REWA RIVER DREDGING PROJECT

FINAL EIA REPORT

Prepared by the Institute of Applied Sciences
University of the South Pacific

for

Land & Water Resources Management Division
Ministry of Primary Industries, Suva, FIJI.

January 2010

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1 Executive Summary

The subject of this report is the Environmental Impact Assessment (EIA) study of the potential impacts of the proposed dredging of the Rewa River, in the province of Rewa, Viti Levu. The dredging project is being proposed by the Land & Water Resource Management (L&WRM) Division of the Ministry of Primary Industry, who contracted the Institute of Applied Sciences (IAS) of the University of the South Pacific (USP) to carry out the EIA study. The study was conducted over a six-month period from June to December 2009.

The project

The L&WRM Division is proposing to dredge part of the lower Rewa River, from Nadali near the L&WRM depot to the river mouth, a total of about 20 km. The dredge channel would extend for about 1.5 km out from the river mouth into the foreshore area, to a corresponding depth of 6m below mean sea level. The dredge channel consists of six sections from around the Vunivadra channel, up to a point in line with the shorter runway of the Nausori Airport, from which the total volume of 328,250 m^3 of sediment is to be dredged. Another two sections, measuring 1820m and 800m towards the mouth of the Rewa are being proposed for the dredging of 506,000 m^3 and 282,000 m^3 respectively. The total volume of river bed material proposed to be dredged amounts to about 1,116,250 m^3.

The dredged material or spoil will be deposited in a number of sites, proposed by L&WRM (see Figure 2).

Rationale for the project

Flooding of the Rewa river and delta has caused and continues to cause massive losses, not only to the local people, but to the nation in terms of economic costs of rehabilitation, financial assistance to affected communities etc. With the expansion of the Nausori Town and development of their Master Plan, the flooding of the Rewa river is a major stumbling block to progress. Dredging of the Rewa River is one of the non-structural and

less expensive flood mitigative measures, identified by various studies, including the JICA study (1998). The costs to the nation of flood damages far outweigh the costs of dredging the rivers. However, for the long-term management of floods, a holistic approach has to be planned and implemented.

Main findings from the EIA study

The Land & Water Resources Management (L&WRM) Division of the Ministry of Primary Industry commissioned the Institute of Applied Sciences (IAS) of the University of the South Pacific (USP) to carry out the Environmental Impact Assessment (EIA) of the proposed dredging of the Rewa River. As far as water quality is concerned, most of the water quality parameters satisfied the ANZECC 2000 guidelines. The only significant issue of concern is the widespread and high levels of sewage pollution, indicated by the high coliform counts. The Nausori Sewage Treatment Plant (NSTP) is an important source, as well as the villages. It is to be noted that livestock also contribute to the high coliform levels. Apart from sewage pollution, there also appeared to be some effect of the NSTP, or the airport on the water quality in the area near the L&WRM depot, as some samples had elevated readings of conductivity and Total Dissolved Solids from that area. This can be investigated further, if necessary.

For the two lots of sediment samples tested, the pH values were similar for all ten sites, with ranges of 5.8 – 8.2 for the 14 October samples, and from 6.2 – 9.0 for the 29 October samples. These values are within international guidelines[1]. The nutrient content (Total nitrogen and Total phosphorus) of the sediment samples were relatively low. Total nitrogen levels ranged from < 0.1 – 0.23 mg/kg for all sites for both sampling dates. However, for Total phosphorus concentrations, the levels were enhanced on the 14th October, the day following some rain at the project site. Interestingly, the concentrations of lead were very different for the two dates, with the 'wet' weather samples recording much higher concentrations (2.63 – 6.99 mg/kg Pb) compared to the 'drier' weather results where all samples had <0.1 mg/kg Pb. These results appeared to indicate that increased rainfall and associated wash-out effects may be causing increased

[1] CSIRO Guidelines 2005

concentrations of nutrients and lead. Such situations have been found for other rivers and creeks in Fiji[2] .

From the biological and ecological studies, it was found that the project site did not contain any species of special conservation significance. Therefore the impacts of the dredging on the ecological environment should be minimal. The concern about the effects on the *kai* beds may require monitoring. However, this concern can be mitigated with the dredge channel being centered in the middle of the river, as the *kai* (*Batissa violacea*) beds fished by the women are in shallower waters along the river banks. This concern is addressed in the Environmental Management and Monitoring Plan (EMMP). The study found two important roosting sites for migratory birds, in particular the Bar-tailed Godwit, on the eastern shores of Laucala Island. To minimize disturbance to these birds, it is recommended that the dredging operation and disposal of dredge spoil be completed as quickly as possible before the Bar-tailed Godwit returns to roost, from the period end of September – early October.

An interesting and positive finding from the terrestrial surveys of the previous spoil deposit sites was the establishment of new and more diverse habitats where previously, only mangroves existed. The spoil provided suitable substrate for other coastal trees, useful to the communities. In some cases, the uplifted land provided suitable land for agriculture, where previously, no farming was possible. The deposition of spoil on river banks must be above the High Water Mark. Deposition in the mangroves must stay clear of the seaward zone of *Rhizophora* and associated tidal creeks. It is recommended that the spoil be deposited behind the *Rhizophora* zone, at the HWM.

From the socio-cultural surveys, there is overwhelming support (> 95 %) for the dredging project. The majority of the respondents also indicated that the dredging will have minimal impact on their daily lives. The survey for archeologically sensitive sites revealed that the proposed spoil deposit sites had no historical significance. However, if in future there is a need to deposit spoil on the north-east banks of the Rewa River

[2] Tamata 2007

estuary, further archeological investigation is needed, as the area has some significant historical sites.

Conclusions and recommendations from the EIA study

Generally speaking, the EIA study found no major threat to the environment or the ecological communities from the proposed dredging. The studies did not identify any species that were of conservation significance in the terrestrial and aquatic environments. The effects of the dredging on the water quality would be temporary and localized. However, there are some issues that have been raised from the specific studies : concern for the loss of *kai* beds, and the risk of scouring affecting the depth of these beds (increased depth hindering the women from gathering *kai*). To address this concern, it is recommended that the dredge channel be maintained in the central part of the river, and that the *kai* beds be avoided altogether.

The roosting sites for migratory birds on Laucala Island also requires that the deposition of spoil on the island be controlled, and that the whole operation be implemented and completed within a short time, to ensure minimum disruption to the birds. These are addressed in the EMMP.

The findings from the local community surveys indicated overwhelming support for the dredging. However, for the safety of river users, adequate warning, signage and reminders need to be in place prior to commencement of the works.

One positive effect of the previous dredging and deposition of spoil was the enhancement of the quality of substrate, and the increased diversity of plant species that were found growing in what was previously only mangrove habitats. The deposit sites were also available for farming, another positive effect of the dredging operation.

2 Introduction and Background

This document presents the Final Draft Environmental Impact Assessment (EIA) Report, prepared by the Institute of Applied Sciences (IAS), University of the South Pacific (USP), being the EIA consultants, for the Land & Water Resources Management (L&WRM) Division (employer) of the Ministry of Primary Industry. This Final Draft Report is a requirement under section 6 vi) of the EIA Terms of Reference[3], and section 29 of Contract Number CSC 12/07, between the L&WRM of the Ministry of Primary Industry and the IAS of the USP, the EIA consultants. The contract was officially signed on 30 June 2009, at the L&WRM headquarters, Raiwaqa in Suva. The EIA report details the outcome of the EIA study conducted by the IAS team over a six month period from June to December 2009. The study involved assessing the environmental and social impacts of the proposed dredging of the Rewa River by L&WRM. The dredging of the Rewa River is being implemented as a flood-control measure.[4]

2.1 Background

Historically, flooding in the lower Rewa River delta has been a common occurrence, often in association with tropical cyclones that affect the Fiji group from November to April. Flooding had caused a lot of damage to villages, crops, livestock and sometimes have caused fatalities. The worst flood damage so far occurred in 1993 during tropical cyclone Kina, when 23 lives were lost, and costs of damage reached F$188 million.[5] Local communities and villages have built up a characteristic resilience to flooding and its effects.[6] However, with increasing population, infrastructural development and economic value of property and agricultural crops in the flood-prone area, the costs of flooding to the people and the nation as a whole continues to increase.

[3] EIA Terms of Reference, Appendix A

[4] Director L&WRM 2009
[5] World Bank Study, cited in Raj 2004
[6] Pers.communication, Roko Tui Rewa/Bale Tamata, Nov. 2009

2.1.1 Causes of flooding

The causes of flooding have been attributed to a combination of factors; natural and anthropogenic-derived. The Rewa River is the largest river in Fiji, with the Rewa water shed area of 3,092 km^2,[7] taking up about one third of the total land area of Viti Levu (10,389 km^2). The Rewa watershed receives high rainfall in the range of 2,500 to > 4000 mm annually. From annual rainfall and annual discharge figures, analysis of the run-off coefficient is also highest for the Rewa catchment (0.6 – 0.9) compared to the Nadi and Ba catchments (0.4 – 0.6).[8] The high runoff coefficient may be indicating the increasing extent of land clearance in the upper reaches of the Rewa River. The problem is compounded by the nature of the terrain in the Rewa watershed and drainage basin, being dominated by steep slopes. A study by Morrison *et al*., 1991 showed that as much as 70 % of the Rewa drainage basin have slopes > 18 ^{o}, and these flatten out into the Rewa delta for about 20 km from Nausori town to the river mouth.[9] Studies have also shown that in the upper Rewa, the stream velocities can be very high. The effects of high and intense rainfall, combined with steep slopes and strong currents contribute to high rates of soil erosion and increased sediment-carrying capacity of the river.[10] Studies of soil characteristics in the Rewa drainage basin have also indicated a high erositivity index of 1500 to 2000[11], another factor contributing to high erosion rates for soils in the upper Rewa basin. The JICA study compared soil loss in the four river catchments, and the Rewa with the biggest watershed area also recorded the highest total soil loss (million ton/year) :

[7] JICA Summary Report 1998
[8] JICA Summary Report 1998
[9] Deo 2000
[10] Deo 2000
[11] Willat and Limalevu 1994

Table 1: Soil Loss in the Four Watersheds

Watershed	Soil Loss (ton/ha/year)	Soil Loss (mm/year)	Total Soil Loss (million ton/year)
Rewa	32.3	2.2	9.3
Ba	69.0	4.6	6.4
Sigatoka	76.9	5.1	1.1
Nadi	81.4	5.4	4.2

(from JICA, 1998).

2.1.2 Geological evolution of the Rewa delta

The Rewa delta is in a very dynamic area, and is exposed to a high wave energy environment. According to Armstrong (1993), the Rewa delta is a 'rapidly prograding delta system' comprised of a variety of morphostratigraphic units which can be grouped into four main groups: river-dominated units, wave dominated units, anthropogenic units and reef units. The delta progradation (spreading out into the sea) is controlled by fault systems to the east, west and south. [12] The changing shape, size and orientation of Nukulau Island reflects the dynamic processes at play in the Rewa river delta and estuary. Also contributing to the dynamism of the process is the interplay among the Rewa river discharge (fresh water outflow), the high energy wave action and the strong South East Trade winds pushing saline water upstream (forming an under-layer beneath the surface freshwater layer), and underpinned by anthropogenic factors (man and development). Apparently corals once existed at the mouth of the Rewa, but a combination of historical factors and sedimentation in the river killed off the corals except for those species tolerant to sediment, such as *Porites* sp.[13] According to Armstrong (1993), a Pleistocene reef which extends from Nasilai passage to central Laucala Bay, and forming the northern limits of Vunidawa channel accreted during the late Pleistocene, and the resultant geomorphology is considered to be one of the main causes of flooding in the lower Rewa River.

[12] Armstrong 1993
[13] Squires 1962

2.1.3 Natural flood channels

According to historical information, the Rewa delta downstream from Kasavu is composed of at least five principal lobes[14] each with their own system of flood channels. Apparently, these channels served to dissipate flood waters in the Rewa River, in recent geological times.[15] These channels were very deep and active during the mid 18th and 19th centuries.[16] One of these channels known as *Wai ni ki* (*Ki* being the Fijian name for a salt water fish) was explored by the H.M.S Herald in 1857[17] which goes to show how deep these channels would have been. By disregarding the existence and roles of such natural flood channels as man develops and inhabits the area, the cost of floods to man and his property is a lesson which maybe should be re-visited, as flood control measures are being investigated and implemented.[18]

2.1.4 Addressing flood mitigation

Any flood mitigative measure will need to take the historical evolution or changes in the Rewa delta morphology into account, as well as the more recent changes in land use and infrastructural development in the upper reaches of the Rewa river.[19] In fact extensive modeling is proposed as a need, in order to understand the interactive processes affecting delta evolution and therefore implement appropriate flood control measures. However, with high costs involved in such an exercise, the dredging of the river and depositing of spoil in village sites to raise them above flood level may be an easier mitigative measure for now.[20]

Although floods are a natural phenomenon, recently in Fiji they have become more severe with more drastic effects. As floods become frequent with climate change effects, the drainage efficiency of flood waters continue to decrease. It has been observed that recently, flood waters and sea water along the shorelines stand for longer times, so flood

[14] Appendix B figure
[15] Howorth et al., 1993
[16] Macdonald 1857; Thiele,1891
[17] Armstrong 1993
[18] Howorth et al., 1993
[19] Pers.communication Robert Smith/Bale Tamata, Nov. 2009
[20] Armstrong 1993

levels are higher than usual. One of the effects of such situation is increased erosion of river banks and coastal areas.

As far as man is concerned, one of the causes of flooding relates to unsustainable land use practices in river catchment areas. Problems caused by flooding are exacerbated by increased downstream development; economic value of property and infrastructure in the path of flood waters; roads and bridges are barriers to path of floodwaters; increased population downstream; poor drainage systems.[21]

2.1.5 The national dredging project

The national dredging project was first introduced as part of 'Cyclone Wally rehabilitation works' in 1981, for the protection of agricultural lands. The first rivers to be dredged were the Rewa and Navua Rivers, and this has now extended to include others such as the Nadi River, currently being dredged, as of November 2009.

The L&WRM has had remarkable achievement as far as volumes of spoil dredged, and the uses of spoil to improve the livelihood of the rural people. The table below summarizes some of these achievements, and it can be seen from the table that the Rewa River dredging has been the largest, and has also achieved some positive impacts such as bank protection (Nailililli), and land reclamation (Lokia).

[21] Director L&WRM Presentatuion to government, 2009

Table 2: Achievements by L&WRM in the national dredging program

River	Rewa River	Navua River	Ba River	Qawa River	Labasa River	Wailevu River
Length	34km	14.9km	12.5km	2.5km	3.55km	1.5km
Volume m^3	10million	2.6million	3.24million	0..97million	1.3million	0.43million
Bank Protection	9.34km	1.4km	5.65km	0.55km	0.3km	
Land Reclamation	34ha	0.4ha	45.8ha			

(Source: Director L&WRM, 2009).

Figure 1: Rewa River Bank Protection

(Source: Director L&WRM, 2009).

2.2 Rationale and objectives of the project

For the national dredging project, the objectives are:

- To reduce risk and vulnerability to flooding;
- To increase discharge capacity of major rivers and reduce flooding duration;
- To improve the quality of life for rural communities.

The purpose of the Rewa River dredging project is to maintain a clear passage through the river channel/estuary to the sea in order to mitigate the risk of flooding in surrounding areas. The project is part of L&WRM's ongoing flood mitigation programs under which various other major rivers namely Navua, Ba, Qawa, Labasa and Wailevu have been dredged in the past years.[22]

3 Description of the proposed project

3.1 Background

The Rewa River Maintenance Dredging Project is being initiated by the Land and Water Resources Management Division of the Ministry of Primary Industry. The dredging operation will extend to the Rewa River mouth and foreshore area. The actual execution of the dredging works may be undertaken by L&WRM, or outsourced.[23] According to L&WRM, the overall design dredge channel would be about 20 km long from the river mouth/foreshore, to Nadali area. The dredge channel would extend for about 1.5 km out from the river mouth into the foreshore area, to a corresponding depth of 6m below mean sea level.[24]

[22] Director L&WRM Presentation to government 2009.
[23] L&WRM EIA Terms of Reference (TOR), Nov. 2008
[24] Figure 2 – Design Dredge Channel and spoil deposit sited proposed by L&WRM

The engineering drawings showing details of river cross sections are appended. These drawings were prepared by L&WRM engineering sections. Altogether four drawings were prepared, but for this EIA report, only two of the drawings are appended.[25] The two drawings include :

- Layout Plan of Design Dredge Channel – C/DR/RW 0426
- Rewa River Main Cross Section - C/DR/RW 0427

3.2 Physical environment

The Rewa river runs from the central high lands to the south-east of Viti Levu. At the lower reaches, the river meanders and splits into a number of tributaries. The area lies between latitudes 17^{o} 25' – 18^{o} 05' south, and between longitudes 177^{o} 57' – 178^{o} 40' east. The Rewa River is fed by four rivers : the Waimanu, Wainimala, Wainibuka and Waidina. The Rewa watershed is the largest of watersheds in Fiji, occupying about one third of the total land area of Viti Levu, the largest of the islands in Fiji. The river passes by Nausori town, a bustling and rapidly developing urban center serving the people of Rewa and Tailevu provinces. From the Bureau of Statistics 1996 Census figures, the urban population of Nausori Town is 5744, and an additional 15,873 people live in the peri-urban area.[26]

[25] Appendices C1 and C2
[26] Raj 2004

<u>Figure 2</u>: Layout of dredge channel and proposed Spoil Deposit sites (by L&WRM)

The town has major plans for infrastructural development, but flooding of the Rewa River is a matter of concern for the Nausori Town Council.[27] Villages of both the Rewa and Tailevu provinces are part of the stakeholder groups, and these were surveyed and consulted during the socio-cultural study (see section 5.6).

In an earlier seismic investigation of the Rewa river, for the siting of the new Rewa bridge, it was found that the bedrock equivalent occurred at 17 m below chart datum on the Suva bank of the river edge and dipping eastwards to a depth greater than 80 m on the Nausori side of the river. In general, water depth was about 4.7 m.[28] The currents were stronger on the Suva bank of the river, with no clear river channel. Seismic tests revealed the presence of deep depressions north and south of the old bridge on the Suva side, and the bedrock being comprised of erosion-resistant material, causing rapid flow and strong currents. This feature of the bedrock is assumed to be responsible for localized eddies in this part of the river, which in turn prevents the silting up of this part of the river.[29]

3.2.1 Boundaries of the project

The physical boundaries of the project as determined by L&WRM in the original contract is shown in Figure 2. The EIA team worked from this map to select study sites for the various study components (biological, water and sediment quality and socio-cultural studies). Each study component has its own map, derived from the original map provided by L&WRM.

For ease of discussion, the proposed dredge spoil deposit sites have been numbered. The botanical and vegetation surveys were concentrated on the numbered sites in the map shown in Figure 3. The discussion in section 5.4.1 is referring to Figure 3, showing numbered deposit sites.

