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Botanical Environmental Impact
Survey for the Proposed Dredging
of the Nadi River and Estuary
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by

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Introduction

River estuaries especially those associated with mangroves are amongst the most productive ecosystems. They provide breeding sites for hundreds of marine species and organisms and are important dispersal centers for obligatory mangrove plant species. The mangroves also, especially those found along the fringes of the coastline, act as natural barriers to the direct impact of strong winds and waves on the shoreline. The Nadi River estuary is no exception. As a result of the intent to dredge the river mouth and along the river to Moala Village, a biological environment impact assessment was conducted on the 2 and 3 April 2001 to assess the impact of this activity on the flora and fauna. The purposes of the survey are threefold: 1). To assess the current growth status, plant composition, density and threatened status (where applicable) of plants in the area where dredged sediments from the river would likely be dumped. 2). To assess the likely impact of the dredging activity on the vegetation and fauna in the proposed dumpsites. 3). To compile baseline checklists of the fauna and flora for the area.

Method

The survey involved the documentation of plants and animals in and around the proposed dumpsites. For vascular plants (Appendix 1) and animals (Table 6) their checklist was compiled based on field observations whilst trekking through the area and from the assessment of the vegetation's growth status, and plant distribution along the area (Mueller-Dombois and Ellenberg 1974) proposed for the dumping of the dredged river sediments. Plant names are those used by Smith 1979-1991 for the higher vascular plants and by Brownlie 1976 for ferns and their allies. For the fauna those used by Watling 1982 and Morton and Raj 1974.

In assessing plant distribution patterns where the vegetation composition, in terms of growth form and species composition is heterogeneous, a Belt Transect 6m wide was centrally located across the area proposed for the dumpsite and the name, position, height > 3m and diameter at breast height (dbh) >2cm of shrubs and trees recorded. On the contrary if the vegetation composition is homogenous a transect was laid across the proposed dumpsite. At every 20m interval a 5m X 5m quadrat marked out and the Braun-Blanquet cover abundance assessment method used to determine species distribution and qualitatively assess species abundance of plants in the area (Mueller-Dombois and Ellenberg 1974; Derhammen *et. al.* 1989). Attempts were made to select an area with the least evidence of recent disturbances and that it had plants that were representative of the area (Mueller-Dombois and Ellenberg 1974). The transect was laid perpendicular from the coastline or riverbank.

Plants and vertebrates specimens not identified in the field were collected and/or preserved and later identified at the South Pacific Regional Herbarium and at the Marine Studies Programme by relevant resident taxonomists.

Results and Observations

Overall the growth status of the mangrove trees were far less vigorous than those of the Suva-Navua and Labasa locales. This could be due to climatic conditions (Watling 1987) or based on dbh, could be indicative of a young stand. This was deduced from the observed size range of the more common tree species found. Most *Rhizophora* species observed had dbh less than 12cm. For *Bruguiera gymnorrhiza* the largest tree had a dbh of only 15cm. For *Xylocarpus granatum*, most of it was saplings less than 4m in height. Besides *Lumnitzera littoralis* all exclusive mangrove species were present although it was reported that this species could be found in the mangrove stands towards Sonaisali.

An obvious feature about the whole river system from Moala village to the river mouth opening, and south west along the coast towards Sonaisali, was the recent evident of erosion along the river bank and coast line. Portions of the riverbank and associated vegetation [mangrove trees] were noticed submerged in the river. Along the coastline [near site 2] mangrove tree stumps and roots remnant were observed partially exposed during low tide. Also from conversation with locals, the coastline has changed drastically. A few years back the foreshore at site 2 was further out towards the sea now it has receded inland in some places by about 50m. This was also noticed when comparing old and more recent aerial photographs.

Site 1. Sandbank

The flora for the area (see Table 1) are composed of those associated with secondary stage of plant succession and their growth status is indicative of plants that are still at the early stages of their growth. This can be seen in some of the larger trees or dominant trees like *Cocos nucifera*, *Terminalia catappa*, *Casuarina equisetifolia* and *Inocarpus fagifer* have attained heights of not more than 7-10m (see Profile 1). For *Cocos nucifera* there were 12 fruiting trees and all have indications that they have just began fruiting. There are no mangroves on the sandbank except inland of the inter-tidal mudflat towards the Nawai Creek where about 25 young *Rhizophora* and *Bruguiera gymnorrhiza* saplings (1m to 3m high) were noticed (see Figure 2).

Towards the center of the sandbank, the following sparsely scattered Beach Forest Type trees were noticed which included *Terminalia catappa*, *Inocarpus fagifer*, *Calophyllum inophyllum*, *Morinda citrifolia*, *Pandanus tectoris*, the shrub *Scaevola taccada*, *Casuarina equisetifolia* and the creeper *Vigna marina*, *Derris trifoliata*, and *Ipomoea cres-pes*. The weed/invasive shrub *Leucaena leucocephala* was plentiful. The vegetation here is dominated by weeds which includes the noxious weeds *Mimosa pudica*, *Ricinus communis*, *Solanum torvum* and *Leucaena leucocephala*. Other more common weeds include *Mikania micrantha*, *Passiflora foetida*, *Urena lobata* and *Brachiaria mutica*. Recent vegetation growth or early stages of succession was also noticed in the area towards the mangrove stand at Site 2. The coastline is literally choked with detritus material and in some places it was 0.5m thick. Where the substrate is more stable it was covered with weeds, shrubs and young tree seedlings.

