1	1	X	2	2	X	X
	SHORELINE PROTECTION		P	2	X	2	1	2	X
		SEWAGE PROCESSING	X	2	2	2	2	1	X
		URBAN DEVELOPMENT	2	2	X	2	2	X	1
		TOURIST DEVELOPMENT	X	2	X	2	2	X	1
		AGRICULTURE DEVELOPMENT	X	X	X	X	X	X	1
CABINET	MINISTERIAL	MANGROVE MANAGEMENT COMMITTEE	DECISION REQUIRED FOR DESIGNATION CHANGE						

TABLE A Mangrove Zonation a Use-Compatibility Matrix.

Key 1 - PRIMARY FUNCTION
 2 - SECONDARY FUNCTION
 P - PERMITTED
 X - INCOMPATIBLE

National Reserve

Areas of major scientific, educational or aesthetic interest. The objective is to provide full protection for the areas.

SECONDARY DESIGNATION - MANAGED RESOURCE AREAS

Traditional Use Zone

Mangrove areas which are subject to continual use and are required for the sustainable subsistence needs of rural communities. In some localities Traditional use Zones will be effective 'Buffer Zones' around Resource Reserve.

Wood Production Zone

Mangrove areas which have potential either through location or species composition, to be managed for commercial timber or firewood. Exploitation should be managed by the Forestry Department and based on specific Working/Management Plans. Potential Wood Production Zones should be regarded as Resource Reserve until they are managed for wood production.

Shoreline Protection Zone

Mangrove areas which are clearly required for the protection of adjacent land - roads, seawalls, agricultural land; or adjacent offshore reefs from inland erosion causing silt or pollutant dispersal.

Planting of mangroves should be carried out in vulnerable areas which have lost their mangrove flora.

TERTIARY DESIGNATION - DEVELOPMENT ZONES

Sewage Processing

There are two components to the mangrove areas required for sewage processing, a relatively small site converted during the construction of the oxidation ponds and a larger dispersed area which is likely to receive the effluent. Monitoring for possible health hazards in the latter area is essential.

Urban

Areas primarily destined for conversion in peri-urban environs. Conversion should not be seen as the only development option. Designation of some mangrove areas as 'open space' - to enhance the waterfront, for local coastal protection or for aesthetic and educational purposes would be important. However, the zones should not be considered as essential to the national resource and their destiny should to a large part be controlled by the plans or urban authorities. The latter should appreciate or be made aware of the aesthetic, conservation function in addition to the conservation option.

Tourism

The development of the tourist industry is a national priority and as such, mangrove areas will be considered for conversion if associated with development sites. Tourist operators are increasingly aware of the value of mangroves as tourist attractions and this should be encouraged in the preliminary planning period.

Agriculture

Areas which should be converted for agricultural use. Projects involving large scale clearance of mangroves will always be considered on their own merits and decisions made at the highest level. They cannot be zoned for in advance. At present only those areas cut off from salt water by sea wall construction are zoned for agriculture. Mangroves should not be clear-felled along the banks of creeks in such areas, as they will survive for many years in fresh water and will help prevent bank erosion.

Cabinet endorsement of the National Policy Plan for Fijian Mangroves

CABINET DECISION NO. 261

Extract from Minutes of Meeting held on Thursday, 24 July 1986

261

MANGROVE MANAGEMENT PLAN

Cabinet -

CP(86) 184

- (a) Noted the contents of the Report on Mangrove Management Plan for Fiji (Phase 1); and
- (b) Endorsed the National Policy Plan, recognising that mangroves are an important national asset - primarily as a resource based for capture fisheries and secondarily as a renewable source of products which contribute significantly to the quality of life of associated coastal communities - and that the natural processes of the ecosystem should be preserved wherever possible thereby allowing the sustained harvesting of its renewable products and the preservation of future development options. Conversion activities should be minimised and permitted only in the national interest and after a detailed socio-economic comparison with the expected loss to the capture fisheries and other renewable uses.

Principal species of the Fijian Mangrove.

Dogo	<u>Bruquiera gymnorrhiza</u> (L.) Lam
Tiri (Wai)	<u>Rhizophora samoensis</u> (Hochr.) Salvoza (Tomlinson, 1978)
Titi (Tabua)	<u>R. stylosa</u> Griff.
Selala	<u>R. x selala</u> (Salvoza) Tomlinson Putative hybrid of <u>R. samoensis</u> and <u>R. stylosa</u>
Dabi	<u>Xylocarpus granatum</u> Koenig
Sagali	<u>Lumnitzera littorea</u> (Jack) Voigt
Sinu gaga	<u>Excoecaria agallocha</u> L.
Kedra ivi na yalewa kalou	<u>Heritiera littoralis</u> Dryand.

APPENDIX 4

Maps

Mangroves of the Suva-Navua Coast	- 1	Map 1
	- 2	Map 2
	- 3	Map 3
Magroves of the Nadi Delta	- 1	Map 4
	- 2	Map 5
	- 3	Map 6
Mangroves of the Lautoka Environs	- 1	Map 6
	- 2	Map 7
Proposed Mangrove Zonation of the Suva-Navua Locale	- 1	Map 8
Proposed Mangrove Zonation of the Nadi Bay Locale	- 1	Map 9
	- 2	Map 10



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