[27] Pers.coomunication Nausori Town Council CEO/Bale Tamata, Nov. 2009
[28] Smith 1997.
[29] Smith 1997

Figure 3 : Proposed and recommended dredge spoil deposit sites – numbered 1 - 12

3.3 Quality and volume of spoil to be dredged

According to documents obtained from L&WRM, the total volume of sediment to be dredged from six sections along the Rewa River, stretching from the area around the Vunivadra channel, up to point in line with the shorter runway of the Nausori Airport, is 328,250 m^3. In addition to this, an additional two sections, each measuring 1820m and 800m towards the mouth of the Rewa are being proposed for the dredging of 506,000 m^3 and 282,000 m^3 respectively. The river mouth has filled up quite significantly over time, such that at low tide, it is too shallow for boats to navigate up the river, and instead the Vunivadra channel has been the preferred route of navigation. The map showing the river sections and proposed volumes to be dredged is shown Figure 4.

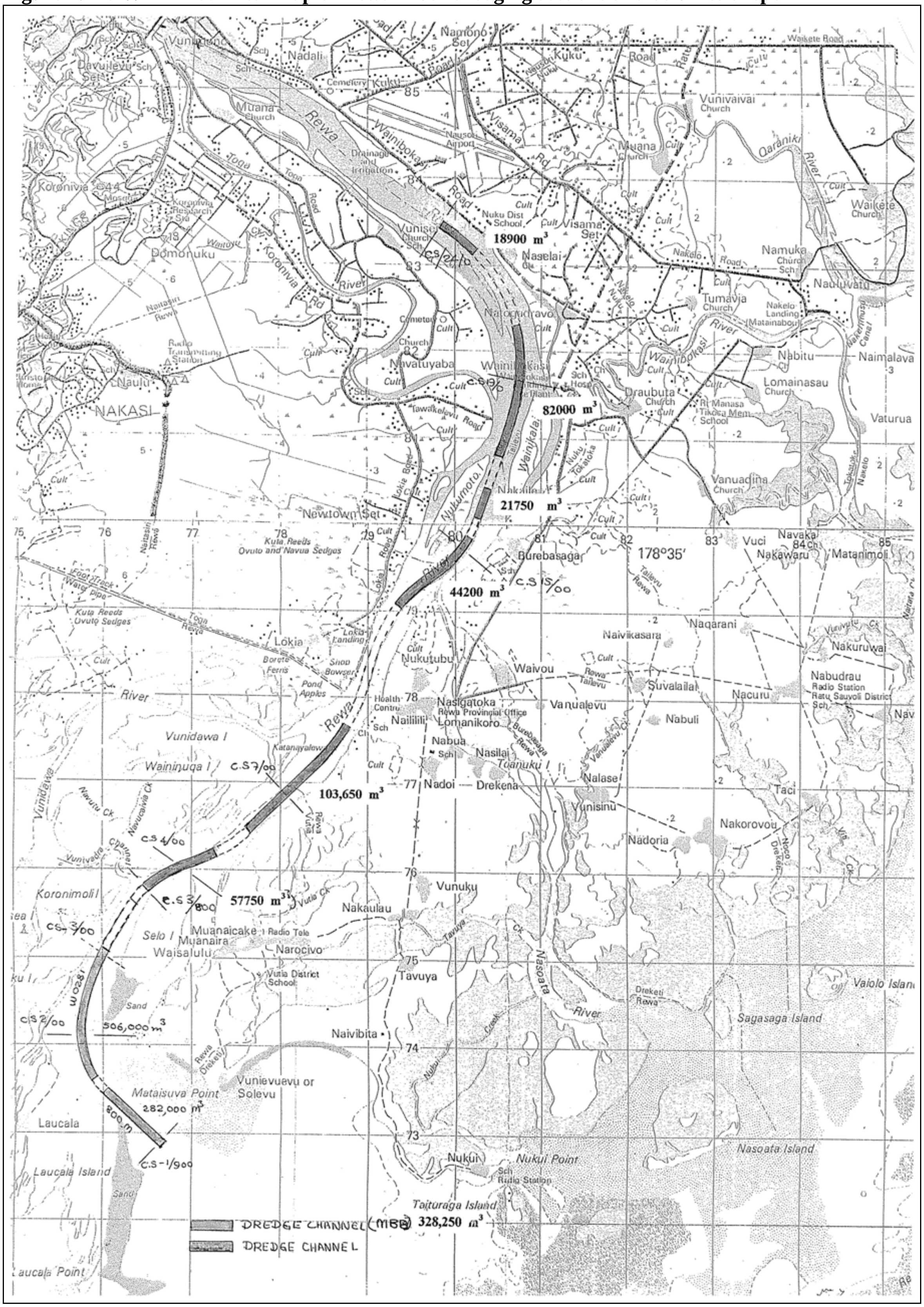
The Rewa River had been dredged previously on a number of occasions and the dredge spoil had been deposited at certain locations along the river bank. The first dredging was carried out by the Colonial Sugar Refining Company (CSR) in the 1930s and 1960s for the purpose of facilitating navigation of barge movement to and from the sugar mills in Nausori. In 1982, the Fiji Government with funding assistance from FAO and UNDP carried out the dredging of the Rewa River downstream from the old Nausori bridge.[30] There was no EIA study for these earlier projects because the environmental legislation had not been developed at the time. From historical records and observations, the deposited spoil mixes well and quickly with the receiving material[31] and actually adds to the quality and value and usefulness of the deposit site, for example on Selo Island, a coastal forest comprised of typical coastal trees (with their diverse uses) has developed in the middle of the island, and among the mangroves[32]

3.4 Type of dredging equipment, transportation, disposal...

Generally speaking, L&WRM is very limited as far as equipment is concerned. Dredging equipment is very expensive. The current price of a dredger is between $6m and $8m.

[30] Prasad 1997
[31] Armstrong 1993
[32] Pers.communication Tuiwawa/Bale Tamata, Dec. 2009

Figure 4: L&WRM Technical map of Rewa River dredging sections and volumes of spoil



The Fiji Government owns two dredgers : the *Mana Bati Bati* (MBB), and the *Dau Qeu Qeu* (DQQ), both of which were bought in the 1980s at a cost of $1.35m and $3.5m respectively.[33] These dredgers had an economic life of 20 years when purchased; in other words, they have now (2009) both outlived their economic usefulness. Break-downs are common, and the DQQ is due for maintenance and repairs. To add to the problem, spare parts are expensive and take a long time to obtain (often up to six months). There is only one dredge currently operational, which operates by suction method.[34] The length of the tubing is also not very long (50m).[35] This limits the range for disposal of dredge spoil. From economic perspectives, L&WRM is more likely to outsource the dredging operation, rather then attempt to conduct the dredging themselves.[36]

3.5 Project schedule, time lines

According to the senior engineer, the dredging of the Rewa River is currently scheduled for the beginning of the second quarter of 2010, i.e. from April to October 2010, as soon as the EIA report is approved by the Department of Environment.[37] The dredging will start from near the L&WRM depot in Nausori, and progress downstream along the designated dredge channel.

3.6 Justification of the project

The justification of the project is considered from economic, ecological or environmental and social perspectives.

3.6.1 Economic justification

The costs of floods to the national economy has been massive, especially for the Rewa river environment. The figure below (Figure 5) shows the costs to the nation of the various floods that affected Fiji during the period 1965 – 2003. The costs to individual

[33] Director L&WRM 2009.
[34] Pers. communication Epi Cavanavanua/Bale Tamata, Oct. 2009
[35] Pers.communication Deo/Comley, October 2009
[36] Interview Cavanavaanua/BVale Tamata, Oct. 2009
[37] Interview Aung Yi/Bale Tamata, Dec.2009

families who suffer damages to their property and livestock is often unaccounted for, but have been significant.

More recently, the costs of the floods that affected Nadi in early 2009 has been phenomenal, especially with the businesses in Nadi town being affected. The effects of cyclone Mick is still to be finalized, but preliminary estimates show the cost of damage from cyclone Mick to be more than $38 m.[38]

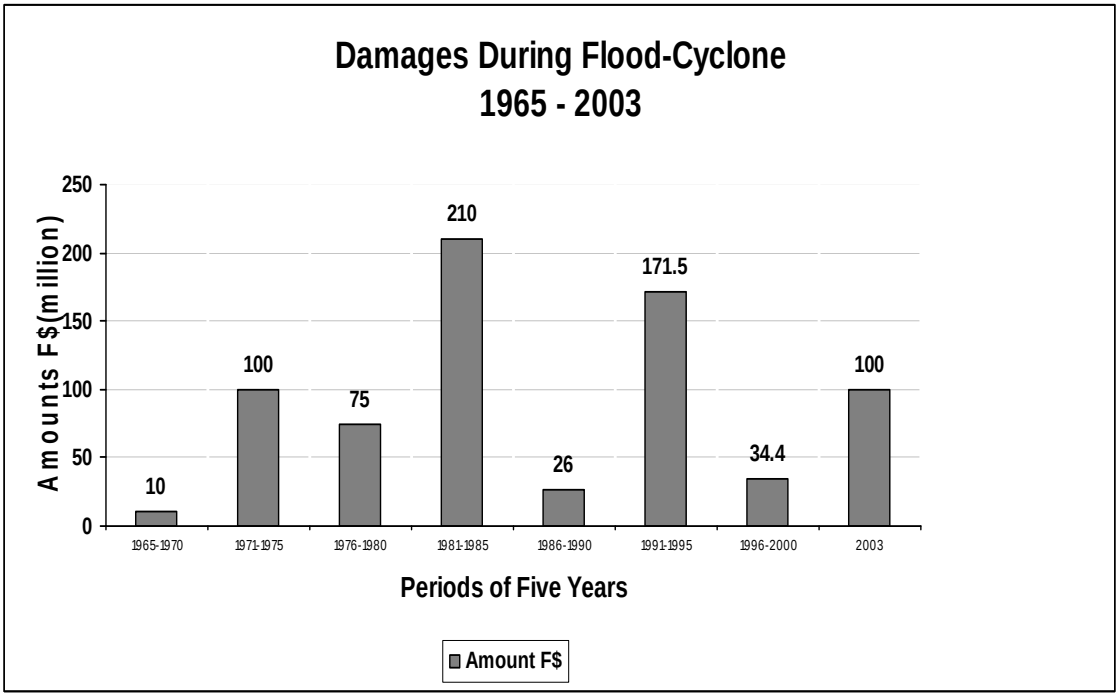


Figure 5: Costs for damages caused by floods (Director L&WRM, 2009).

From Figure 5, the peaks are explained as follows: effects of Cyclone Bebe in October of 1972 (costing $100 m for the periods 1971 – 1975); cyclone Meli in March 1979 (costing $75 m for the period 1976 – 1980); and at least seven cyclones (including Eric, Oscar, Gavin. Nigel, Sarah and Arthur) affecting Fiji from 1981 – 1985, costing the highest so far of $210 m. Cyclone Kina in January 1993 (hailed as the worst so far for Fiji) along

[38] DISMAC 2009

with Cyclone Joni of December 1992 caused damages amounting to $171.5 m, the second highest so far. From these figures, there is direct correlation between the number and intensity of cyclones (and associated floods), and the cost of damages.

The economic costs of dredging of the rivers as proposed by L&WRM fall short of the costs of damage from floods, based on the above and the information provided by L&WRM (see Table 3a below). The dredging program has also been hindered by the funding trend, i.e. the amount requested by L&WRM as opposed to the actual amount provided by the government (see Table 3b).

Table 3a : Costs of proposed dredging for Viti Levu rivers.

Future Dredging Program for Viti Levu

Location	Volume m^3	Cost (m$)
Nadi	**650,000**	**5.2**
Rewa	**1,800,000**	**14.4**
Sigatoka	**800,000**	**6.4**
Penang	**300,000**	**2.4**
Nasivi	**400,000**	**3.2**
Navua	**600,000**	**4.8**
Ba River Mouth	**1,300,000**	**10.4**
Sabeto	**350,000**	**2.8**
Deuba	**300,000**	**2.4**
Korovou	**300,000**	**2.4**
Wainibokasi	**600,000**	**4.8**
TOTAL	**7,400,000m^3**	**$59,200,000**

Table 3b : Funding Trend for Dredging Program by L&WRM

Year	Funds Requested ($)	Funds Received ($)
2005	7,000,000	2,200,000
2006	10,000,000	3,000,000
2007	12,000,000	4,300,000
2008	9,000,000	5,000,000

Tables 3a and 3b are from the Director L&WRM Presentation to Government, 2009.

To accurately assess the economic effects of any flood control/mitigative measures (dikes, diversion channels, dredging), one needs information on the amount and costs of flood damages *with* the flood control measures in place, and this is compared with the amount and costs of flood damages *without* the flood control measures in place.[39] This sort of calculation is easier for structural flood control measures such as dikes and diversion channels, but is more complex in the case of dredging, where the continual in-filling of dredged river bed by sediment means that the dredging operation is only a temporary flood mitigative measure, and that to be effective, it needs to be on-going. Earlier observations following the dredging of the Rewa River in the 1980s were that the severity of flooding was reduced as a result of dredging (Prasad, 1997). The question to be addressed then is, how often should the Rewa River be dredged in order to be effective as a flood control measure. For the 4 major rivers in Fiji, the L&WRM, has a 1 in 10 yr dredging design program. The decision to dredge a river also depends on the Divisional Development priorities.[40]

As a temporary flood control measure dredging is necessary, but in association with other flood control measures, such as those proposed by the JICA Study team:

Non structural measures for flood control – at the watershed

- Forest rehabilitation; reforestation of large areas of watershed to reduce peak flood discharge;

[39] JICA Summary Report 1998
[40] Director L&WRM presentation to government 2009

- Land – use to be monitored and regulated : construction of reserving lakes and ponds to retain water at the watersheds;
- Suppressing of soil inflow into river channels by maintaining cross sections of river channels (through dredging), to maintain flow capacity of the river channels.

The JICA study had recommended structural flood control measures (dikes and diversion channels), but the costs involved favoured a step-wise implementation program starting with the dike. The study found non-structural measures (including dredging) as more economical. In fact, the study recommended an integrated approach involving dredging plus other measures, as the most economically viable option. Other studies had also recommended dredging as a viable flood mitigative measure, because of the benefits that can be gained from usage of the dredge spoil.[41]

3.6.2 Physical and ecological justification

The JICA study found that '*no particular impacts from sedimentation of the river'* can be expected. The study also concluded that any effects on the water quality is temporary but intrusion of saline water on the aquatic animals must be monitored.[42]

The Rewa watershed is the largest in Fiji, and rainfall is also some of the highest (2,500 to > 4,000 mm/yr.). Therefore the risks of flooding in the Rewa is very high compared to the other watersheds. With impending climate change effects, floods may be more frequent and more devastating.

According to the JICA study, an evaluation of the various flood control measures came up with this summary[43] :

[41] Armstrong 1993.
[42] JICA Summary Report 1998
[43] Part of Table 5.5 in JICA Summary Report 1998

Table 4: Evaluation of river bed dredging in the Rewa River by JICA study team

Merit	The flow capacity of the river can be increased without any influence on the inland side
Shortcoming	The large volume of dredging is required to suppress the flood at the required level. Effectiveness can only be expected as dredging is carried out **over a long length of the river**. Periodic dredging is necessary since sedimentation may happen continuously.
Evaluation	POSSIBLE since its effect on flood control is small, it is only effective to maintain the cross section of the river.

The study goes on to recommend a number of measures to be taken by other agencies:

- Monitoring of land clearance and logging in catchment areas (Forestry Dept.);
- Monitoring of unsustainable agricultural practices (Agriculture Dept.);
- Enforcement of policies on proper building (away from flood prone areas) – Department of Town & Country Planning, Local Authorities like the Nausori Town Council etc.

For the long-term solution to the flooding problems in the Rewa River, team collaboration among the government agencies (listed above) and non-government stakeholders is necessary.

4 The EIA Process

The Environmental Management Act 2005 stipulates that development projects be subject to the EIA process, if the development has potential to affect the environment in an adverse way. The EMA defines 'environment' as " *the interacting natural or human system that include air, land, water, all layers of the atmosphere; all organic or inorganic matter or living organism "*. According to Environmental Management Act (2005)[44], the proposed dredging operation falls into Part 1 category, i.e., those development proposals that are to be approved by the EIA Administrator. In fact subsection (r) of Schedule 2 states: "a proposal that involves dredging or excavating a river bed" requires approval by the EIA Administrator (Director Department of

[44] EMA 2005, Schedule 2 and section 27

Environment). For the dredging of the Rewa River, the LAWRM being the project proponent has contracted the Institute of Applied Sciences (IAS) of the University of the South Pacific (USP) to carry out the EIA study.

4.1 The EIA Team and expertise

The EIA team from the IAS includes specialist experts in the various components of the EIA study. These include:

- Project Manager and Team Leader – Professor Aalbersberg (Director, Institute of Applied Science, University of the South Pacific (USP-IAS))
- Project Assistant Manager and Water Quality consultant – Dr. Bale Tamata (Manager, Environment Unit (USP-IAS)
- Terrestrial Flora & Fauna Coordinator – Marika Tuiwawa (Curator, South Pacific Regional Herbarium (USP-IAS))
- Marine Study Coordinator – Ron Vave (Senior Scientific Officer, USP-IAS)
- Socio-cultural Study Coordinator – Sakiusa Fong (Senior Scientific Officer, USP-IAS)
- Cultural heritage and historical sites study – Elia Nakoro of the Fiji Museum
- Spatial Information Coordinator – James Comley (Consultant, USP-IAS)

Figure 6 shows the organizational structure of the IAS EIA team.

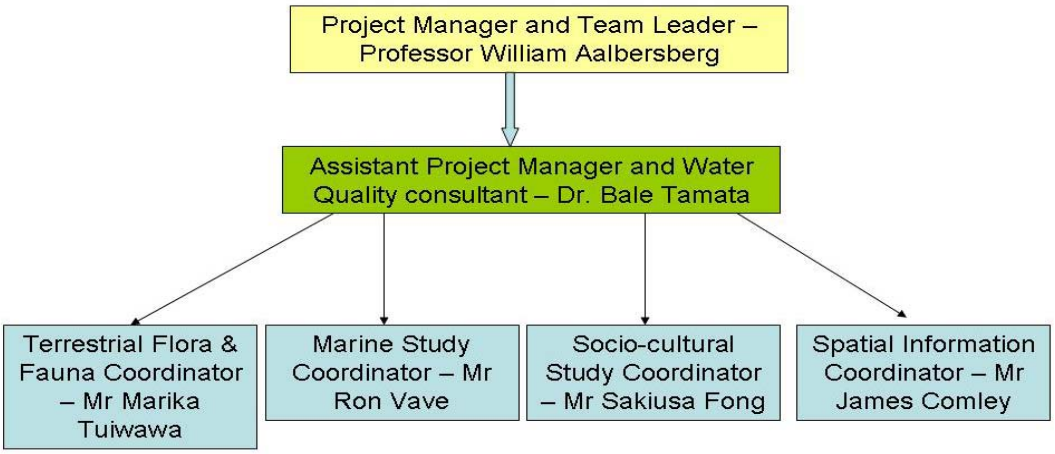


Figure 6: Organizational structure for the Rewa Dredging Project EIA Team, IAS, USP.

5 Description of the existing environment

5.1 The physical environment

5.1.1 Soil types

The Rewa River delta is dominated by mangroves and floodplain deposit/crevasse splay fan, according to a morpho-stratigraphic assessment.[45] The dominant direction of material transport is sea-ward, down the river towards to coastline. However, tidal influence is strong, especially during periods of dry weather when the salinity wedge moves upstream. Appendix D shows the distribution of morphological units, according to an earlier investigation by Armstrong, (1993).