Table 1. Checklist of plants on Site 1 including their local name, growth form and use(s) if provided. Also included are the results of the species abundance and distribution analysis using the Braun-Blanquet assessment method. Keys to the abbreviations: exo = exotic; ind = indigenous; nat = naturalized; c = common; uc = uncommon; mc = most common. Braun-Blanquet symbols: + = one plant; X = 1% - 5%; 1 = 5% - 25%; 2 = 25% - 50%; 3 = 50% - 75%; 4 = >75%.

| Scientific Name | Local name | Status | Distance in metres | | | | | | |
|-------------------------------------|------------------|-----------------------|--------------------|----|----|----|----|-----|-----|
| | | | 0 | 20 | 40 | 60 | 80 | 100 | 120 |
| <i>Cocos nucifera</i> | Niu | Tree, ind., c | X | 1 | + | | | | |
| <i>Xanthium pungens</i> | | Herb, nat., uc | X | | X | | | | X |
| <i>Tridax procumbens</i> | | Herb, nat., uc | | X | | | | | |
| <i>Wedelia trilobata</i> | | Herb, nat., uc | X | X | | | | | X |
| <i>Barringtonia asiatica</i> | | Tree (sap.), ind., uc | | | + | | + | | |
| <i>Caesalpinia bonduc</i> | Sili | Liana, ind., c | | | | X | | | |
| <i>Cassytha filiformis</i> | | Creeper, nat. c | | X | X | | | X | |
| <i>Terminalia catappa</i> | | Tree, ind., uc | | | | + | | | |
| <i>Ipomoea pes-caprae</i> | | Creeper, ind., c | | | | | | | X |
| <i>Coccinia spp.</i> | | Creeper, nat., uc | | | + | | | | |
| <i>Cyperus rotundus</i> | | Grass, nat., c | X | X | | X | X | X | |
| <i>Ricinus communis</i> | | Shrub, nat., c | + | | + | | | | |
| <i>Excoecaria agallocha</i> | Toca | Tree, ind., ms | X | + | | | | + | |
| <i>Vigna marina</i> | | Creeper, ind., c | 1 | X | | | | X | 1 |
| <i>Derris trifoliata</i> | Tuva | Creeper, ind., c | X | | | | | X | |
| <i>Indigofera trita var. scabra</i> | | Shrub, nat., c | | X | | X | X | | |
| <i>Crotalaria pallida</i> | | Shrub, nat., c | | + | X | | + | | |
| <i>Inocarpus fagifer</i> | | Tree, ind., uc | | | | + | | | |
| <i>Scaevola sericea</i> | | Shrub, ind., uc | | X | | | | | X |
| <i>Gyrocarpus americanus</i> | | Tree (sap.), ind., uc | | | | | + | | |
| <i>Urena lobata</i> | | Herb, nat., uc | | + | + | | | + | |
| <i>Hibiscus tiliaceus</i> | | Tree, ind., c | | + | | | + | | |
| <i>Xylocarpus granatum</i> | Leqileqi yalewa | Tree, ind., ms | | + | | | | | |
| <i>Albizia saman</i> | Vaivai mocemoce | Seedling, nat., ms | + | | | | | + | |
| <i>Mimosa pudica</i> | | Herb, nat. c | X | X | X | | X | | |
| <i>Leucaena leucocephala</i> | Vaivai ni yavulo | Shrub, nat., c | | X | X | | X | | |
| <i>Pandanus tectorius</i> | | Tree, ind., uc | | | | | X | | |
| <i>Passiflora foetida</i> | | Creeper, ind., c | | X | X | | X | | X |
| <i>Eleusine indica</i> | | Grass, nat., uc | X | X | | X | | X | |
| <i>Brachiaria mutica</i> | | Grass, nat., ms | X | X | X | X | X | X | X |
| <i>Paspalum distichum</i> | | Grass, ind., ms | X | X | X | | | X | X |
| <i>Perisetum polystachyon</i> | | Grass, nat., c | X | X | | | | X | X |
| <i>Sporobolus diander</i> | | Grass, nat., uc | | | | | | | |
| <i>Saccharum spontaneum</i> | | Grass, exo., c | | | | | | | |
| <i>Polygala paniculata</i> | | Herb, nat., uc | X | X | X | X | | | |
| <i>Rhizophora spp.</i> | Togo | Tree (sap.), ind., c | X | | | | | | |
| <i>Bruguiera gymnorrhiza</i> | Lailai | Tree (sap.), ind., uc | X | | | | | | |
| <i>Rubus moluccanus</i> | | shrub, ind., uc | | + | | | | | |
| <i>Morinda citrifolia</i> | | Tree, ind., uc | | | | | + | | |

Site 2. Coastline from Rivermouth to Sandbank

Two transects were used in assessing plant abundance and distribution. A transect was laid adjacent to the sandbank where it was littered with sand, silt and debris near the coastline and further inland is partially vegetated by common herbs, shrubs and grasses. A transect 160m long, was laid from the seaward side across the recently buried channel to the mudflat. At every 20m interval a 5m X 5m quadrat marked out and the Braun-Blanquet cover abundance assessment method used to qualitatively assess species abundance in the area (Hammen *et. al.* 1989). The growth status was assessed qualitatively. A plantation of about 12 recently planted (1-year-old) *Cocos nucifera* seedlings was also noticed. The entire "beachfront" was littered by debris (in some places its 0.5m thick) brought down by the river. Most of the non-obligatory mangrove species were found on this section of the area surveyed and about 95% of plants listed in Table 2 are those recorded from this section of the proposed dumpsite (see Figure 1 and Profile 2).