With use of GIS and Google earth satellite imagery, a land-use map was generated by IAS (section 5.1.2).

5.1.2 Land cover mapping- methods

An Ikonos-2 high resolution panchromatic-sharpened (0.8m pixel size in 4-bands (red, green, blue and infra-red)) image acquired over the study area on 15th April 2009 was purchased for use in the mapping work.

This image was masked to provide an area for analysis extending 1km in all directions from the centerline of the proposed dredge channel as provided in schematic drawings provided as part of the project brief.

The subset image was processed using an image segmentation algorithm in which initially each and every picture element (pixel) in the image is considered to be a segment; then by iteratively grouping these segments, it produces a vector (outline) file of features discernable in the image. There were in total some 4,500 individual segments produced in this process; each differing from its neighbor in terms of colour and texture.

[45] Armstrong 1993

A land cover classification was then developed including the following categories by examining the image;

Land cover class	Description
River or open water	Main Rewa River channel, a tributary, the open sea around the river mouth or an area of land-locked water
Grassland or scrub	Areas that have previously had vegetation removed from them; previously used either for agriculture or in many instances used as previous dredge spoil sites. Typically these areas are covered in grass, weed species of shrubs or coconut palms
Mangrove or mangrove associate forest	Includes both true mangrove vegetation influenced directly by rising and falling tides and areas of vegetation immediately bordering the landward margin of mangroves
Settlement or infrastructure	Buildings, roads, compounds or areas of grass within village boundaries distinct from grassland areas by being cut regularly and not overgrown
Land covered in terrestrial coastal forest	Areas that are covered in either primary or, more likely, disturbed secondary forest. These areas are differentiated from scrubland covered in vegetation as they have a more complex vegetation community
Actively under agricultural use	Areas visible in the imagery as being under active agricultural use. Typically these are packets of land with liner boundaries; often with bare soil and rows of crops visible
Unclassified	Areas covered in cloud or shadow from cloud in which it was not possible to run the image analysis
Bare land/Beach	Typically land along river banks that are accreting; where sand and silt has been deposited yet has not yet been colonized by vegetation

Using visual interpretation on each of the segments, segments were labeled with one of these functional land cover classes. Finally, a process of merging adjacent segments together that shared the same land cover class produced a continuous layer containing 358 discreet areas of land cover classes.

Using GIS it was then possible to calculate the areas and perimeters of each of these segments and present overall statistics of the spatial coverage of land cover classes within the study area.

5.1.2.1 Land cover mapping – results

The total area of the 1km buffer area of interest is 31.3km^2. Of this area, 9.79 km^2 was classified as river or open water; the class dominated by the main channel of the Rewa River. Land cover classes over the remaining 21.4 km^2 are shown on the map (figure 8) and by proportion of the total area on figure 7.

The dominant land cover class within the study area is grassland or scrub which is especially dominant upstream of Katanayalewa Island on both banks and also on Laucala Island. This land cover class is most likely a progression between land covered in coastal forest which has been cleared; though is not at the time of the image processing actively under agricultural use.

The second most dominant land cover class is mangrove or mangrove associated forest. This cover class is, by its nature, restricted to the lower reaches of the river downstream of Katanayalewa Island.

By contrast, the majority of the third most dominant land cover class settlements or infrastructure is confined almost solely to areas upstream of Katanayalewa Island. Indeed, the further towards Nausori township, the greater the density of this cover class.

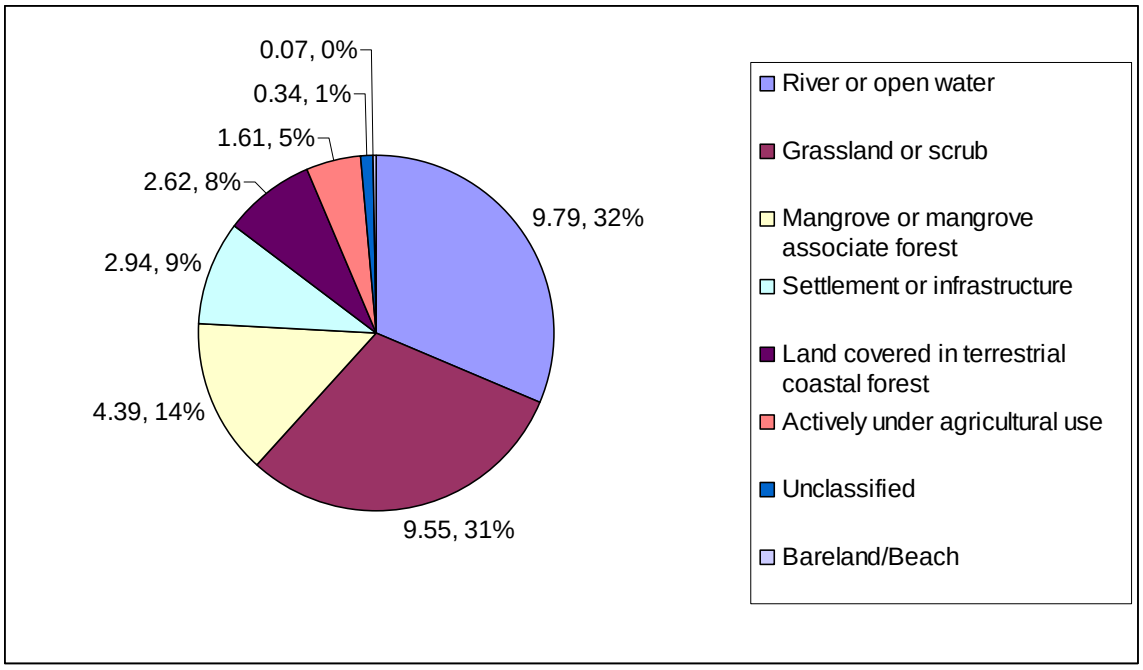


Figure 7: Land cover (km^2 and %) by class within the study area. Figures derived from image segmentation and classification based on an Ikonos-2 image acquired over the study area on the 15th April 2009.

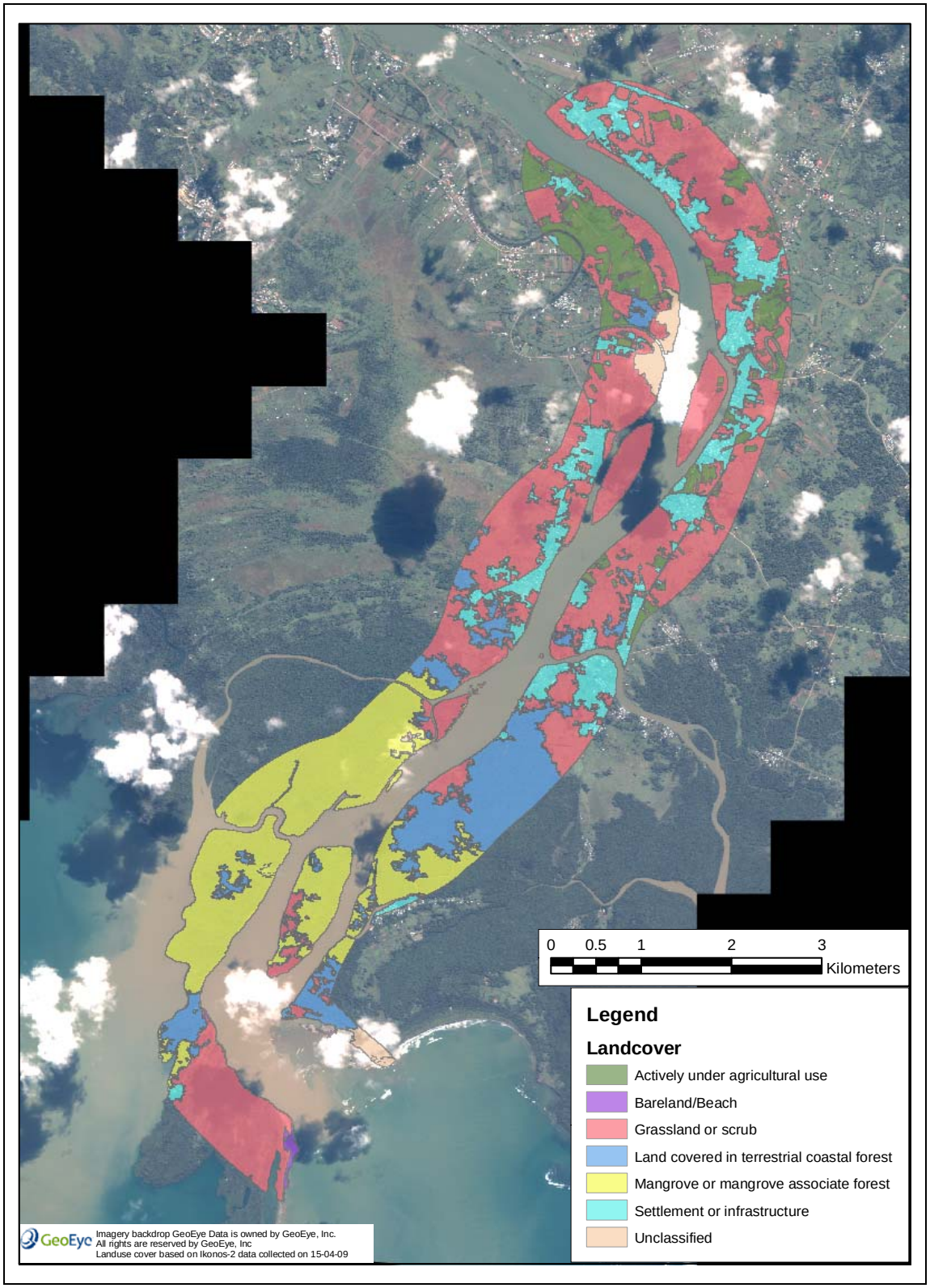


Figure 8: Spatial distribution of land cover classes within the study area. Layer derived from image segmentation and classification based on an Ikonos-2 image acquired over the study area on the 15th April, 2009

5.2 The mangroves and coral reefs within the project site

Earlier studies showed the richness of the mangrove ecosystems in the Rewa River delta. Earlier studies for the period 1850s, also recorded the presence of natural deep flood channels where the Rewa river discharged into during flood events.[46] Corals were also a feature in parts of the Rewa estuary, with relict reefs, sand cays, reef platforms and submerged reefs making up one of the four main types of morphostratigraphic units found in the Rewa delta and estuary. One can assume that with increased human settlement in the area, clearance of mangroves would have been on the increase, and this would have increased siltation of the flood channels, and caused the death of corals. The mangroves act to hold and trap sediment, preventing it from filling up the flood channels. The sediment affects the clarity and light penetration in the water column. High sediment loading in the water prevents growth of corals through incapacitating of the symbiotic zooxanthellae within the corals. The unsustainable use of mangrove resources by man, and his ignorance of the intricate linkage among the various components of the ecosystem (mangrove, corals, sediment load in the rivers and channels) are factors contributing to the damaging effects of floods.

5.3 Water and sediment quality

5.3.1 Introduction

The quality of the river water is often the first and worst affected during floods. For the Rewa River, the persistent brown appearance of the Laucala Bay and Suva Harbour, several days after a flood event or heavy rainfall indicate the extent to which the upper Rewa catchment has been affected by the rain, and how much soil material has been eroded and carried down by the river. Sedimentation of the river, and soil loss have been quite significant, and dredging of the lower Rewa River is just one mitigative measure to recover some of the eroded material carried down during flood events. However, for protection of the environmental quality of the dredge spoil deposit sites, the quality of the sediment that will be dredged is also important and must be assessed prior to dredging. For these reasons,

[46] Cited in Armstrong 1993

baseline quality of the river water and the riverbed sediment needed to be determined prior to dredging.

Baseline water quality assessment is important for the purpose of monitoring the effects (if any) of the proposed dredging on the important parameters such as dissolved oxygen, water clarity, suspended solid concentration (TSS mg/L), micro-biological status (total and faecal coliform counts), temperature and conductivity. The river and marine environment play very significant roles in the livelihood of the people living along the river banks, and in the adjoining coastal villages. They provide sources of food including fish, shellfish, seaweed and other invertebrates. However, with progressive land clearing occurring upstream and in the river catchments, for agriculture, forestry and other infrastructural needs, the quality of the water in rivers and tributaries has continually deteriorated in recent times. The concentrations of suspended matter in the water has increased (thereby reducing water clarity and the general aesthetic value), nutrient loading has increased leading to fertilization of coral reefs and death for the corals. It is important therefore to gauge the pre-development status of the river water, for future monitoring and mitigative measures.

In an earlier study,[47] it was found that generally the water quality satisfied recommended guidelines, except for specific locations along the river: near certain villages and the Nausori Sewage Treatment Plant (NSTP). Deo (2000) found that the metals iron, zinc and copper were high in water, sediment and *kai* at sites close to Kasavu, Naselai, Nakaile and the NSTP. These would appear to be implying some industrial discharge was occurring at some locations along the river. Naqasima[48] also found high levels of faecal coliform in *kai*, indicating high levels of sewage pollution at sites close to villages, and the NSTP. The JICA study[49] found that pH, dissolved oxygen (DO), COD (chemical oxygen demand) satisfied recommended guidelines. However total nitrogen (TN) and total phosphorus (TP) were high at the estuaries, exceeding recommended levels. However, for the Rewa river, TN and TP was not a problem, but as would be expected, flooding would elevate TN and TP levels to critical levels above the recommended levels for rivers.

[47] Deo 2000
[48] Naqasima 1996
[49] JICA Summary Report 1998

5.3.2 Water and sediment quality – study sites

Ten stations were selected along the main Rewa River, starting from the river mouth, and moving upstream towards the Rewa bridge. Sites selected were those that were as close as possible to proposed dredge spoil deposit sites, and also to mouths of creeks and tributaries of the Rewa River (see Figure 9)

The first three sites RW1, RW2 and RW3 are located along a diagonal from the southern tip of Laucala Island, and moving easterly towards Nukui Point. This is a highly turbulent area with very swift currents and high energy waves. As such, the sites could only be accessed during low tide when the weather is calm. The location of the ten stations are shown on Figure 9. The sites were located using the MAGELLAN eXplorist 100 model of the GPS. At the same time as GPS points were being recorded, photographs of each sampling site was taken with a digital Sony camera. Back at the office, the two (GPS and photograph) are matched according to time on each (these were synchronized in the office prior to leaving for the field), using a special GIS software. The photographs of the ten sampling stations are appended (Appendix O -Water sites photos.)

5.3.3 Methods for water quality study

The number of water and sediment sampling stations was reduced from twenty to ten, while the number of sampling events was increased from one to two, thus maintaining the total number of samples to be analyzed at 20. Water quality testing on-site was conducted on 14th, (morning and afternoon), 16th and 29th October. The first field visit was undertaken on Wednesday 14 October, 2009. Prior to the field work, it had been raining for some days (field work was cancelled on Tuesday 13 October due to wet and rough weather), thus the results for 14 October may be taken to represent 'wet' weather data.

Standards methods for water quality assessment were used. The Horiba multimeter was used to measure multiple parameters *in-situ*: pH, water temperature, salinity, electrical conductivity, turbidity, dissolved oxygen and total dissolved solids (TDS). Water samples were collected from the 10 sites, and analysed in the laboratory, using standard methods (APHA, 1998) for suspended solids (TSS); organic pollution (BOD); heavy metal (lead);

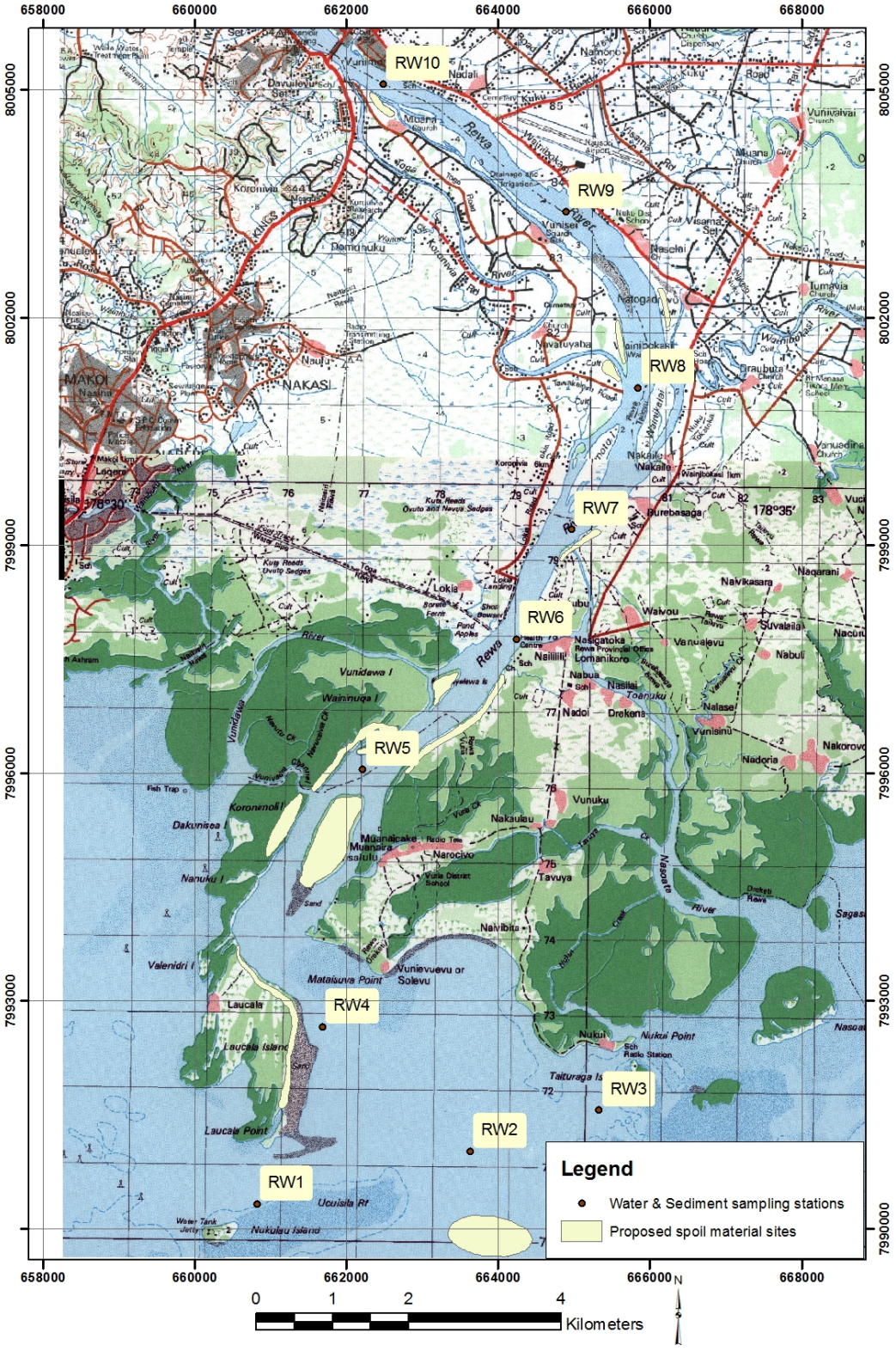


Figure 9: Rewa River Water and sediment sampling stations (RW1 – RW10) 2009.

and micro-biological status (total and faecal coliform). The second field visit will be undertaken on Thursday 29 October, 2009.

5.3.4 Methods for sediment quality study

Two lots of grab samples of sediment were collected from the same 10 monitoring sites as for the water samples. The sediment samples were treated in the IAS laboratory in preparation for chemical analysis. The dried sediment samples were tested for pH; and nutrients (total nitrogen and total phosphorus). Sediment toxicity was tested by analyzing the sediment samples for lead concentrations (SPACNET methods). The baseline concentrations of the tested parameters are being compared with international guidelines for acceptable levels in the aquatic environment.

5.3.5 Water quality on-site, 14, 16 and 29 October 2009 - Results and discussion

The water quality results for the 14th , 16th and 29th October are appended to this report[50] (Appendix E), and are compared with ANZECC Guidelines.[51] All of the parameters satisfied the ANZECC guidelines. In fact, pH, DO, temperature did not vary much from site to site and for different sampling dates. On all of these dates, the weather was fine, and the water was generally clear.

As expected, there was direct and positive correlation among conductivity, total dissolved solids (TDS) and salinity, these being higher towards the mouth of the river, and decreasing as one moved upstream. The site RW3 near Nukui Point recorded the highest values for salinity, TDS and conductivity, showing the effects of oceanic water flushing at this site, being driven by the south-east trade winds and the long-shore current affecting the eastern side of the estuary. There was some deviation in the pattern of variation in the levels of TDS and conductivity for site RW9 which is near the L&WRM depot, the NSTP, as well as the airport. At site RW 9, there appeared to be a steep increase in TDS and conductivity. This may be caused by some effluent from any of these sources, but further investigation

[50] Appendix E – Water Quality Results
[51] ANZECC Water Quality Guidelines 2000

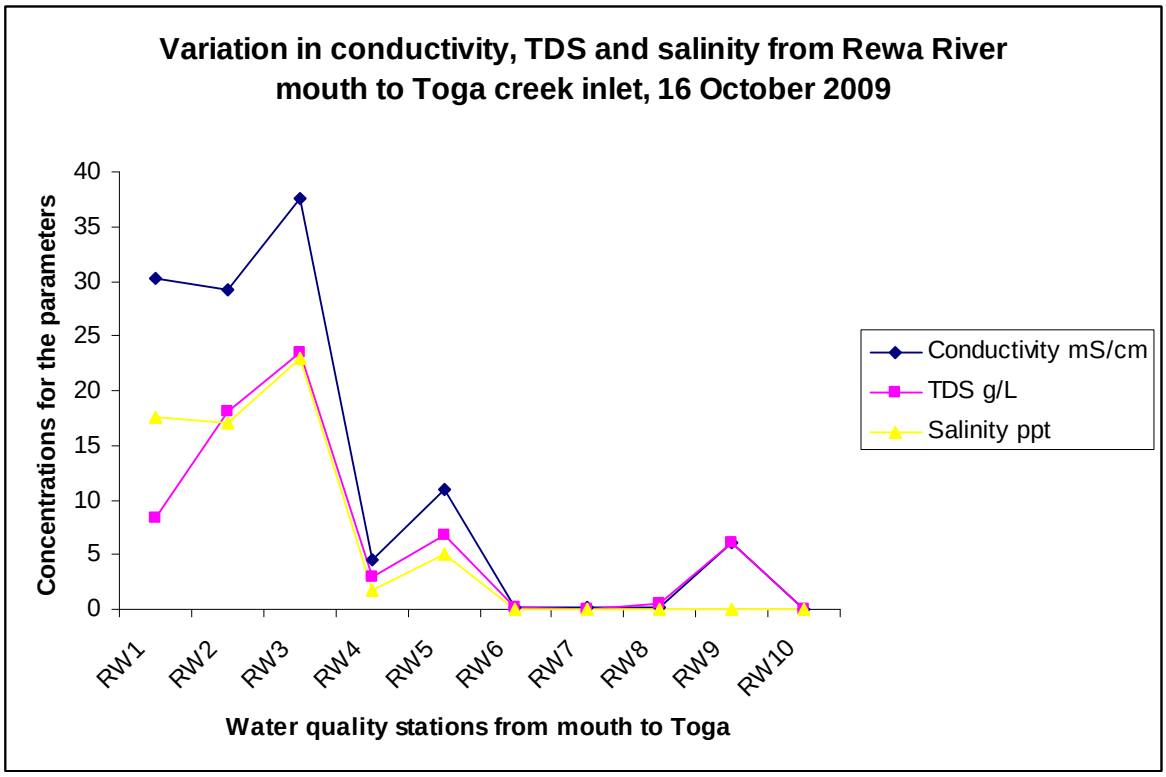


Figure 10: Variation in conductivity (mS/cm), TDS (g/L) and salinity along Rewa River, October 2009.

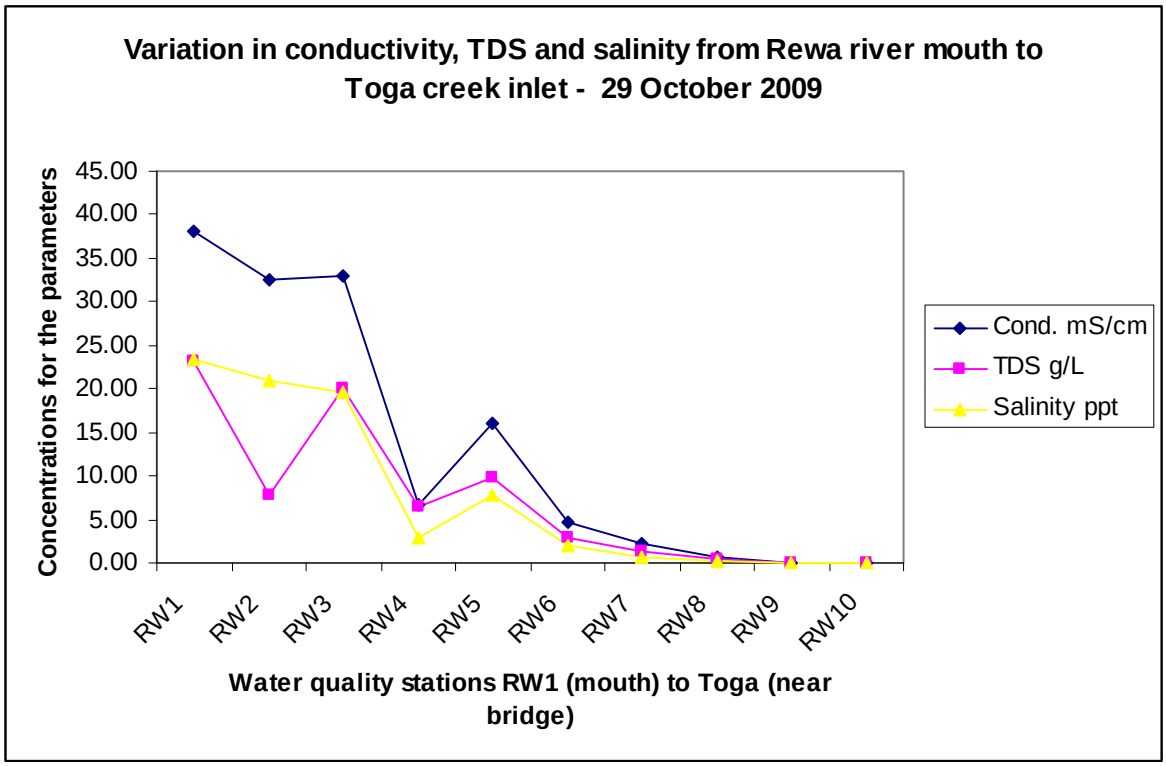


Figure 11: Gradation in conductivity, TDS and salinity from Rewa River mouth to Toga Creek inlet (near bridge).

may be necessary if this causes other environmental problems (see Figure 10). As expected, TDS, salinity and conductivity decreased moving upstream (Figure 11).

5.3.6 Water samples tested in the laboratory - Results and Discussion

Two sets of water samples were collected from the ten sites on 14th and 29th of October, and tested in the IAS laboratory for TSS, BOD, lead concentration, and for sewage pollution (coliform counts). The results for coliform counts on 14th October (Appendix E2) showed high levels of sewage pollution with levels exceeding recommended guidelines.[52] In fact, most sites from Nailili and upstream recorded TNTC (too numerous to count) for total coliform.[53] This has health implications for the local people that consume *kai* harvested from the river or swim in the river. The results for the 29th showed a similar pattern, with high coliform counts near village sites (Nailililili and upstream), as well as near the NSTP (Appendix E6). The levels for coliform exceeded the levels suitable for 2^{o} contact , i.e. bathing. This information is important for the local women who harvest *kai* and the children who bathe in the river.

5.3.7 Sediment quality results and discussion

The results for sediment quality tests are appended (Appendices F1 and F2). For both sets of sediment samples collected on 14th and 29th October, nutrient levels (total nitrogen and total phosphorus) and lead levels were within expected levels, but showed some variation by dates. The nutrient content (Total nitrogen and Total phosphorus) of the sediment samples were relatively low. Total nitrogen levels ranged from < 0.1 – 0.23 mg/kg for all sites for both sampling dates. However, for Total phosphorus concentrations, the levels were enhanced on the 14th October, the day following some rain at the project site. Interestingly, the concentrations of lead were very different for the two dates, with the 'wet' weather samples recording much higher concentrations (2.63 – 6.99 mg/kg Pb) compared to the 'drier' weather results where all samples had <0.1 mg/kg Pb. These results appeared to

[52] ANZECC Water Quality 2000
[53] APHA 1998

indicate that increased rainfall and associated wash-out effects may be causing increased Lead concentrations satisfied the CSIRO guidelines.[54]

5.3.8 Effects of cyclone Mick on the water quality – observations

Tropical cyclone Mick hit Viti Levu with category 2 strong winds, on 14 December 2009. The cyclone caused massive flooding in many parts of Viti Levu including the Rewa River. The parameter of water quality during this study in October are relatively insignificant when compared with the appearance of the Rewa River during cyclone Mick. During cyclone Mick, the Rewa River burst its banks, and flooded low areas in the project site. The water level reached by the Rewa River during cyclone Mick would have flooded most if not all of the proposed dredge spoil deposit sites.[55] Whether the proposed dredging would have made any difference to the flood levels experienced during cyclone Mick is uncertain, and it goes to show that an integrated approach (dredging in combination with other measures) is definitely needed. From an environmental perspective, the impacts of the proposed dredging by L&WRM (typified by Navua dredging in left photograph below) are insignificant in comparison with the forces of nature displayed during cyclone Mick (see photograph on the right below).

[54] CSIRO 2005
[55] Photographs in Appendix O

Navua river mouth dredging

Cyclone Mick floods in upper Rewa, River, Waila, Nausori, December 2009

Figures 12 a and b: Comparing dredging impacts to flood effects (cyclone Mick)

5.4 Biological and ecological environment -terrestrial

5.4.1 Terrestrial fauna and flora study

The full report for this section is appended (Appendix G)

Most of the 'old' dredge spoil deposit sites were surveyed. The potential 'new' deposit sites were also surveyed. During the field surveys, the focus was on gathering vegetation data. Other members of the team concentrated on gathering terrestrial fauna and bird presence. Unique or unusual forest types were recorded, and reported in detail in the appended full report.

The effects of 'old' deposit sites on the mangrove vegetation were investigated, and are reported in detail in the appended report. In most cases, the deposited spoil had mixed well with mangrove material, and new habitats with enriched biodiversity (coastal trees amongst the mangroves) have resulted. These are the positive effects of dredging and filling in of

low areas. The use of the terrestrial resources by the local communities was assessed as well.

5.4.2 Terrestrial vertebrates and bird study

The full report for this section is appended (Appendix H)

The study of birds and terrestrial vertebrates of the Rewa delta dredge sites were undertaken by Dr. Dick Watling, Principal of Environmental Consultants. The survey was undertaken during the week of 7-11th September, and again on 29th September, 2009.

Habitat Assessment

The habitat requirements of Fiji's terrestrial vertebrates are well known – the most important variable being forest cover. The majority of Fiji's native terrestrial vertebrate species are forest or forest edge restricted species and within the forest, they tend to be generalists, there being no altitudinal or other distribution variables. Mangroves are a distinctive habitat and there are no terrestrial vertebrate species restricted to mangroves or reliant on them in any way, other than the mangrove heron *Butorides striatus*.

The fauna of habitats adjacent to mangrove reflect the nature of those habitats, where good lowland forest occurs, then the more diverse forest birds and other vertebrates will be found immediately adjacent to the mangroves and some forest species will visit mangroves from time to time. Much more commonly, converted secondary or agricultural habitats occur on the inland of mangroves. Such habitats are of very little conservation significance for Fiji's native and endemic birds or herpetofauna. A habitat assessment of the proposed dredged sites will therefore provide a good indication of the birds and herpetofauna which are found on the sites.

The introduced mongoose *Herpestes auropunctatus* is found on Viti Levu, it has devastated the terrestrial herpetofauna and ground-dwelling birds, as such these groups are either extirpated or occur only at very low densities. The mongoose is a common inhabitant of mangroves and secondary habitats adjacent to them.

Additional important observations were required to determine if the proposed sites may be feeding or roosting sites for migratory waders or seabirds.

Survey Methods

The habitat of each site was assessed by either a walk over, visual inspection from a boat together with a review of Google images. Three sites were selected for intensive survey.

Bird survey work was initially timed to view the proposed dredge sites at high tide when important roosts for migratory waders would be observed. Elsewhere birds were surveyed on unstandardised transects and incidental observations in mangrove and other habitats as and where possible. Three of the major dredge disposal sites were selected for field survey, the remaining dredge areas were assessed on the basis of their habitats (refer Full Report appended, Appendix H).

For the herpetofauna, opportunistic diurnal surveys were conducted along trails in mangroves and the adjacent terrestrial habitats. Searches were made in known microhabitats for cryptic geckos. GPS coordinates of target species were recorded using a Garmin etrex Legend HCX. The coordinates were recorded in WGS 84.

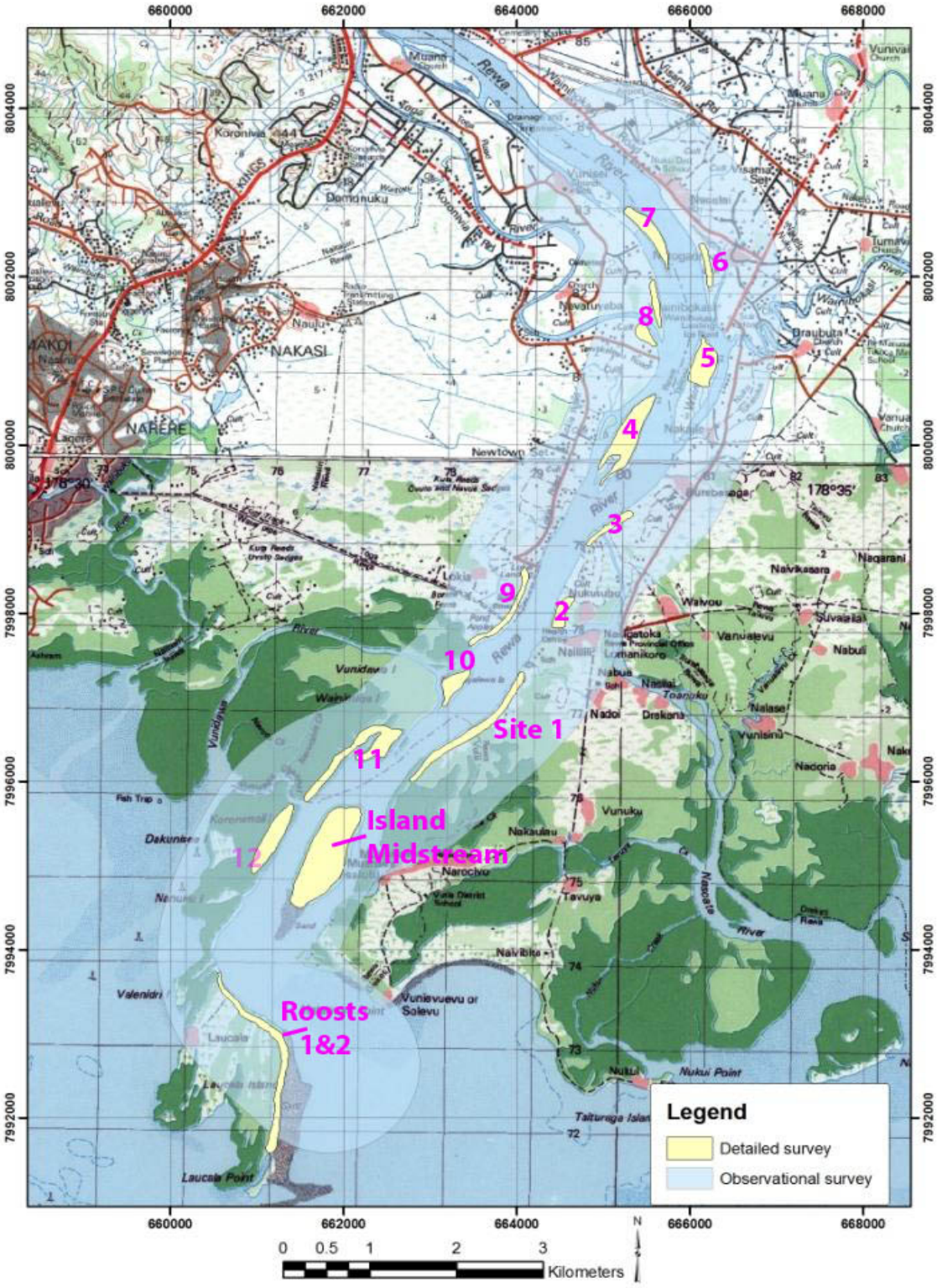


Figure 13: Rewa River Mouth with Potential Dredge Sites Migratory Wader Roosts; Intensive Survey Locations and Habitat Assessment Sites

Main findings

There are 49 land and freshwater bird species occurring on Viti Levu that are potentially present at the study area. However, as noted above, the majority of Fiji's native and endemic species are forest residents and are absent from mangroves and converted, open habitats. Of the 49 species, 13 were recorded during the survey (refer Table 4, Appendix H). All of the 13 species recorded are common, generalist species and not of conservation significance. A further 9 species have been recorded in the Rewa Delta and could potentially be recorded at the dredge sites. Only one of these, the Collared Lory *Phigys solitarius* is an endemic species but it is widespread and common, and not a threatened species.

Migratory Shore Birds

Sixteen migratory shore bird species have been recorded in the Suva Lagoon – Rewa Delta area (Watling 2006). Migratory shore birds feed almost exclusively in the inter-tidal flats. At high tide they find roosting/loafing areas where they are safe from disturbance and predators. Different species tend to use different locations. The playing fields on the Suva foreshore are used when possible by the Pacific Golden Plover, but other species use other sites, often quite some distance away.

There are two very important high water roosts on the eastern shores of Laucala Island which were first recorded in 1964 (Morgan & Morgan 1965) and are still in active use (Watling *pers. obs.*). The sites (about 150 m apart) were surveyed at high tide on 10th and 11th September. Table 2 in Appendix H summarizes the species using the sites at that time. The site is most important for the Bar-tailed Godwit which at the time of the visit had not yet arrived back in Fiji – they are expected at the end of September or early October.