A second transect was laid from the coastline into the *Rhizophora* dominated mangrove stand. The *Rhizophora* stand or Tiri alliance (Watling 1978[mostly composed of *R. stylosa* and *R. samoensis*]) dominated this site and there are a lot of signs of recent disturbance (erosion) especially along the coastline. The mangrove strip appears to be retreating rather than advancing as expected. Some mangroves immediately along the coastline are dying, some even uprooted from the waves and tidal force. In this section of the coastline the mangrove cover (mostly *R. samoensis*) is completely closed and this continues inland for up to 100m. *Rhizophora* x selala - like trees appears in the background but none observed towards the edge of this stand. The only trees observed in the area are the two *Rhizophora* species and an occasional *Bruguiera*. All other "trees" are seedlings.

Table 2. Checklist of plants on Site 2 including their local name, growth form and use(s) if provided. Also included are the results of the species abundance and distribution analysis using the Braun-Blanquet assessment method. Keys to the abbreviations: exo = exotic; ind = indigenous; nat = naturalized; c = common; uc = uncommon; mc = most common.

| Family | Scientific Name | Local name | Status |
|----------------|-----------------------------|------------|--------------------|
| Arecaceae | <i>Cocos nucifera</i> | Niu | Seedling, ind., uc |
| Asteraceae | <i>Xanthium pungens</i> | | Herb, nat., c |
| Asteraceae | <i>Sida acuta</i> | | Herb, nat., uc |
| Asteraceae | <i>Mikania micrantha</i> | Wa bosucu | Vine, nat., uc |
| Asteraceae | <i>Vernonia cinerea</i> | Kaukamea | Herb, nat., c |
| Asteraceae | <i>Ageratum conyzoides</i> | Suguvanua | Herb, nat., uc |
| Asteraceae | <i>Synedrella nodiflora</i> | | Herb, nat., uc |
| Caricaceae | <i>Carica papaya</i> | | Seedling, nat., uc |
| Commelinaceae | <i>Commelina diffusa</i> | | Grass, ind., uc |
| Convolvulaceae | <i>Ipomoea pes-caprae</i> | | Creeper, ind., c |
| Cyperaceae | <i>Cyperus rotundus</i> | | Grass, nat., c |
| Euphorbiaceae | <i>Excoecaria agallocha</i> | Toca | Seedling, ind., uc |

| | | | |
|----------------|-------------------------------|--------------------|---------------------|
| Euphorbiaceae | <i>Ricinus communis</i> | | Seedling, nat., c |
| Euphorbiaceae | <i>Manihot esculenta</i> | | Seedling, cult., uc |
| Fabaceae | <i>Derris trifoliata</i> | Tuva | Creeper, ind., c |
| Malvaceae | <i>Thespesia populnea</i> | Wiriwiri | Seedling, ind., c |
| Malvaceae | <i>Hibiscus tiliaceus</i> | | Seedling, ind., uc |
| Meliaceae | <i>Xylocarpus granatum</i> | Leqileqi yalewa | Seedling, ind., uc |
| Mimosaceae | <i>Albizia saman</i> | Vaivai mocemoce | Seedling, nat., mc |
| Mimosaceae | <i>Leucaena leucocephala</i> | Vaivai ni yavulo | Seedling, nat., uc |
| Mimosaceae | <i>Mimosa pudica</i> | | Herb, nat. uc |
| Poaceae | <i>Brachiaria mutica</i> | | Grass, nat., c |
| Poaceae | <i>Eleusine indica</i> | | Grass, nat., uc |
| Poaceae | <i>Sporobolus diander</i> | | Grass, nat., uc |
| Poaceae | <i>Saccharum spontaneum ?</i> | | Grass, exo., c |
| Rhizophoraceae | <i>Rhizophora samoensis</i> | Togo Du | Seedling, ind., mc |
| Rhizophoraceae | <i>Rhizophora stylosa</i> | Togo Buco | Seedling, ind., c |
| Rhizophoraceae | <i>Bruguiera gymnorrhiza</i> | Lilai | Seedling, ind., c |
| Rubiaceae | <i>Morinda citrifolia</i> | | Seedling, ind., uc |
| Sapotaceae | <i>Planchonella grayana</i> | | Seedling, ind., uc |
| Solanaceae | <i>Solanum torvum</i> | | Seedling, nat., uc |
| Solanaceae | <i>Physalis peruviana</i> | | Herb, nat., uc |
| Verbenaceae | <i>Vitex trifolia</i> | Drala | Shrub, ind., uc |

Site 3. Mamaqa (Hyper saline flat) and Nacova Islet.