Herpetofauna

Three species of herpetofauna were recorded from the survey sites, while three others are known to occur in the Rewa Delta. The Green Tree Skink is endemic but is widespread and common in Fiji and is not of conservation significance.

Mammals

Only two mammals were recorded during the survey, the sign of Mongoose *Herpestes*

auropunctatus was seen everywhere at the edge of mangroves. The Pacific Flying Fox *Pteropus tonganus* was seen on three occasions on different tracks, a single each time. There was no sign of a flying fox roost.

5.5 Marine and aquatic environment

The full report on this section is appended (Appendix I)

5.5.1 Survey methodology

A number of field visits were undertaken, by boat as well by road. The first visits involved visiting the five villages (Muanaira, Muanaicake, Narocivo, Laucala and Nukui), during the same time as the socio-cultural surveys on 14th and 15th October. Questionnaires were administered to the key informants, as well as the main fishermen and women in these villages. The purpose of the questionnaires was to gather information on:

- Where the main fishing locations are
- What were the main species caught
- How much of the main species are usually caught
- Are the catch for subsistence use or commercial, or both
- If any, what has changed over the years with regards to species caught, and what volume of each species have been caught

On the 29th and 30th October, more field work was carried out, this time by boat. Fishermen were interviewed as they fished, their catch was assessed, and the 'catch per unit effort' was estimated. The consultants also dived and conducted benthic surveys of molluscan invertebrates (*kaikoso* and *kai).* The water clarity at each sampling site was also assessed using the secchi disk.

5.5.2 Results

Map & history of marine resource use/dependence

The first map[56] shows areas frequented by community folk for fishing and an area known to be a good 'kai' bed. This was a result of interviews with fisher folk in twelve villages. Good fishing areas are concentrated around mangrove areas and also at river mouths, although fishing was also occurring in other places.

It should be noted that a majority of community reps interviewed feel that dredging will have minimal impact on fishing in the short term, and improve it in the long term. The improvement is attributed by some fishermen to more fish occupying a 'deeper' water column as a result of 'more space'. 'Kai' beds were noted to be all along the river banks, but some fisherwomen indicated the area marked in red below, to be a really good area for getting 'kai'. This area is located directly across the Nuku District School

5.5.3 Discussion

Kai (*Batissa violacea*):

There are rich *kai* beds in the mid and upper stretches of the Rewa river, which could be impacted by the proposed dredging operations. Women who glean kai, do so in the shallow river beds (up to about 1.5m water depth) which are immediately adjacent to the river bank. Dredging this shallow, river bank portions would result in destruction of some rich *kai* beds, and therefore affect the livelihoods of people that depend on it.

The *kai* larvae are known to have limited movement, which results in very short distances travelled before settling.

A recommendation would be to restrict dredging operations to the center of the river. This would ensure the protection of the kai beds and possibly prevent erosion of river banks.

5.5.4 Mitigation options

1) BREEDING GROUND

The river system is a breeding ground for most marine fish species such as travellies, groupers, sharks etc in their respective breeding seasons. The fish seasons and time is

[56] Appendix I has full report and maps

well known by local traditional fisherman. There has been a regular sighting and catch of macro fishes in the upper trophic chain in the river system by local fisherman. Over the survey the team came across two bull sharks which were caught by a local fisherman. Gutting of the larger female bull shark revealed 15 juvenile sharks which jumped out into the water and all swam away alive. Hence the Rewa river system is rich in supporting the transverse of brackish and freshwater reliant species at different stages of their live cycle especially in their re-productivity stages.

Recommendation

The river system is a productive one in terms of ecological support and services to freshwater and marine species and the ecological balance needs to be intact so it continues to serve its role. The dredging activity will get rid of alluvial deposits and other inland debris that is clogging and causing instability in the system. A proper dredging design is to be undertaken to maintain constant flow of water and low destruction on the ecological integrity of the system to support reproduction of freshwater-marine species.

2) ZERO SALINITY SHIFT

Over dry seasons the zero salinity shifts further upstream hence brackish water fish species migrates further upstream as well. Over these periods the communities towards the mouth of the river would record catches of marine species as the salinity would be considerably higher. The higher salinity in the river mouth brings about abrupt changes in the species composition and low catch abundance. They would have to travel long ranges either to the reef crest or travel to upper reaches of the river to get a good catch. However after every flood the zero salinity level shifts towards the river mouth and then the lower reaches consequently becomes productive for fishing. The main cause of the shift is the clogging and instability in the river system that does not regulate or maintain main the zero salinity towards the lower ranges.

Recommendation

Dredging is to be well designed to consider the constant flow of the river system and minimize alluvial deposits that would cause clogging or bottlenecks into the system. Transverse fish species dependent of salinity would be more ecologically reproductive in their respective habitats such as the mangrove zones rather than to move about based on salinity shifts.

3) FISHING COMPLIANCE AND ENFORCEMENT

There are some forms of management in place on the river system by the Fisheries Department, placing a ban on gillnet fishing along the river system. The ban enriches the river with brackish water fish species such as mullets and snappers. However there were some fishermen that were using gillnets and had quite considerable catches of the fishes.

Recommendation

The enforcement of the management actions needs to be given to community so they would take greater responsibility in managing their areas of jurisdiction. This would also enrich the species abundance and biomass in the river system and making them more resilient to any form of disturbance in the river zone.

5.5.5 Conclusions

The site is similar in character to many areas of alluvial delta in Fiji. Habitat-wise, the area includes eroded bank areas, grassy bank zones, riparian green vegetated tree coverage, mangroves thickets and natural water bodies. A number of fish species were noted by local communities to be of rare occurrence (as a result of intensive subsistence and artisanal fishing). However, none of these fish species are threatened at either national and international level.

The dredging will have the most potential for impacts as a result of habitat loss and physical disturbances. The proposed site has a relatively moderate ecological value since it is not quite ubiquitous in Fiji. Furthermore, its value is moderate in relation to both species

diversity and productivity. None of the species believed to be present have any special value conferred upon them as a result of rarity or protection status. Given the semi-urban nature of the site, most of the fish species present would be expected to have behavioral and physiological adaptations that suit them to an existence in close proximity to the new geomorphogical river bed. The communities, speaking over their experience over previous dredging undertaking, are confident that a significant impact upon local flora and fauna are not expected however those projects deemed smaller scale compared to the current undertaking.

5.6 Socio-cultural Environment

The socio-cultural environment for the project is treated as two main studies, for ease of surveys and also because two different agencies are involved: the Fiji Museum was responsible for surveys of sites of heritage and traditional significance, and the IAS was involved in the survey of local communities, villages and settlements.

5.6.1 Study of cultural and heritage sites

The purpose of the study was to ascertain if any of the sites proposed for deposition of dredge spoil has cultural, traditional or historical significance. The study was conducted by staff of the Archeology Department of the Fiji Museum, under the guidance of two main pieces of legislation – the Fiji Museum Act and the Preservation of Object of Archeological and Palaeontogical Interest Act.[57] The methodology consisted of in-house literature research, followed by field surveys where field assistants from the villages assisted. Local knowledge of the local field assistants was explored during the assessment.

5.6.1.1 Results, recommendations and conclusions

During the course of the field survey, the team did not encounter any significant cultural remains nor does the location hold any historical account or records of any significance. Informal discussions with villagers also revealed the same sentiments. It is therefore our recommendation that the development of the

[57] Appendix J has full archeological survey report

proposed deposit sites on the said locations by Land and Water Resources Management [LWRM] go ahead as planned. However, should development extend to the opposite bank particularly Northeast of the river mouth,[58] additional investigation will be required as this area houses several interesting cultural sites.

The full report on this section is appended (Appendix J).

5.6.2 Socio-cultural survey of local communities

A social impact assessment was conducted in 22 villages that have customary fishing rights area along the proposed dredge area and also settlements and businesses along the same area of the Rewa River. The assessment was made to gather the views of the local people and businesses on the proposed project and to gauge their support of the project. Part of the assessment was the suitability of the proposed dump sites and the effect of the proposed development project on surrounding local residents and business during the construction stages of the development and as a result of the finished project. Communities' concerns and proposals to the project were also gathered and clustered together. The social demographics, community development and significance of the Rewa River and infrastructure of the area have been located, identified and described.

Aims and Objectives

The primary objectives of the social impact assessment are to:

- provide a description of the social demographic setting of the villages that have fishing rights area along the proposed dredged site and also the settlements along the same site
- provide a description of the public health, employment and community current and proposed development of the area and also provide information on the significance of the proposed dredged site to the local people
- gauge the views of the local people on their support for the project and also to note their concerns on certain aspects of the project

[58] Appendix J, Figure 5

- provide information of the proposed project to the various *turaga ni koro, mata ni tikina* and *Turaga ni vanua* along the project site in the presence of the staff from the Rewa and Tailevu Provincial Office. Presentations were made and feedback was received from several villages regarding some specific concerns or requests

Methodology

Community consultations in the form of a focus group interview using an unstructured questionnaire were conducted in the villages along the Rewa River (see table below). The villages were first informed through the village headman prior to these gatherings to ensure the full participation and availability of representatives from all social units and groups within the village.

Qoliqoli Ownership	**Villages surveyed**
Yavusa Buregadro and Maraki	Naselai
Yavusa Natogadravu, Nuku, Muana and Natavea	Natogadravu and Nataveya
Vanua of Toga	Navatuyaba, Vunisei and Muana
Vanua Vutia	Muanaira, Muanaicake and Laucala
Vanua of Burebasaga	Narocivo, Nukui, Burebasaga, Nukutubu, Nadoi, Waivou, Vunuku, Tavuya, Nasilai, Nasigatoka, Nabua, Drekena and Lokia

Also, key informants in these villages were interviewed in order to get information on proposed community development programs and how they feel the proposed project will affect the local people and the at the village level. An open-ended questionnaire was used for this interview and the list of some of the key informants is given below:

1. Village headman
2. Village chiefs
3. Head of village committees (e.g. Development Committee, Health Committee
4. Women's group rep
5. Youth group rep
6. Head of religious body
7. Village advisors

Also, household interviews using semi-structured questionnaire were conducted in the 22 villages and also in the settlements, housing and satellite households along the Lokia road, Tawakelevu road, Toga road, Koronivia road, Naselai road and Wainibokasi road. A

sample size to represent the total households in this region was determined and the households interviewed were selected using the random sampling method. In total, 270 household interviews were conducted representing 30% of the total households in the region.

Significance of the Rewa River to local community

The Rewa River plays a pivotal role in the livelihood of the people that live alongside it and is significant in the economy in this region and also in providing social services to the people. From the survey, it is identified that the local people use the river for fishing, recreational purposes, transportation, bathing, drinking and farming purposes. As shown in Figure 5[59], fishing is the main livelihood activity that most (63%) households take part in followed by transportation (54%), recreational purposes (53%), bathing (39%), drinking (3%) and irrigation purposes (2%). Several parts of the study area are not accessible by road as they are part of another island or landmass and this includes the villages of Lomanikoro, Nasilai, Nasigatoka, Nailili, Drekena, Nabua, Vunuku, Tavuya, Lokia, Narocivo, Muanaira, Muanaicake, Laucala and Nukui. Small punt and fiberglass boat with outboard powered engines is the main transportation mode in these villages.

There are several landing sites for those that travel by boat which include Nasali, Lokia, Vatuwaqa and Laqere. Nasali which is located close to the Rewa Provincial Office is the main landing site which housed several boats, known locally as “water taxis” that can be hired to transport people to their desired destinations.

Perception, attitude, concerns and requests for the proposed project

Through the survey, most respondents (60%) are unaware of the proposed project while the remaining 40% are aware through provincial, district or village council meetings, or from staff of relevant government department who visit the area or *word of mouth* from other fellow villagers.

In terms of supporting the proposed project, the majority (97%) of the respondents fully support it while a handful (3%) do not support. Also, the majority of the respondents (96%)

[59] Figure 5 in Appendix K

stated that the project will not affect their daily activities during implementation while only a few (4%) mentioned otherwise. [60]

For those who support the proposed project, the reasons for their support are clustered below:

- The river will be deeper which will help in reducing floodwater or totally stop flood in this region.
- It will ease village development as sand will be readily available for instance for those who want to construct concrete houses.
- Sand from dreading can be used to bury low-lying village area and reclaim more village or farming areas.
- Sand can be used to bury outskirts of villages therefore, village boundary can be extended.
- If done properly, fish and invertebrates stock within the river might increase
- Coastal erosion will be reduced
- The river mouth will be deeper which will improve the passing of water from the river towards the sea.

For the few who do not support the project or mentioned that the project will affect their daily activities, the reasons are clustered below:

- It will affect some daily activities such as fishing, especially when dredging is done on an important or famous fishing spot.
- The dredging machine and activity might cause noise pollution to nearby village or settlement.
- Deepen the river will affect some key resources such as *kai* for the people of Toga district or will affect the harvesting methods of these resources.

For the proposed dump sites, a map was shown to the respondents to gauge their views on the location. The majority of the respondents (94%) support the site while a few (6%) do not. There are a few concerns for the dump sites or proposals from the respondents which are clustered below:

[60] Appendix K has full socio-economic report

- If the dump sites could be move in front of the village so that the people can use sand for some village development
- If the Nabuna river can be used as a dump site
- The dump sites can be brought to the edge of the nearby village to prevent overflooding and to level the village
- To dump sand on eroded river banks to reclaim area and prevent further erosions
- To dump sand on outskirts of nearby village so that the village can be extended for more houses and also more farming areas
- Proposed dump site to be brought to village for village use

Overall, there was overwhelming support from the various villages and settlements for the proposed project and the dump sites. There are some concerns or proposals though from the region and some are village or settlement specific for the whole project.

Overall project concerns or proposal:

- If at least some of the unemployed youths in the villages to work in the various phases of the project. The community feels that the best approach to conduct the recruitment is through liaising with the Provincial Offices.
- The dredging or deepening of the river to be done in the middle of the river. This issue has been the center of discussions from the various villages and settlements that the team visited due to lessons learned from the previous dredging in the 1980s. In some villages, the last dredging has deepened the side of the river close to the village causing fast erosion of the river banks.
- Also, an informant who used to work as an engineer in the previous dredging of the Rewa River mentioned that some villagers used to bribe the workers in exchange for dumping of sand on their piece of land. This exercise resulted in the dredging of any part of the river to meet the request of the villagers rather than working according to the dredge plan.
- The dredging of the side of the river has also affected the collection of resources as local people; especially older women find it hard to fish in deeper dredged fishing

grounds. It should be noted that fishing, transportation and other water activities along the Rewa River are concentrated on the sides of the river rather than the middle, therefore, any dredging activities should focus on the center of the river.

- In the recent Cyclone Mick, the team revisited or contacted some of the villages and settlements and most highlighted that most proposed dump sites were flooded. This raises the concern of similar situations in future when sand is already dumped on the sites, which might result in the sand being washed back into the river. The dump sites with high elevation should be considered as the best spot for dumping dredging materials.

Other specific requests from villages and districts:

Rewa District

- A request from this district to is for L&WRM to also dredged the Nasali River, an important river in the economy of this district. Most of the water taxi operators highlighted that this river is becoming shallow and dredging the Rewa River might cause the Nasali River to be shallower.

- For the government to assist in constructing sand trap to prevent dredged sand from washing back into the river and also to reduce or stop coastal erosion.

Burebasaga District

- The village of Burebasaga mentioned during the consultation meeting that about 50 acres of their farming land next to the river bank have been washed away into the river. Therefore, they request that sand be dumped into these lost areas and retaining materials be constructed to stop further erosion of the river bank.

Vutia District

- Muanaira village has offered part of an island opposite the village, known as Koronigone to be a dump site. This will enable them to have access for more land to build houses and extend the already very limited village boundary.

Toga District

- The river bank along Muana village has eroded at a faster rate as a result of the last dredging activity, according to a village member. To the community, this was the result of the dredging of the side of the river and a special request from this village for the center of the river to be dredged and sand to be dumped on the side to make it shallow.

Tokatoka District, Tailevu

- Nakaile village made a special request for the dredge to be done according to the plan and that no dredging to be done along the Wainibokasi River as this is the main area that the villagers fish in for sustenance and income.

Nuku District, Tailevu

- Naselai village has offered a piece of land in front of the village as adump site. The sand can be used to reclaim lost lands along the river banks and can also be used for community development such as building constructions.

The whole report for this section is appended (Appendix K)

5.7 Hazard vulnerability and risk assessment

The major hazards that Fiji is exposed to include tropical cyclones, earthquakes and floods.

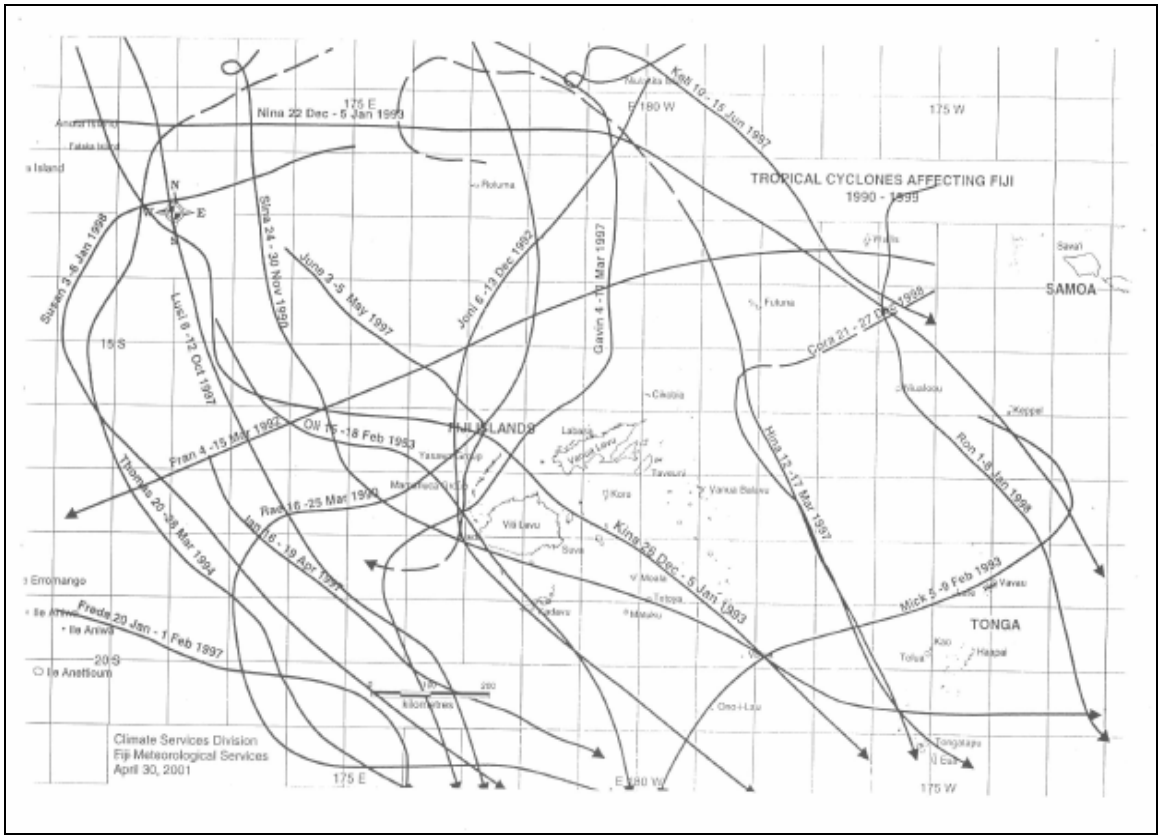
5.7.1 Tropical cyclones

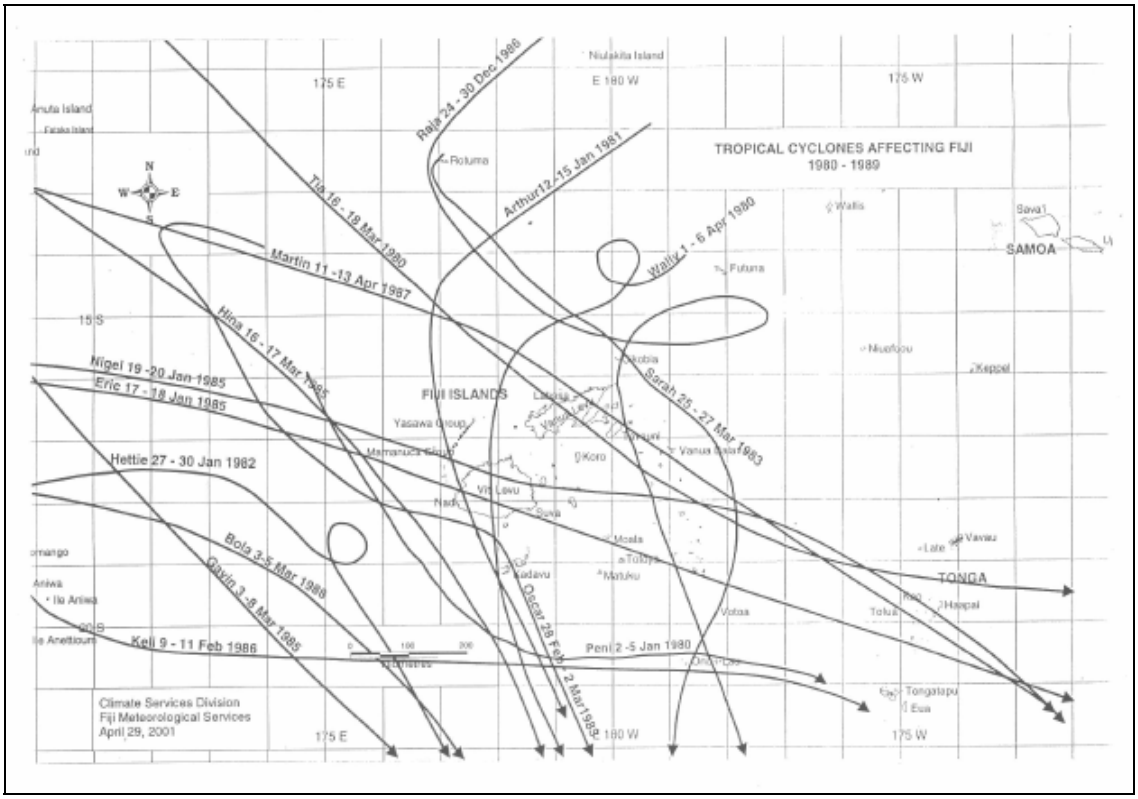
The two figures (Figures 14a & b) below show the pathways of the tropical cyclones that passed by and through Fiji during the period 1980 – 1999. Since then, tropical cyclone Ami in January 2003 passing to the east of Vanua Levu caused extensive damage as well. In January 2009, heavy rains caused major flooding in Nadi. Tropical Cyclone Mick in December 2009 is the most recent of tropical cyclones to affect Fiji.

One of the most devastating ones for the project site include cyclone Bebe which passed right through Viti Levu from the north-west (between Lautoka and Ba) towards the south-east (between Navua and Suva) in October 1972. Many parts of Viti Levu were flooded, including the Rewa delta. Cyclone Kina in January 1993 has been identified as one of the worst to hit Fiji, again with devastating floods in the Rewa delta. Although the two figures show that the usual pathways for tropical cyclones appear to be concentrated on the western side of Viti Levu (Yasawas and Mamanuca groups), the Rewa river watershed (being the size that it is) always gets its share of intense rainfall, and subsequently, the Rewa river always gets flooded to some extent. On this basis, the project site is very vulnerable to high intensity rainfall associated with tropical cyclones.

The Fiji group was hit by a Category 2 tropical cyclone in December 2009 – Cyclone Mick which caused a lot of damage to many parts of Fiji espcially Viti Levu. The pathway for Cyclone Mick is very similar to that of Kina, with the eye passing across Viti Levu from north-east (Lautoka, Yasawas) through the island and exiting between Navua and Suva. The Rewa river was flooded with water levels almost touching the bottom of the old Rewa bridge[61]. Figure 15 below shows the pathway of tropical cyclone Mick.[62]

[61] Cyclone Mick photographs in Appendix O
[62] Fiji Meteorological Services





Figures 14a & b : Pathways for tropical cyclones passing through Fiji, 1980 - 1999

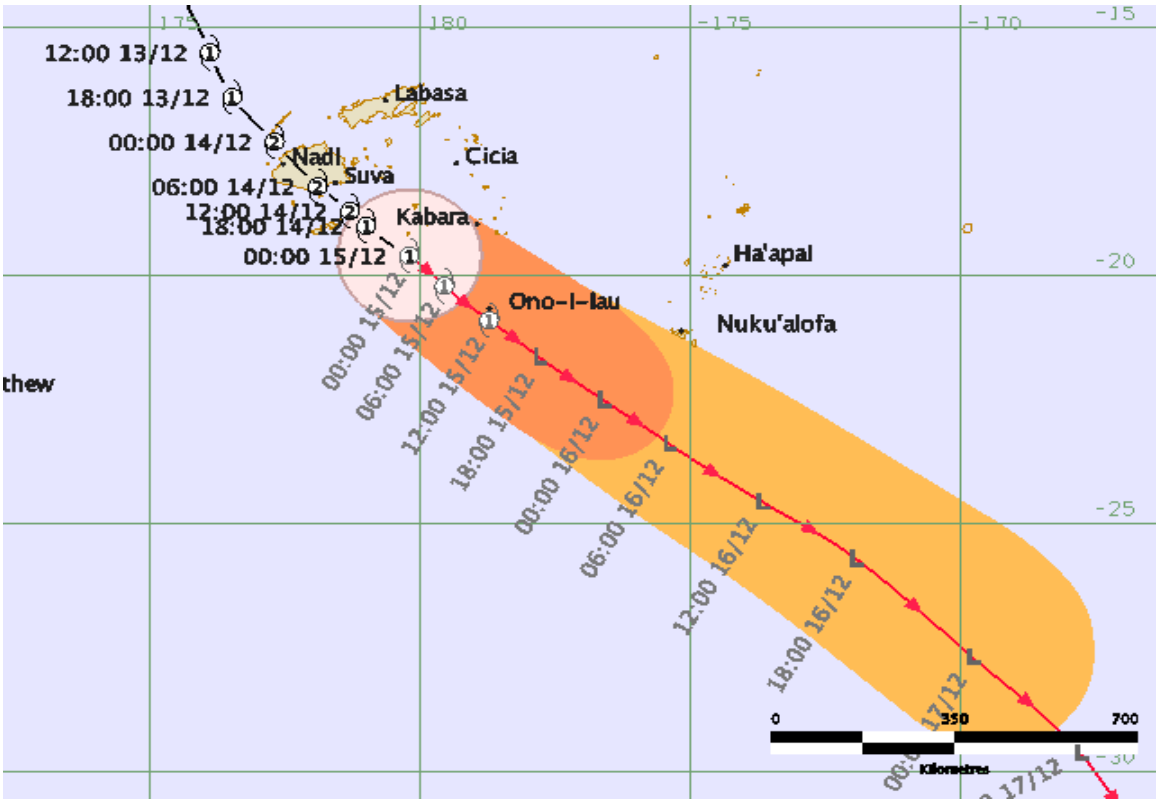


Figure 15 : Pathway for tropical cyclone Mick, 14 December, 2009.

5.7.2 Seismic activity in Fiji

The map in Figure 16 below shows the location of the earthquake epicenters around the Fiji group. Using the map, a seismic risk zoning map has been derived (Figure 17). From the map and risk zoning map, it can be seen that the project site lies within the Low to Medium risk zone for seismic activity.

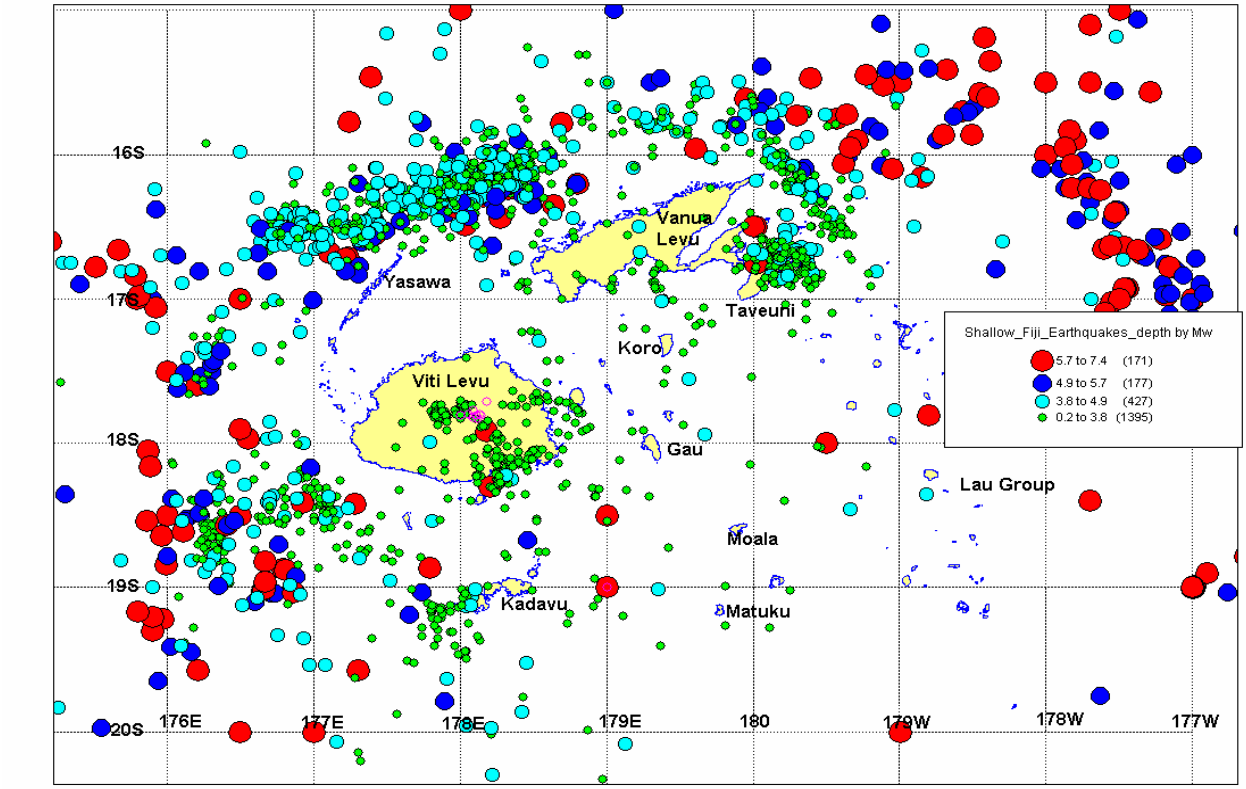


Figure 16: Location of earthquake epicenters around Fiji.

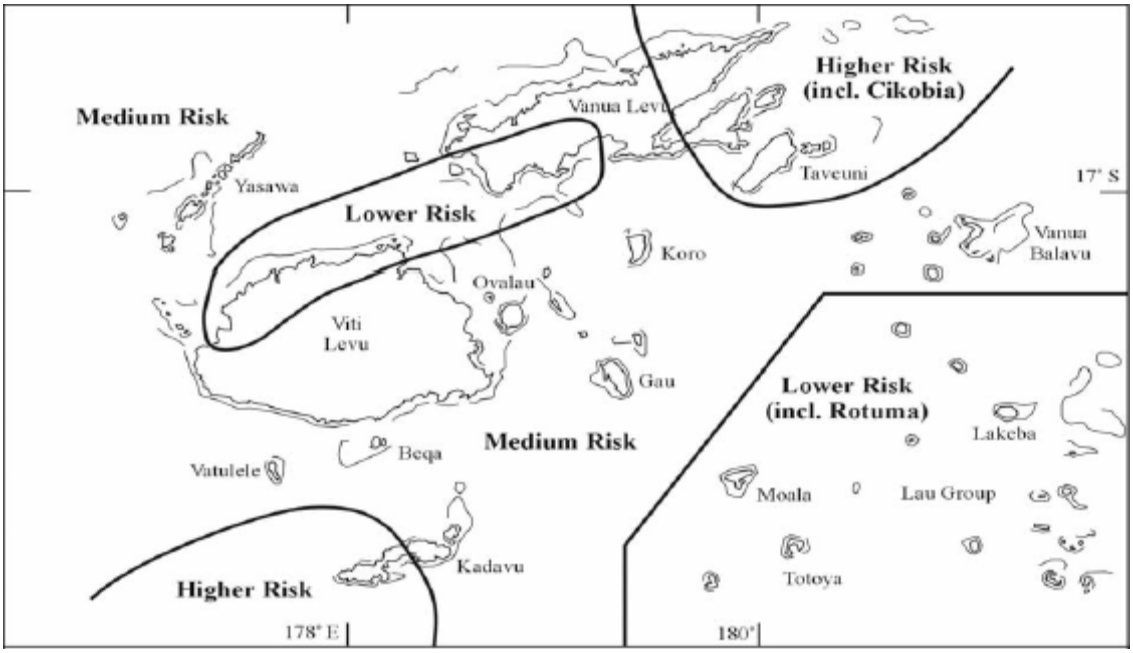


Figure 17 : Seismic activity risk zoning map for Fiji

Figures 16 and 17 above are taken from Baleivanualala (2009). Most of Viti Levu including the Rewa watershed falls within the Lower to Medium Risk zones for seismic activity.

5.7.3 Environmental hazard and risk assessment of potential impacts of dredging

Risk Assessment is an integral part of an EIA study for any project. In Risk Assessment, the identified impacts are rated, in order to determine the appropriate response or management actions that must be implemented, to minimize the impacts. There are a number of standardized methods of risk assessment, one of which is the Australian Standard for Risk Management (AS4360: 1995). The level of risk posed by the dredging and associated activities are assessed under two categories : the *likelihood* or *probability* and the *consequences* of the impacts (Table 5).

Table 5: Risk Assessment Matrix

	Consequences				
Likelihood	***Insignificant (1)***	***Minor (2)***	***Moderate (3)***	***Major (4)***	***Catastrophic (5)***
Almost certain (a)	Significant (1a)	Significant (2a)	High (3a)	High (4a)	High (5a)
Likely (b)	Moderate (1b)	Significant (2b)	Significant (3b)	High (4b)	High (5b)
Moderate (c)	Low (1c)	Moderate (2c)	Significant (3c)	High (4c)	High (5c)
Unlikely (d)	Low (1d)	Low (2d)	Moderate (3d)	Significant (4d)	High (5d)
Rare (e)	Low (1e)	Low (2e)	Moderate (3e)	Significant (4e)	Significant (5e)

From the matrix, there are four main levels of risk after combining the 'likelihood' and 'consequences' factors. For each level, there is an appropriate response or management control action. The four 'Risk Levels' are:

- High (H) Risk (those impacts with catastrophic consequences and high probability) – these usually require immediate action, at the highest level of management.

- Significant (S) Risk (those impacts with less than catastrophic consequences, i.e. major consequences but still highly likely to occur) – these usually require action at senior management level.
- Moderate (M) Risk (those with less significant consequences, and low probability) – policies must be in place to address these impacts, and monitoring programs must include these.
- Low (L) Risk (those with insignificant consequences and are highly unlikely) – these impacts do not require any specific management actions, but may be part of routine management and monitoring plans.

As far as potential operational impacts are concerned, the dredging of the Rewa River is no different from the dredging of other rivers (e.g. the Nadi River, Sinclair Knight Merz, 2002). The risks are therefore of similar rating, and the control measures are also similar. Table 6 summarizes the outcome of the risk assessment for the Rewa River dredging activities:

Table 6 : Summary of risk assessment for Rewa dredging activities

Activity	**Task**	**Potential Impact**	**Risk rating**	**Control measures**
Mobilisation	1) Moving dredge to L&WRM depot, Nausori	a)Re-suspension of sediment – increased turbidity	L (1c)	Mobilize only in dry season and dry weather
	2) Storing up fuel at depot	a)Fuel spill and seepage into groundwater or river b) Risk of fires	S (3b) H (5c/5b)	a1)Repair any leaking buildings a2) Fix and re-inforce bunding to prevent seepage into groundwater/river b1) Fire drill training for all staff b2) Ensure fire extinguishers working b3) Training for staff on fire response & actions
	3)Ensuring toilet facilities in good working condition	a)Pollution of groundwater and river with sewage	M (3c)	Fix and repair toilet facilities; ensure septic tanks or sewer lines intact
Excavation of river bed	1) Dredging operation	a) Injury to workers b)Re-suspension of	M (2c)	a1) Adequate training for personnel

material		sediment – increased turbidity c) Disturbance of biological communities		b1) dredge only during dry weather c1) Only dredge along deeper centre of river channel to avoid *kai* beds near banks
Transport & Deposition of dredge spoil	1) Assembling and laying of pipeline over water and mudflats (SKM, 2002)	a) Obstruction to navigation b) injury to workers c) Disturbance to ecology at deposition sites	S (2a) M (2c) S (2b)	a1) clear maps & signage on pipeline, information for river users & personnel; lights on pipeline at night. b1) Trained staff to apply First Aid. Emergency procedures for medical needs c1) clear demarcation of deposition sites e.g. avoid tidal channels among *Rhizophora*
	2) Deposition of spoil on river banks	a) Erosion back into river and sedimentation	M (2c)	a1) Ensure deposition above HWM, to be well-surveyed and marked (with help from NLTB and Lands Dept.)
	3) Deposition of spoil among mangroves	a)Disruption to tidal flow within *Rhizophora zone* b) smothering of mangal flora and fauna	S (3b)	a1) Ensure deposit between the landward boundary of *Rhizophora* zone and the HWM, monitor tidal flow over full tidal cycle to endure free flow b1) Deposition to be controlled in clearly marked suitable areas. Positive impact outweighs negative impact – as new habitats are created, with increased biodiversity (coastal trees) in an otherwise single-species zone.
Administrative support	1)Solid & liquid waste management at the L&WRM depot, Nausori	a) Pollution of the river from spills; impacts on health at depot	M (3d)	a1) Ensure a Waste Management policy is in place a2) all personnel to be aware of waste policy a3) Liaison with Nausori Town Council on solid waste removal; and sewage treatment at NSTP. a4) A hazardous waste

				management policy to be in place and adequate training of responsible staff is a must.