This was the only observed hyper saline or saltmarsh (**mamaqa**) seen in the area (see Figure 4). It covers an area of about 3 acres. The area was qualitatively assessed for its biodiversity. Several dead stumps of mangrove were noticed towards the mangrove edge (i.e. away from the land). The fringes of the saltmarsh was dominated by stunted *Rhizophora stylosa* some of which were only 50cm tall and had propagules (seedlings) however there were no mangrove seedlings noticed. Few mounds of the Mud Lobster *Thalassina anomala* were noticed in the saltmarsh. On the landward side toward Nacova Islet (see Figure 3), a few *Xylocarpus granatum*, *Heritiera littoralis* and *Excoecaria agallocha* tress were noticed growing close to the edge of the saltmarsh. The vegetation generally on the islet was typically composed of weeds and shrubs associated with neglected gardens or pastures. These include *Mikania micrantha*, *Indigofera trita* var., *scabra*, *Caesalpinia bonduc*, *Lantana camara* and *Acacia farnesiana*. This type of vegetation continued on into the islet for up to 150m inland. Also most *Cocos nucifera* are old and a few are topless.

Table 3. Checklist of plants on Site 3 including their local name, growth form and use(s) if provided. Keys to the abbreviations: exo = exotic; ind = indigenous; nat = naturalized; c = common; uc = uncommon; mc = most common.

| Family | Scientific Name | Local name | Status |
|-----------------|--|------------------|------------------|
| Acanthaceae | <i>Thunbergia alata</i> | | Vine, nat., uc |
| Adiantaceae | <i>Acrostichum aureum</i> | Burete | Fern, ind., c |
| Annonaceae | <i>Annona glabra</i> | | Tree, nat., uc |
| Arecaceae | <i>Cocos nucifera</i> | Niu | Tree, ind., c |
| Asteraceae | <i>Sida acuta</i> | | Herb, nat., uc |
| Asteraceae | <i>Sida rhombifolia</i> | | Herb, nat., uc |
| Asteraceae | <i>Mikania micrantha</i> | Wa bosucu | Vine, nat., uc |
| Bignoniaceae | <i>Spathodea campanulata</i> | | Tree, nat., uc |
| Caesalpiniaceae | <i>Caesalpinia bonduc</i> | Sili | Liana, ind., c |
| Caesalpiniaceae | <i>Senna tora</i> | | Shrub, nat., c |
| Caesalpiniaceae | <i>Senna occidentalis</i> | | Shrub, nat., uc |
| Convolvulaceae | <i>Ipomoea obscura</i> | | Vine, ind., uc |
| Euphorbiaceae | <i>Excoecaria agallocha</i> | Toca | Tree, ind., ms |
| Fabaceae | <i>Derris trifoliata</i> | Tuva | Creeper, ind., c |
| Fabaceae | <i>Indigofera trita</i> var., <i>scabra</i> | | Shrub, nat., c |
| Fabaceae | <i>Dendrolobium</i> <i>umbellatum</i> | | Shrub, ind., uc |
| Fabaceae | <i>Abrus precatorius</i> | | Vine, ind., uc |
| Lamiaceae | <i>Hyptis pectinata</i> | | Shrub, nat., c |
| Malvaceae | <i>Thespesia populnea</i> | Wiriwiri | Tree, ind., c |
| Malvaceae | <i>Hibiscus tiliaceus</i> | | Tree, ind., c |
| Malvaceae | <i>Urena lobata</i> | | Herb, nat., c |
| Mimosaceae | <i>Leucaena leucocephala</i> | Vaivai ni yavulo | Shrub, nat., c |
| Mimosaceae | <i>Acacia farnesiana</i> | | Shrub., nat, uc |
| Myrtaceae | <i>Psidium guajava</i> | | Shrub, nat., c |
| Poaceae | <i>Bambusa vulgaris</i> | Bitu ni vavalagi | Grass, nat., c |
| Poaceae | <i>Axonopus affinis</i> | | Grass, nat., c |
| Poaceae | <i>Ischaemum indicum</i> | | Grass, nat., c |
| Rhizophoraceae | <i>Rhizophora samoensis</i> | Togo Du | Tree, ind., c |
| Rhizophoraceae | <i>Rhizophora stylosa</i> | Togo Buco | Tree, ind., c |
| Sterculiaceae | <i>Heritiera littoralis</i> | | Tree, ind., c |
| Verbenaceae | <i>Stachytarpheta</i> <i>urticaefolia</i> | | Herb, nat., uc |
| Verbenaceae | <i>Lantana camara</i> | Lanitana | Shrub, nat., c |
| Verbenaceae | <i>Premna serratifolia</i> | | Tree, ind., uc |

Site 4: Malovava (Back of the School)

A walk through qualitative analysis was conducted on the flora and fauna composition of the site (see Figure 6). The area has been greatly altered by recent human activities in the form of farming and grazing of domesticated animals. The vegetation has been mostly taken over by weedy shrubs and herbs and a few scattered *Albizia saman*, *Cocos nucifera*, *Psidium guajava*, *Glochidion sp.* and *Mangifera indica* trees. This trend continues inland for about 60m where a sugarcane plantation begins. On either sides of the area are remnants of mangrove forests. The riverbank shows recent evidence of erosion, as exposed and bare riverbanks are common.

Table 4. Checklist of plants on Site 4 including their local name, growth form and use(s) if provided. Keys to the abbreviations: exo = exotic; ind = indigenous; nat = naturalized; c = common; uc = uncommon; mc = most common.

| Family | Scientific Name | Local name | Status |
|----------------|--|------------------|-------------------|
| Amaranthaceae | <i>Achyranthes aspera</i> | | Herb, nat., uc |
| Annonaceae | <i>Annona muricata</i> | | Tree, nat., uc |
| Arecaceae | <i>Cocos nucifera</i> | Niu | Tree, ind., c |
| Asteraceae | <i>Vernonia cinerea</i> | Kaukamea | Herb, nat., c |
| Asteraceae | <i>Ageratum conyzoides</i> | Suguvanua | Herb, nat., uc |
| Asteraceae | <i>Mikania micrantha</i> | Wa bosucu | Creeper, nat., uc |
| Asteraceae | <i>Xanthium pungens</i> | | Herb, nat., c |
| Convolvulaceae | <i>Ipomoea pes-caprae</i> | | Creeper, ind., c |
| Euphorbiaceae | <i>Manihot esculenta</i> | | Shrub, cult., c |
| Fabaceae | <i>Pongamia pinnata</i> | | Tree, ind., c |
| Fabaceae | <i>Indigofera trita</i> var. <i>scabra</i> | | Shrub, nat., c |
| Fabaceae | <i>Derris trifoliata</i> | Tuva | Creeper, ind., c |
| Meliaceae | <i>Xylocarpus moluccensis</i> | Leqileqi tagwane | Tree, ind., mc |
| Meliaceae | <i>Azadirachta indica</i> | | Tree, nat., c |
| Mimosaceae | <i>Mimosa pudica</i> | | Herb, nat., c |
| Oxalidaceae | <i>Oxalis corniculata</i> | | Herb, nat., uc |
| Passifloraceae | <i>Passiflora foetida</i> | | Creeper, ind., uc |
| Poaceae | <i>Sporobolus diander</i> | | Grass, nat., c |
| Poaceae | <i>Pennisetum polystachyon</i> | | Grass, nat., c |
| Poaceae | <i>Paspalum distichum</i> | | Grass, ind., c |
| Poaceae | <i>Eleusine indica</i> | | Grass, nat., c |
| Poaceae | <i>Ischaemum indicum</i> | | Grass, nat., c |
| Poaceae | <i>Brachiaria mutica</i> | | Grass, nat., c |
| Poaceae | <i>Panicum maximum</i> | | Grass, nat., c |
| Rubiaceae | <i>Morinda citrifolia</i> | | Tree, ind., uc |
| Solanaceae | <i>Solanum torvum</i> | | Shrub, nat., uc |

Site 5: Southeast of Moala Village

On the southeastern side of Moala village the mangrove is made up mostly of the Tiri Alliance. From the edge of the village towards the mangrove swamp a strip of 15m to 20m of *Paspalum distichum* dominated this very soggy inter-tidal area with scattered clusters of the fern *Acrostichum aureum*. Beyond this and stretching out to about 100m is a relatively young stand of *R. samoensis* and *R. stylosa* with an occasional *Bruguiera* tree. The *Rhizophora* stand is not continuous, gaps are quiet frequent and lots of mud lobsters mounds noticed (see Figure 5).

Table 5. Checklist of plants on Site 5 including their local name, growth form and use(s) if provided. Keys to the abbreviations: exo = exotic; ind = indigenous; nat = naturalized; c = common; uc = uncommon; mc = most common.

| Family | Scientific Name | Local name | Status |
|----------------|------------------------------|-----------------|-------------------|
| Adiantaceae | <i>Acrostichum aureum</i> | Burete | Fern, ind., c |
| Meliaceae | <i>Xylocarpus granatum</i> | Leqileqi yalewa | Sapling, ind., uc |
| Poaceae | <i>Paspalum distichum</i> | | Grass, ind., mc |
| Rhizophoraceae | <i>Rhizophora samoensis</i> | Togo Du | Tree, ind., mc |
| Rhizophoraceae | <i>Rhizophora stylosa</i> | Togo Buco | Tree, ind., c |
| Rhizophoraceae | <i>Bruguiera gymnorrhiza</i> | Lilai | Tree, ind., c |
| | | | |

Fauna observed during the survey included a flock (14 adults) of native ducks, sea birds, and associated mangrove molluscs and crustaceans. A list of fauna observed during the two days survey is listed below. No fish detailed survey was conducted although various common species of fish associated with mangroves and estuarine systems were noticed.