The identified control measures (last column) in Table 6 are a summary of the EMMP, which is again discussed in section 11.

6 Socio-economic analysis of the project

The benefits of the proposed dredging to the stakeholders namely the local people of Rewa and Tailevu, the township of Nausori, and the nation as a whole, far outweigh the environmental costs of the project. The environmental impacts are temporary and minimal. [63] In fact there is overwhelming support (> 90 %) for the project from the stakeholders interviewed or consulted. According to findings from the survey of local communities (villagers), the dredging will not affect their daily livelihood (see section 5.6.2), provided the dredging takes place along the centre of the river and not the sides of the river where the women gather *kai*. From previous experience, the local people oppose any dredging in the shallower sides of the river because of enhanced river bank erosion (section 5.6.2). The benefits for the local communities are both short-term (spoil being available for land reclamation, building houses and roads, and for filling in of low areas), and long-term (mitigation against floods). The effects of natural events such as tropical cyclones far outweigh the impacts from dredging, for example, preliminary cost of damage caused by tropical cyclone Mick which hit Viti Levu in mid-December 2009 amounts to more than $38 m[64]. This cost will increase as food rations continue to be delivered to rural and farming communities who suffered damage to crops.

7 Legislative and regulatory considerations

The dredging project, because of its potential adverse impacts on the environment, comes under Part 1 of the classification of Development proposals. These projects need the approval of the EIA administrator or the Director of the Department of Environment, as

[63] Armstrong 1993
[64] DISMAC 2009

stipulated in Schedule 2, section 27 of the Environmental Management Act (EMA) 2005. The EIA process which is being followed in this project is set out in the Environmental Management (EIA Process) Regulations 2007. The project proponent (L&RWM) in consultation with other relevant line ministries had prepared the Terms of Reference (TOR) for the EIA study, which is being followed and implemented by the EIA consultants, the Institute of Applied Sciences of the USP in this case.

The Fisheries Act is currently being reviewed. However, for this EIA, the request for dredging has been an on-going issue at the Rewa Tikina Council meetings and also the Rewa Provincial Council meetings[65]. The fishing rights for the Rewa River belong to the *Marama Roko Tui Dreketi*, Ro Teimumu Kepa and according to the Rewa Provincial Office, the *Marama* supports the dredging for the purpose of flood mitigation[66].

8 Potential Impacts and mitigative measures

The potential impacts of the project on the environment were assessed by the EIA team as a group, following completion of the field work. With information already gathered from the field work, the team was in a better position to discuss, and rank the various potential impacts, by *Magnitude* (amount of change), *Significance* (actual effects), and *Extent* (spatial boundary affected). The impact analysis process followed that of the UNEP EIA Guidelines (1996), and the list of potential impacts were taken from the Asian Development Bank (ADB) *List of potential impacts for port and harbor development*, as the issues of concern were very similar to the dredging project. The resultant matrix is presented below:

Figure 18 : **ASSESSMENT AND RANKING OF POTENTIAL ENVIRONMENTAL IMPACTS OF REWA RIVER DREDGING PROJECT ON RECEIVING ENVIRONMENT**

Rank 1 (lowest) – 5 (highest) for the 3 characteristics:

- **MAGNITUDE – amount of change**
- **SIGNIFICANCE – actual effects**
- **EXTENT – spatial boundary affected**

[65] Interview Roko Veivuke Joji Kalounivalu/Bale Tamata
[66] Roko, Rewa Provincial Office

Potential Impacts *from ADB Guidelines*	**Impacts on Receiving Environment**			
	Magnitude	**Significance**	**Extent**	**Sum of scores**
Encroachment on precious ecology resulting in loss or damage to fisheries & fragile habitats such as coral reefs, mangroves & seagrass beds?	4	1	1	6
Short-term increase in turbidity & sunlight penetration as well as changes in sediment pattern & flows at dredging site?	2	2	Spatial 4	**8**
Removal & disturbance of aquatic flora and fauna at dredging site?	4 (kai fisheries)	2	2	**8**
Deterioration of water quality due to silt run-off & sanitary wastes from worker-based camps, & chemicals used in construction	2	2	2	6
Alteration of bottom surface & modifications to bathymetry, causing changes in tidal bore, river circulation, species diversity and salinity?	1	1	1	3
Changes in sediment pattern & littoral drift that may cause beach erosion of neighboring areas?	4	4	3	**11**
Modification of terrestrial habitat by upland disposal of dredged material, or covering of potential archeological sites with dredge spoil?	4 Positive impact is	2 the creation of new	1 habitats like coastal	**7** forests among mangroves
Short-term air quality degradation due to dredging-related operations?	1	1	1	3
Noise & vibration due to blasting and other civil works?	1	1	1	3
Dislocation or involuntary resettlement of people	n/a	n/a	n/a	n/a
Other social concerns relating to inconveniences in living conditions in the project areas?	3	2	1	6
Social conflict if dredging depletes local fishery resources on which local community depend for subsistence?	2	1	1	4
Poor sanitation and solid waste disposal in construction camps and work sites, & possible transmission of communicable diseases	n/a	n/a	n/a	n/a

From the matrix, it can be seen that a few potential impacts rank high (sum of the three categories) above the others :

- Changes in sediment pattern and littoral drift that may cause beach erosion of neighbouring areas
- Short term increase in turbidity and sunlight penetration
- Removal and disturbance of aquatic fauna and flora at dredging site
- Modification of terrestrial habitat by upland disposal of dredged material or covering of potential archeological sites with dredge spoil.

From our observations and interviews with local communities, none of these are of critical importance, but they warrant addressing in the EMMP. The level of dredging is low and should not cause significant changes in flow regime in the river. The surveys of biological fauna and flora also revealed that there were no species of any conservation significance at the project site. The archeological survey also showed up no sites of historical significance. However, there is an area of historical significance, on the north-east bank of the estuary which should be protected.[67] Any effects on the water quality is temporary and localized.

8.1 Physical environment

Any impacts on the physical environment such as water quality are temporary and localized, and should not affect other habitats, provided the dredging is managed in a sustainable manner e.g. no dredging during rainy or flood conditions.

8.2 Biological and ecological environment

The biological and ecological surveys revealed that there were no species of special significance, so the dredging should not have any major adverse effects on the biological and ecological environment at the project site. However the following concerns were noted:

- There are rich kai beds in the mid and upper stretches of the Rewa river, which could be impacted by the proposed dredging operations. Women who glean kai, do so in the shallow river beds (up to about 1.5m water depth) which are immediately adjacent to the river bank. Dredging this shallow, river bank portions would result in destruction of some rich *kai* beds, and therefore affect the livelihoods of people that depend on it.
- The dredging will have the most potential for impacts as a result of habitat loss and physical disturbances. The proposed site has a relatively moderate ecological value since it is not quite ubiquitous in Fiji. Furthermore, its value is moderate in relation to both species diversity and productivity. None of the species believed to be

[67] Appendix J, Figure 5

present have any special value conferred upon them as a result of rarity or protection status.

- There will be temporary loss of habitat following dredge disposal. Provided the disposal sites are restricted to those shown in Figure 1 – comprising existing dredge disposal sites or adjacent secondary or open habitat areas, then the temporary loss of habitat will have no significant impact on the terrestrial wildlife of the Rewa delta.
- Depositing dredge spoil on the east coast of Laucala Island will disturb and modify an important wader roosting area.
- Elevating the coastline a meter or more with dredge spoil is unlikely to result in any habitat change which will materially affect the site as a wader roost. There will be temporary disturbance which will result in the waders having to leave the area during the operation, but there are other potential roosting sites, including recently dredge deposits upstream which will provide a similar, little-disturbed and open site with good all-round views.

8.3 Socio-cultural environment

The dredging will have positive impacts rather than negative impacts – this is the conclusion reached after extensive consultation and interviews. As much as 98 % support the dredging project, and they see the project is providing opportunities to reclaim land, protect their shorelines, make more land available for farming and building. As for the historically significant sites, there were none among the proposed spoil deposit sites. However, there was one concern:

- should development extend to the opposite bank particularly Northeast

of the river mouth, additional investigation will be required as this area houses several interesting cultural sites.

8.4 Hazard vulnerability and risk assessment

There are some aspects of the dredging project that create hazardous situations and need to be taken care of in the Environmental Management and Monitoring Plans (EMMP). The handling of the equipment, the storage of flammable materials such as fuel are only two

examples. By following the guidelines contained in the EMMP, any hazardous situation can be managed.

9 Alternatives to the proposed project

In considering 'Alternatives to the project', the question asked is : what will be the effects of 'no dredging' works in the Rewa River?

Against the background information on the Rewa River and its high vulnerability to flooding (as a consequence of the large watershed; high and intense annual rainfall; high run-off coefficient, high potential for erosion, increased land clearance in the upper reaches); it can be confidently concluded that dredging of the Rewa River is an urgent and necessary project. This opinion is shared by many stakeholders including the NTC Administrator, Mr Napolioni Masirewa[68].

10 Inter-Agency Coordination and Public/NGO Participation

10.1 Stakeholders

For this EIA, two main categories of stakeholders were consulted : the official and government agencies whose jurisdictions include this area or project; and the non-government and local community members who live within the area, and use the resources in the Rewa River and the dredge spoil deposit sites. The methods of consultation also differed for the two groups.

10.1.1 Government and official stakeholders

The government and official stakeholders were informed about the proposed Rewa River dredging project in the form of official letters written to each department by the EIA consultants' assistant project manager (Bale Tamata). Each letter had attached to it a copy of the map showing proposed dredge channel and dredge spoil deposit sites. The letter also requested and invited the written submissions from the government departments, because of

[68] Interview Nausori Town Council CEO/Bale Tamata, Nov. 2009

their interests in the proposed project. Apart from letters, the relevant departments were also contacted by telephone by the EIA team management.[69] The same government departments were also invited (again by letter and followed up by phone calls) to a national stakeholder meeting, where the local and village community representatives were to be present, and for all stakeholders to hear from L&WRM the technicalities about the proposed Rewa River dredging (section 10.2)

For the government and official agencies, the main stakeholders who were consulted (by letter and telephone) and invited to the national meeting included:

- Nausori Town Council (NTC) – Mr Prakash (CEO) and the Ratu Napolioni Masirewa (Administrator)
- The Native Lands Trust Board (NLTB)
- Native Lands Commission (NLC)
- The Department of Environment (DoE) – Director, Mr Nasome
- The Lands Department - Director
- The Fisheries Department - Director
- The Ministry of Indigenous Affairs – Rewa and Tailevu Provincial Offices
- Bureau of Statistics
- Ministry of Tourism
- Methodist Church – Davuilevu and Principal of Lelean Methodist High School
- Koronivia Research Station – Director
- Rokos of the Rewa and Tailevu Provincial Councils

10.1.1.1 The Nausori Town Council submission

The Nausori Town Council is one of the more important official stakeholders for the project, and a lot of effort was spent getting views and submissions from both the CEO (Mr Prakash) and the Administrator (Mr Napolioni Masirewa), on issues of:

- the Nausori Town Master Plan – its status and contents

[69] Bale Tamata phone calls

- how the proposed dredging project by L&WRM fits in or otherwise, with the Nausori Town Council development plans including the Master Plan.

Apart from letters and phone calls, the EIA consultant visited and interviewed the CEO or Town clerk.[70] The Administrator provided a written submission to the EIA consultants[71] which included a report on the damage caused to the Nausori residents by Cyclone Mick which struck Fiji on Monday, 14 December, 2009. The main points raised by the Administrator included:

- the completion of the preparation of the Nausori Town Council Master Plan is on-hold due to financial problems;
- to mitigate the effects of floods in the Rewa/Nausori area, dredging of the Rewa River is urgent, and needs to be undertaken continuously;
- the Rewa delta is especially vulnerable to flooding because a large portion of the delta area is only a few feet above sea level;
- flooding effects may become more devastating in future as a resultant of climate change and associated extreme weather conditions including more frequent tropical cyclones;
- the river banks within Nausori and around Nausori are particularly vulnerable to erosion, as re-vegetation and planting of trees along the river banks have had limited success;
- the recent cyclone (Mick) caused flooding in Waila and Dilkusha, affecting 135 families; and causing road damage, water blockages, disruption to power supply, and extensive damage to agricultural crops; and during high tide, the Rewa river burst its banks and flooded low lying areas;
- some mitigative measures to address flooding and mitigate the effects of flooding as proposed by the Administrator include:
    - construction of dams and levees within the Rewa river system to ensure efficient and fast flow of water within and out of the river system;

[70] Interview Mr Prakash, NTC Town Clerk/Bale Tamata, Sept. 2009
[71] Appendix L contains written submission from Administrator, NTC

- enforcement of regulations and policies to control and guide construction of buildings and houses, e.g. building on piles (cooperation of the Department of Town and Country Planning needed in this matter)
- a greater collaboration and cooperation among the relevant government and other agencies to address watershed issues, as well as mitigating the effects of the floods (see below);
    - Department of Town & Country Planning in ensuring construction of buildings take into account the high flood risk of the Nausori area (this was done for the Naiyala sub-division, and those that heeded the advice were spared the effects of the floods during cyclone Mick, whereas those that did not build on piles were flooded);
    - Ministry of Agriculture for the development of sound agricultural practices to prevent excessive erosion;
    - Drainage and Irrigation Board to ensure drainage of low lying areas;
    - Department of Forests to monitor logging in the catchment areas within the Rewa Watershed;

The Nausori Town Council is also proposing to develop their own:

- 'Hazard Maps' to identify areas vulnerable to flooding, hurricanes, fire damage etc.; and
- Standard operating procedures (SOPs) for disaster management.

According to the NTC Administrator, there is 'linkage' between the proposed dredging project and the NTC development plans.

10.1.2 Non-government and other stakeholders

The non-government stakeholders who lives are affected on a more personal basis by the dredging project are just as important as the government and official stakeholders. The non-government stakeholders included the local communities living along the Rewa River within the project site, i.e. the villages and settlements; the Methodist Church community in Davuilevu; and the Nausori Airport management (Air Terminal Services). The Rewa and Tailevu Provincial offices were the first point of contact for the villages within the project site. Letters were written to these stakeholders, followed by telephone calls. All of the villages and tikinas were invited to the national stakeholder meeting through the

respective provincial councils (section 10.2). Detailed socio-cultural surveys of the villages and settlements were conducted by the EIA consultants (section 5.6). Personal meetings and interviews were also held wherever possible.[72]

10.2 National Stakeholder Meeting

A national Stakeholder Consultation meeting was held on November 4, 2009 at the Rewa Provincial Office in Lomanikoro, to enable the *Turaga ni Koros* and other Provincial Office staff, to hear first hand from L&WRM management the details of the proposed dredging. The full list of participants is appended.[73] The agenda and minutes of the national consultation meeting are also appended.[74]

11 Management Plans

From a watershed management perspective, it is necessary to treat dredging for flood control as only one of the necessary mitigative measures. It is generally understood that 'whole catchment' and a holistic approach is required to address problems causing and arising out of floods.[75]

11.1 Framework for Watershed Management

A framework for watershed management which looks at watershed management from a holistic perspective is recommended as the way forward. This is shown in Figure 14 below[76] :

[72] NGOs interviewed included Principal, Lelean Mem. School; CEO ATS, Nausori airport; Roko Tui Rewa
[73] Appendix M contains the full list of participants at the national stakeholder meeting, 4 Nov. at Rewa
[74] Appendix N contains the minutes and agenda for the 4th November national stakeholder meeting
[75] JICA Summary Report 1998; Director L&WRM presentation to government 2009
[76] Extracted from JICA Summary Report 1998

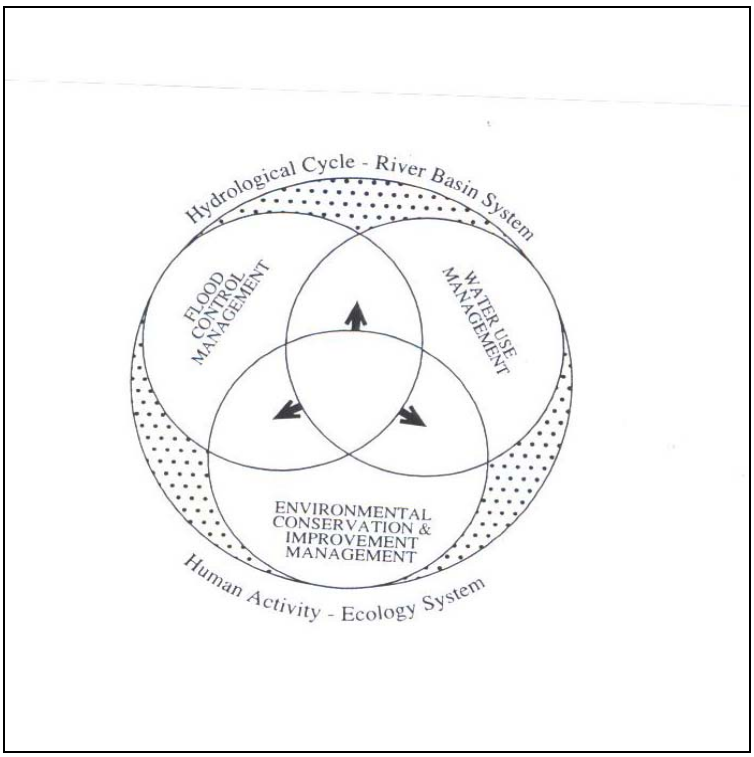


Figure 19: Framework of Watershed Management (from JICA Summary Report 1998).

This framework recognizes the interaction among two main systems: the Hydrological Cycle-River Basin System and the Human Activity-Ecology System. The balance between these two over-arching systems can be achieved by the sustainable management of three overlapping sub-systems: Flood Control Management, Water Use Management and the Environmental Conservation & Improvement Management systems. On the ground, this interaction and collaboration will involve policies to guide land use and construction of buildings, housing; legislation to ensure the policies are implemented; trained and committed technical personnel to implement the policies; and the overall support of the local stakeholders to ensure the success of the framework.

11.2 Management Plans for dredging activities (EMMP)

The EMMP will only focus on the impacts identified during the EIA study as being significant for the Rewa dredging project. The contents of the EMMP are as recommended in the EIA TOR. Not all of the columns are necessary or relevant.

Table 7: Proposed EMMP for Rewa River Dredging

ACTIVITY	TASKS	IMPACT	MITIGATION	WHOSE RESPONSIBILITY	PARAMETERS TO MONITOR	METHODS	EVALUATION PROCESS	INITIATION OF CORRECTIVE MEASURE	REPORTING FORMAT/FREQUENCY
Mobilization	Moving dredge to Nausori depot	a)Obstruction to navigation b)Resuspension of sediment	a1) Clear instructions & warning to other river users b1) Work during dry season and dry weather	i) L&WRM engineers to inform NTC, Rewa & Tailevu Provincial offices	a)Any reports of boating accidents/disgruntled river users b) water quality by observation and documenting	i)Adequate training of personnel ii) networking among stakeholders	i)Review of mobilization phase	i)Senior engineer to order stop-work if conflict observed	One report after review of mobilization phase of project
	Depot fuel storage facilities to be checked	Spillage and seepage into groundwater is possible	Repair any leaking roofs; ensure concrete bunding intact	Depot manager or PWD	i)Fuel storage facility to meet OHS (Fiji) standards	i)One examination before start of usage, and once weekly during operation	Any reports of spillage	Depot manager to report and advise senior engineers at L&WRM	Immediate Reporting on spillage to be forwarded to senior engineer at L&WRM. Implement spill response plans
	Depot toilet and waste facilities to be checked (for increased workforce)	Possible sewage pollution of river	Ensure no leakage in septic systems	Depot management and PWD Water and Sewerage department	Foul smell from overloaded septic tanks, coliform levels in surrounding waters	Checking, observations and testing of water for faecal coliform levels	Record any improvement in health aspects of depot surrounding and waters	Depot manager reporting to senior engineers at L&WRM	Reports on status of facilities at start, during and after the project.