Table 6. Checklist of animals observed at the sites during the two days survey.

| Family | Scientific Name | Local name |
|-------------|-------------------------------------|---------------------------|
| Molluscs | <i>Littorina scabra</i> | Large periwinkle |
| | <i>Chthamalus malayensis</i> | Acorn barnacles |
| | <i>Crassostrea mordax</i> | Rock oysters |
| | <i>Boleophthalmus boddaerti</i> | Mud skipper |
| Crustaceans | <i>Metopograpsus messor</i> | |
| | <i>Uca lactea</i> | |
| | <i>Uca chlorophthalmus</i> | |
| | <i>Caridina sp.</i> | Small shrimps |
| | <i>Penaeus monodon</i> | Marine prawn |
| Avifauna | <i>Egretta sacra</i> | Reef heron |
| | <i>Limosa lapponica</i> | Bar-tailed godwit |
| | <i>Halcyon chloris</i> | White collared kingfisher |
| | <i>Foulehaio c. carunculata</i> | Wattled honeyeater |
| | <i>Pycnonotus cafer bengalensis</i> | Red vented bulbul |
| | <i>Acridotheres tristis</i> | Common mynah |

| | | |
|--|-----------------------------|---------------------------|
| | <i>Accipter rufitorques</i> | Green tree skink |
| | <i>Anas superciliosa</i> | Ga ni viti |
| | <i>Artamus mentalis</i> | |
| | <i>Circus approximans</i> | Pacific Harrier, Manulevu |

Conclusions

There are no plants considered rare and or threatened (NBSAB Technical Report #3, 1998) or deserve special conservation attention (IUCN Red List 1994) found in the areas or sites intended for the dredged sediments to be dumped in. But special attention should be directed towards the degradation of the river and associated mangrove system found therein. The only area where precautions may be required for the dumping is on Site 2 where such activities could lead to the destruction of the already stressed and remaining Tiri alliance stand, especially those along the coast line and directly exposed to the elements (wave action, flooding etc.). On all other sites the dredged sediments can be dumped in the areas suggested as its impact on the flora will be relatively negligible but on the contrary stabilize the area further. For the **maqamaqa** (saltmarsh) it was brought to our attention that a large flock of native ducks frequent the area especially during the neap tides. The dredged sediments, if the saltmarsh is required to be preserved, could than be dumped on the neglected garden site or **Nacova** Islet. This will not only improve the areas agricultural potential, but also stabilize the area further. The intention to further extend the village boundary by reclaiming the soggy area adjacent to the village green should be supported. Again its impact on any unique fauna and flora would be negligible. The same can also be said about the site on **Nalovava**.

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APPENDIX 1.

Trees

| Botanical Name |
|--------------------------------|
| <i>Albizia saman</i> |
| <i>Heritiera littoralis</i> |
| <i>Cocos nucifera</i> |
| <i>Bruguiera gymnorrhiza</i> |
| <i>Rhizophora samoensis</i> |
| <i>Rhizophora stylosa</i> |
| <i>Terminalia catappa</i> |
| <i>Leucaena leucocephala</i> |
| <i>Hibiscus tiliaceus</i> |
| <i>Thespesia populnea</i> |
| <i>Excoecaria agallocha</i> |
| <i>Xylocarpus granatum</i> |
| <i>Pandanus tectorius</i> |
| <i>Casuarina equisetifolia</i> |
| <i>Inocarpus fagifer</i> |

Tree sapling

| |
|------------------------------|
| <i>Planchonella grayana</i> |
| <i>Gyrocarpus americanus</i> |
| <i>Barringtonia asiatica</i> |
| <i>Morinda citrifolia</i> |

Shrub

| |
|----------------------------|
| <i>Colubrina asiatica</i> |
| <i>Clerodendrum inerme</i> |
| <i>Citrus limon</i> |
| <i>Ricinus communis</i> |
| <i>Carica papaya</i> |
| <i>Solanum torvum</i> |
| <i>Xanthium pungens</i> |
| <i>Vitex trifolia</i> |
| <i>Indigofera trita</i> |

| |
|---------------------------|
| <i>Crotalaria pallida</i> |
| Pencil plant |

Creeper

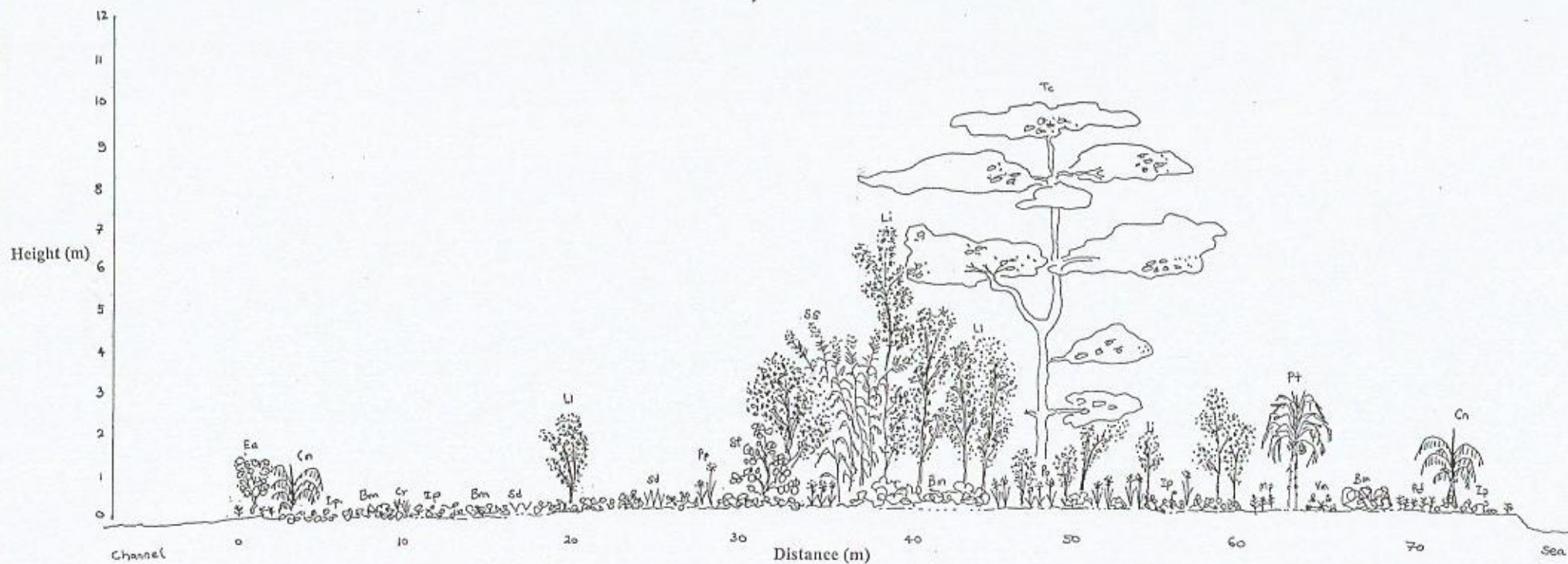
| |
|----------------------------|
| <i>Ipomoea pes-caprae</i> |
| <i>Vigna marina</i> |
| <i>Derris trifoliata</i> |
| <i>Passiflora foetida</i> |
| <i>Mikania micrantha</i> |
| <i>Cassytha filiformis</i> |
| <i>Coccinia grandis</i> |
| <i>Wedelia biflora</i> |
| <i>Caesalpinia bonduc</i> |

Herbs/Grass

| |
|--------------------------------|
| <i>Sida acuta</i> |
| <i>Vernonia cinerea</i> |
| <i>Ageratum conyzoides</i> |
| <i>Synedrella nodiflora</i> |
| <i>Physalis peruviana</i> |
| <i>Urena lobata</i> |
| <i>Mimosa pudica</i> |
| <i>Mimosa sp.</i> |
| <i>Commelina diffusa</i> |
| <i>Polygala paniculata</i> |
| <i>Brachiaria mutica</i> |
| <i>Pennisetum polystachyon</i> |
| <i>Cyperus rotundus</i> |
| <i>Eleusine indica</i> |

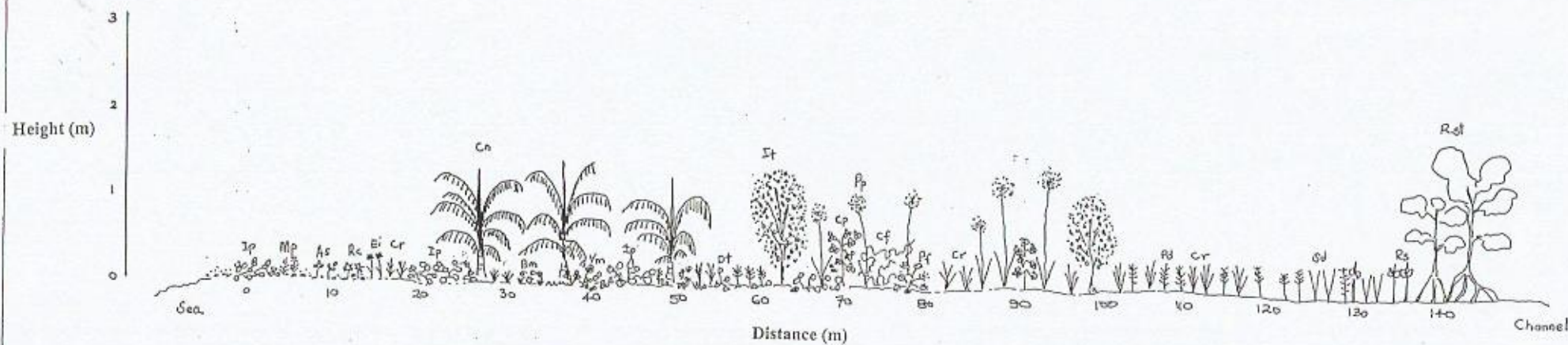
Fern

| |
|---------------------------|
| <i>Acrostichum aureum</i> |
|---------------------------|



Profile 1: Vegetation Structure. Profile Diagram of mixed species on an upraised sandbank near the Nadi River Mouth. Transect width: 5m.

Symbols of plants: Bm - *Brachiaria mutica*, Cn - *Cocos nucifera*, Cr - *Cyperus rotundas*, Ea - *Excoecaria agallocha*, Ip - *Ipomoea pes-caprae*, Li - *Leucaena leucocephala*, Mp - *Mimosa pudica*, Pd - *Paspalum distichum*, Pp - *Pennisetum polystachyon*, Pt - *Pandanus tectorius*, Sd - *Sporobolus diander*, Ss - *Saccharum spontaneum*, St - *Scaevola taccada*, Tc - *Terminalia catappa*, Vm - *Vigna marina*.



Profile 2: Vegetation Structure. Profile Diagram of mixed species on a filled & abandoned river channel, on Natadola Beach, Nadi River Mouth. Transect width: 10m.

Symbols of plants: *As* - *Albizia saman*, *Bm* - *Brachiaria mutica*, *Cf* - *Cassytha filiformis*, *Cn* - *Cocos nucifera*, *Cp* - *Crotalaria pallida*, *Cr* - *Cyperus rotundas*, *Dt* - *Derris trifoliata*, *Ei* - *Eleusine indica*, *Ip* - *Ipomoea pes-caprae*, *It* - *Indigofera trita*, *Mp* - *Mimosa pudica*, *Pd* - *Paspalum distichum*, *Pf* - *Passiflora foetida*, *Pp* - *Pennisetum polystachyon*, *Rc* - *Ricinus communis*, *Rs* - *Rhizophora seedling*, *Rst* - *Rhizophora stylosa*, *Sd* - *Sporobolus diander*, *Vm* - *Vigna marina*.

Figure 5. Part of the area to be reclaimed that is adjacent to Moala village. The young mangrove stand here is not continuous and where gaps occur (as shown in the picture) scattered Mud lobster mounds were noticed.



Figure 6. Proposed dumping site at Malovava. The vegetation is dominated by common weeds and trees associated with neglected gardens. Note the eroded riverbank, which is a common feature along the river most of the way to the river mouth.

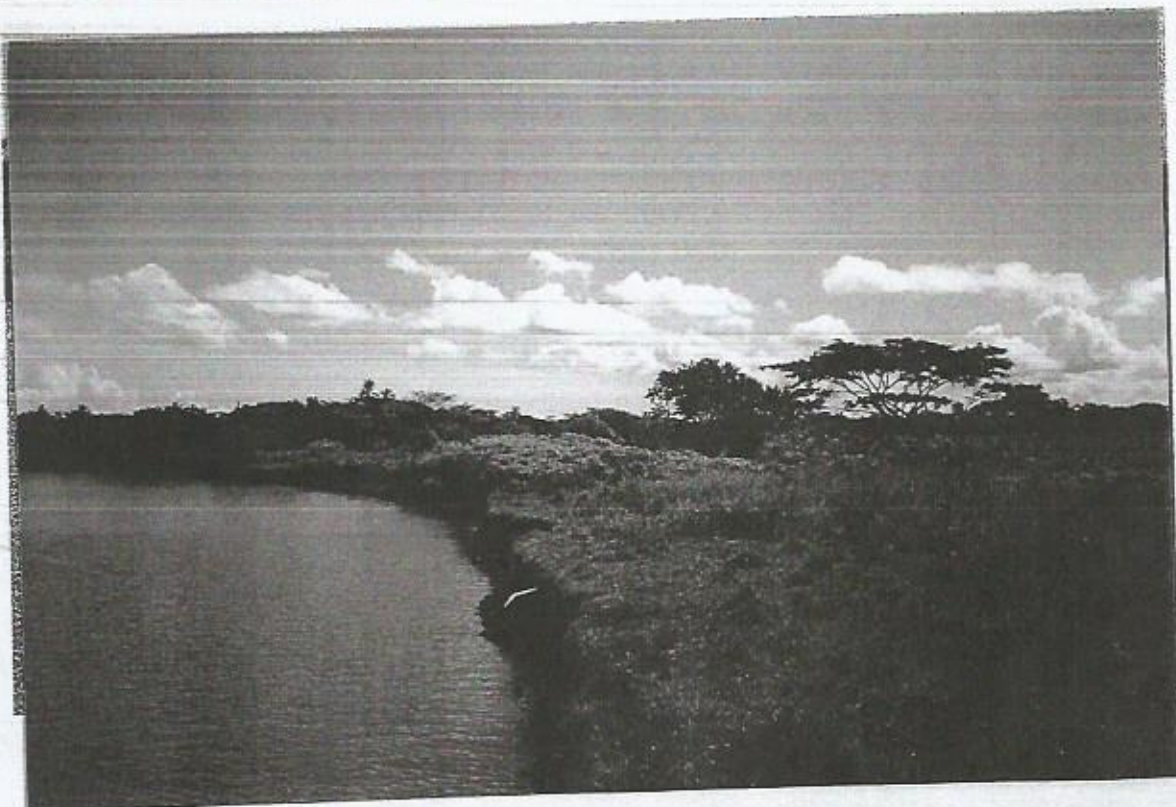


Figure 3. Proposed dumpsite at the Nacova Islet that's adjacent to the saltmarsh. The vegetation is mostly composed of weeds associated with neglected gardens and pastures.



Figure 4. The only saltmarsh observed in the area. Note the dead stumps and stunted mangroves in the foreground. A potential dumpsite for the dredged sediments.



Figure 1. A buried channel with lots of pioneer plant species. A young coconut grove in the background. The foreshore is literally littered with debris washed down river and deposited here by wave actions and strong currents.



Figure 2. Proposed mudflat dump site inland of the sandbank towards the Nawai River. Few mangrove seedlings observed here.