Dredging operation	Operating the dredge	a) Possible injury to workers	a1) Adequate training for personnel a2) First Aid Training to be done	Senior management to ensure training in proper use of machinery and First Aid	Number of accidents to be recorded	Test competence of machine operators. Test knowledge and application of First Aid in staff.	Review operations reports regularly.	Senior and experienced dredge operators to train others, and provide monthly reports on operations to senior engineers	Weekly reviews (oral) but monthly reporting if necessary, depending on senior engineer's judgement.
	Excavation of river bed material	b)Re-suspension of sediment – increased turbidity c) Disturbance of biological communities	b1) dredge only during dry weather c1) Only dredge along deeper centre of river channel to avoid *kai* beds near banks	Dredge operators to be informed about location of *kai* beds and to avoid these. Clear demarcation of kai beds on maps.	Be alert to any complaints from local *kai* gleaners/gatherers.	Review performance of dredge operators wrt following clear maps of dredge channel.	Engineers to carry out weekly checks on work progress, compliance with demarcated dredge channel etc.	Any deviation from designated channel, senior engineer should order stop work for review performance of staff – Retrain if necessary	Weekly staff meetings to update senior L&WRM management on work progress.
Transport and deposition of dredge spoil	Conveying spoil along pipelines	Disrupt use of river by others	Clear guidelines on where and when dredging is on – to be passed on to Rewa and Tailevu Provinc. offices	Senior L&WRM management in collaboration with local community reps. (Provincial offices, NTC).	Observations of affected areas – any smothering. Feedback from local communities who use the river.	Surveyors to conduct physical surveys and observation of sites	Re-visit and assess environmental condition of areas – use EIA consultants	Stop work order by senior engineer and re-view operations if clear breach of recommendations of EIA study –	Weekly reports of operations – to be filed for later use
	Deposition of spoil on river banks	a) Erosion back into river and sedimentation	a1) Ensure deposition above HWM, to be well-surveyed and marked (with	Surveyors to clearly mark out zones for deposition; and document these	Beach profiles by observation – to check for any erosion	Surveyors to conduct physical surveys and observation	Re-visit and assess environmental condition of areas – use EIA	As above	Photography of beach ridges and profiles for checking on erosion.

			help from NLTB and Lands Dept.)			of sites	consultants		
	Deposition of spoil among mangroves	a)Disruption to tidal flow within *Rhizophora zone* b) smothering of mangal flora and faauna	a1) Ensure deposit between the landward boundary of *Rhizophora* zone and the HWM, b1) Deposition to be controlled in clearly marked suitable areas (at least 10m from bank	Surveyors to clearly mark out zones for deposition; and document these. Clear communication of these to dredge operators.	Monitor tidal flow over full tidal cycle to endure free flow among mangroves. Check for blockages and clear these. Observe and monitor growth of *Rhizophora sp*.	Technical env. Consultants can be contracted to survey and document '*before, during and after'* dredging operation.	Review of reports prepared by consultants, by senior L&WRM management or DoE.	If deposition does not comply with demarcated areas, then work can be stopped until EIA recommendations are clearly understood to be implemented.	Weekly surveys by surveyors and reporting to senior engineers L&WRM.
	Deposition on Laucala Island	a)Blockage of natural waterway, on northern part of island b) erosion of eastern bank very likely c) prolonged dredging operation will disrupt roosting area for birds (DW)	a)Clearly map the natural waterway by surveyors; to be clearly communicated to dredge operators b) Deposit above HWM to avoid immediate erosion back into river c) Work to be completed asap, to minimize disruption to birds	Surveyors to clearly mark roosting areas, and areas vulnerable to erosion.	Environmental status of Laucala Island to be monitored by technical expertise – using EIA TOR if need be; are roosting birds being affected?	As above	As above	As above	Weekly reports (oral) on updates. A review of the EIA recommendations relating to the deposit sites to be prepared by consultants, and reviewed by senior management L&WRM. This is to gauge the success or otherwise of the EMMP.

12 Conclusions and Recommendations

The Terms of Reference for the EIA study dictated that the existing environment of the project site be assessed. The existing environment consisted of the biological and ecological environment, the socio-cultural environment, and the hazard vulnerability characteristics of the project site. The biological and ecological studies of both terrestrial and aquatic environments did not find any species or feature that was of special, conservation significance. The flora and fauna found were typical of similar environments found in other parts of Fiji. The presence of rich *kai* beds that were actively harvested by the women was one issue that required particular attention during the actual dredging – that the *kai* beds be avoided. The use of Laucala Island by migratory birds was another important feature that needed attention. To avoid disruption to these birds, it is recommended that the dredging works and deposition of spoil on Laucala Island be conducted expeditiously. The deposition of spoil in the mangroves must be done properly and with carefully mapped out zones, in order to avoid the tidal creeks among the *Rhizophora* zone, as these tidal creeks are vital to the maintenance of life for the mangrove ecosystems. It is therefore recommended that any deposition of spoil be done on the landward boundary of the *Rhizophora* zone, above the high water mark. Provided the EMMP is implemented, the dredging operation should not cause any significant environmental impacts in the project site.

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Roko Tui Rewa, Taniela Tabukarawa – Rewa Provincial Office, Lomanikoro, Rewa
Mr Prakash, Nausiri Town Council CEO and town clerk
Mr Napolioni Masirewa – NTC Administrator
Mr Joji Kalounivalu, Roko Veivuke, Rewa Provincial Council
L&WRM Director – Mr Mudaliar
Mr Jone Waqa – L&WRM, Nausori
Mr Epineri Cavanavanua – L&WRM.

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APPENDIX A – REWA DREDGING EIA

TERMS OF REFERENCE

LAND AND WATER RESOURCE MANAGEMENT DIVISION

TERMS OF REFERENCE FOR REWA RIVER DREDGING ENVIRONMENTAL IMPACT ASSESSMENT STUDY

November 2008

REWA RIVER MAINTENANCE DREDGING PROJECT

Terms of Reference

ENVIRONMENTAL IMPACT ASSESSMENT STUDY

Ministry of Primary Industry
Land and Water Resource Management
Division
Robinson Complex
Grantham Road
Raiwaqa.
P. O. Box 1292
Suva.
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Fax: (679) 3383546

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ACRONYMS AND ABBREVIATIONS

DOE - Department of Environment

EIA - Environmental Impact Assessment

EMA - Environmental Management Act (2005)

L&WRM - Land and Water Resource Management Division, Ministry of Agriculture

MRD - Mineral Resources Department

NGO - Non-Governmental Organisation

NLTB - Native Land Trust Board

NTC - Nausori Town Council

TOR - Terms of Reference

1. INTRODUCTION

This document presents the terms of reference (TOR) for the environmental impact assessment (EIA) of the proposed maintenance dredging works in Rewa River. The TOR has been adopted from local and international environmental assessment guidelines for the planning and execution of coastal and estuarine dredging works and disposal of the dredged materials. The Land and Water Resource Management (L&WRM) Division of the Ministry of Agriculture has prepared the TOR for the consultants to conduct the EIA and report accordingly.

The EIA is technical study, which will examine the potential environmental impacts (both positive and negative) of proposed dredging works in Rewa River and of the Status Quo or null alternative, and will identify appropriate mitigative/optimisation measures. Mitigative and/or optimisation measures are those procedures or protocols that should be employed to ensure that negative effects are minimised and positive effects are maximised during the dredging works.

Additional options identified during the environmental assessment process may also be considered wherever applicable. Following the assessment study, an EIA Report will have to be produced and submitted to L&WRM.

2. BACKGROUND

The L&WRM Division has initiated a project to dredge the Rewa River including the river mouth/foreshore area. L&WRM would prepare the detailed design of the project and the execution of dredging works may be either outsourced or undertaken by the L&WRM. The overall design dredge channel would be approximately 20 km long from the river mouth/foreshore to Nadali area. The channel would extend approximately 1.5 km into the foreshore from the river mouth. The subject area is depicted in **Appendix A.**

3. PURPOSE OF PROJECT.

The purpose of the Rewa River dredging project is to maintain a clear passage through the river channel/estuary to the sea in order to mitigate the risk of flooding in surrounding areas. The project is part of L&WRM's ongoing flood mitigation programs under which various other major rivers namely Navua, Ba, Qawa, Labasa and Wailevu (including Rewa) have been dredged in the past years.

4. EIA STUDY

The EIA study should incorporate the effects of the proposed action on the environment. In this regard, the environment includes all relevant aspects of the natural and human resources. The EIA must evaluate the expected effects on human health, the natural environment and on real estate and infrastructures. The study therefore requires a multi-disciplinary approach in order to assess the project for its environmental feasibility. Furthermore, the EIA study must recognise the legislative requirements of the *"Environment Management Act (2005)"* and the EIA reporting should adhere to the standards defined in the Act and its regulations.

The key focus of the EIA study should be as follows:

- Gather and collate existing information
- Undertake comprehensive sampling and surveying of existing conditions
- Identify and assess impacts of the proposed dredging works
- Assess the proposed dredge spoil disposal sites
- Assess and evaluate all impacts (positive and negative) of the project
- Define potential impact mitigation measures and recommend feasible measures at impact levels where these should be implemented
- Design an adequate environmental management plan for monitoring the actual impacts of the dredging project and assessing the need to adopt necessary mitigation measures.

5. SCOPE OF WORK

The scope of factors to be taken into consideration in the EIA Report is described in this section. Should additional relevant issues, concerns, or potentially significant environmental effects (positive and negative) be identified through discussion with the regulatory agencies, other stakeholder consultation or in any other recognised way, these factors must be incorporated into the assessment of the potential environmental impacts of the project. The assessment will include consideration of, but should not be limited to guidelines in this section.

Potential project-related environmental effects (positive and negative), resulting from dredging and the operation of dredging works, (including potential environmental effects resulting from accidents or malfunctions) should be included in the assessment. These environmental effects should be characterized (i.e., magnitude, frequency, duration, geographic extent, reversibility, ecological and socio-cultural and economic aspect) and their significance should be determined based on residual environmental effects. The environmental effects of the project should be compared to the Status Quo or "no action" alternative.

The following core tasks must be performed for the preparation of the EIA report:

5.1 Executive Summary

A concise executive summary of the EIA should be provided in a non-technical language with the findings and recommendations. The evaluation of the environmental assessment should examine both the short-term and long-term effects as well as the sustainability of the altered environment.

5.2 Introduction

Identify the development project to be assessed and explain the executing arrangements for the EIA. Include the following aspects:

- Describe the rationale for the development and its objectives.
- Describe the context for the proposed dredging works in relation to plans for development of the Rewa Watershed, Nausori Township and in particular Rewa delta. Information on this aspect can be obtained from organisations such as L&WRM and NTC.

- Briefly describe the major components of the proposed project, the implementing agents, a brief history of the project and its current status.
- Specify the boundaries of the study area for the assessment as well as any adjacent or remote areas that should be considered with respect to the project (e.g. dredged material disposal sites).
- State the historical background in terms of flooding within the project area highlighting the losses and damages that have incurred.
- Tabulation of personnel involved in the preparation of the EIA, their expertise and their roles in the EIA process (this portion can be detailed in the appendices).

5.3 Description of the Proposed Project

Provide a full description of all relevant parts of the project, using maps at appropriate scales where necessary. This is to include description on:

- Quality and volume of sediments to be dredged in each area;
- Type of dredging equipment to be used and the manner of deployment including handling, transportation, and disposal of dredged material, sediment containment, settling and turbidity control measures;
- Alternative dredging methods;
- Project schedule;
- Life span of project;
- Justification of project in terms of cost/benefit analysis.

This section should give a detailed statement of all the critical activities, which will be involved in the proposed project including start-up and commissioning through to operational phase of the facilities.

5.4 Description of the Existing Environment

Description of the environmental setting is a record of conditions prior to implementation of the proposed project. It is primarily a benchmark against which to measure environmental changes and to assess impacts. Baseline data should be assembled, evaluated and presented based on the relevant environmental characteristics of the study area (and disposal sites), including the following:

5.4.1 Biological and Ecological Environment

The description should include but not be limited to the following aspects:

- Terrestrial and marine/aquatic flora and fauna;
- Rare or endangered species;
- Wetlands, coral reefs and other sensitive habitats;
- Flora/fauna species of commercial importance and species with the potential to become nuisances.

5.4.2 *Socio-Cultural Environment*

The description should include but not be limited to the following aspects:

- Navigational/boating activities and use of the river;
- Population and land use;
- Planned development activities;
- Employment, recreation and public health;
- Archaeological and historical sites (especially in relation to dredge dump sites);
- Community perception of the development and vulnerability of occupants.

5.4.3 *Hazard Vulnerability*

The description should include but not be limited to the following aspects:

- Vulnerability of area to natural disasters such as flooding, hurricanes, storm surge, and earthquakes. Characterise the extent and quality of the available data, indicating significant information deficiencies and any uncertainties associated with the prediction of impacts. A frequency analysis of the aforementioned natural disasters should also be included especially rainfall and the corresponding flooding.

5.5 Legislative and Regulatory Considerations

This section of the report should describe the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project. Relevant authority jurisdictions that will specifically apply to the project should also be identified.

5.6 Potential Impacts of the Proposed Project

Impact identification should be seen as a critical step in the EIA. The process usually consists of two stages. First, an exhaustive list of all impacts is drawn up. Then the impacts are selected, based on magnitude, significance, extent and spatial sensitivity, for further study.

Magnitude refers to the amount of change to be created by the impact. For some impacts, magnitude is calculated by computer modelling. Significance refers to the actual effects. It looks beyond magnitude. Extent refers to the area to be affected. Quantification of impacts is a technical aspect of an EIA. For some impacts, the theoretical basis for computing the magnitude does not exist. Such impacts may have to be addressed in a qualitative way.

Impacts related to dredging, spoil disposal and possible land filling should be identified. Distinguish between significant impacts that are positive and negative, direct and indirect, and short and long term. Identify impacts that are

cumulative, unavoidable or irreversible. Identify any information gaps and evaluate their importance for decision-making.

5.6.1 *Biological and Ecological Environment*

The effects of the project (dredging and spoil disposal) on existing river/coastal ecosystems and resources should be assessed. Changes in water quality, flow, sediment drifts, flooding and sedimentation may affect the coral reef system, coastal sea floor, river/estuaries, mangroves and other ecosystems which need to be identified and assessed. The impact assessment should include but not be limited to the following aspects:

- Change in marine ecosystems;
- Effects on marine resources such as reproduction and migration.

5.6.2 *Socio-Cultural Environment*

The interaction between the human environment and the ecological environment must be evaluated from which the impact of the project should be assessed. The impact assessment should include but not be limited to the following aspects:

- Maritime, boating/navigation, road traffic, fishermen, and rights/operations of any other stakeholders;
- Future development and the tourism sector;
- National heritage, archaeological/historical and burial sites;

5.6.3 *Hazard Vulnerability and Risk Assessment*

The effects of the project (dredging and spoil disposal) on vulnerability of the area to flooding, hurricanes, storm surge, and earthquakes should be assessed. Furthermore, the risk associated with the operation of the project should be assessed, preferably with use of appropriate matrices.

5.7 Socio-Economic Analysis of Project

The socio-economic characteristics of the area in the project proximity should be identified. The impacts of the proposed project on the socio-economic environment should then be analysed.

The analysis should include the use of land, the main economic activities e.g. tourism, agriculture and fisheries, the social status of communities, employment levels and the existence of archaeological or historical sites. Impacts should be categorised as positive and negative. Examples of negative impacts include conflicts between existing businesses and new project workers, pollutants discharged that have potentially adverse effects on water bodies of economic importance. Positive impacts include creation of jobs, decrease in flooding risks, public health and safety, upgrading of physical infrastructure, and training of workers.

5.8 Mitigation and Abatement Measures

It is recognised that to eliminate an adverse environmental impact altogether is seldom possible, but it is often feasible to reduce its intensity. This reduction is referred to as mitigation. For each potential adverse impact identified, the plan for its mitigation at each stage of the project should be documented and its cost assessed. It is essential that these costs of mitigation be adequately assessed and be fully documented. This is very important in the selection of the preferred alternatives. In the case of beneficial impacts it should be demonstrated how these can be maximised.

Identify possible measures to prevent or reduce significant negative impacts to acceptable levels with particular attention paid to dredge spoil disposal and dispersal/sedimentation control, as well as measures to minimise disruption to existing navigational operations of the river. Provide cost estimates of the mitigation measures and the equipments and resources required to implement those measures. Propose mechanisms for investigating claims for compensation put forward by affected stakeholders.

Mitigation measures recommended should be practical and readily implemental. These should be discussed with the proponent prior to finalisation of the EIA report.
The following factors should be taken into consideration:

- Wide consultation and public involvement
- Set tolerance limits for impacts
- Effective management of project
- Implementation at compensation cost

5.9 Analysis of alternatives to the Proposed Project

Just a brief on the alternative of a "non-dredging works" scenario and compare it to the benefits of this on-going activity.

5.10 Inter-Agency Coordination and Public/NGO Participation

In terms of community groups, a social study should be carried out to identify issues or problems, which the resource owners and/or residents in or around the study area may have regards to the project proposal. This should include but not be limited to:

- Meeting with stakeholders such as provincial councils/district advisory councils together with relevant Government agencies. The minutes of such meetings must be formalised and appended to the EIA report.
- Household interviews in the local communities should be conducted. The focus should be on local communities and villages who utilise respective fishing areas. The questionnaires and relevant responses should be appended to the EIA report.

Public Notice Advertisements should be placed in any two local newspapers for the purpose of inviting comments and/or concerns from the public regarding the project. All responses should be appended to the report.

5.11 Development of Environment Monitoring and Management Plan

This section should focus on environmental monitoring, management and training. Environment management during the implementation of the project at both initialisation and operational phases should be documented. The training programme for employees of the facility should be generally outlined. This section should identify any institutional needs for implementing the recommendations of the EIA.

A brief Environmental Management Plan should be appended to the EIA report to ensure compliance of works to mitigation measures identified
The monitoring plan/programme should clearly state the:

- Institutional arrangements for carrying out the work
- Parameters to be monitored
- Methods to be employed
- Standards or guidelines to be used
- Evaluation of the results
- Schedule and duration of monitoring
- Initiation of action necessary to limit adverse impacts disclosed by monitoring
- Format and frequency of reporting

5.12 References

Any publication or papers, both published and unpublished that were used as reference should be adequately listed.

5.13 Appendices

All required technical sampling protocols or sample data sheets should be included in the appendices. Any technical studies associated with the project should also be included.

APPENDIX B : The Rewa delta – 5 principal lobes (with associated flood channels) from Howworth et al., 1993

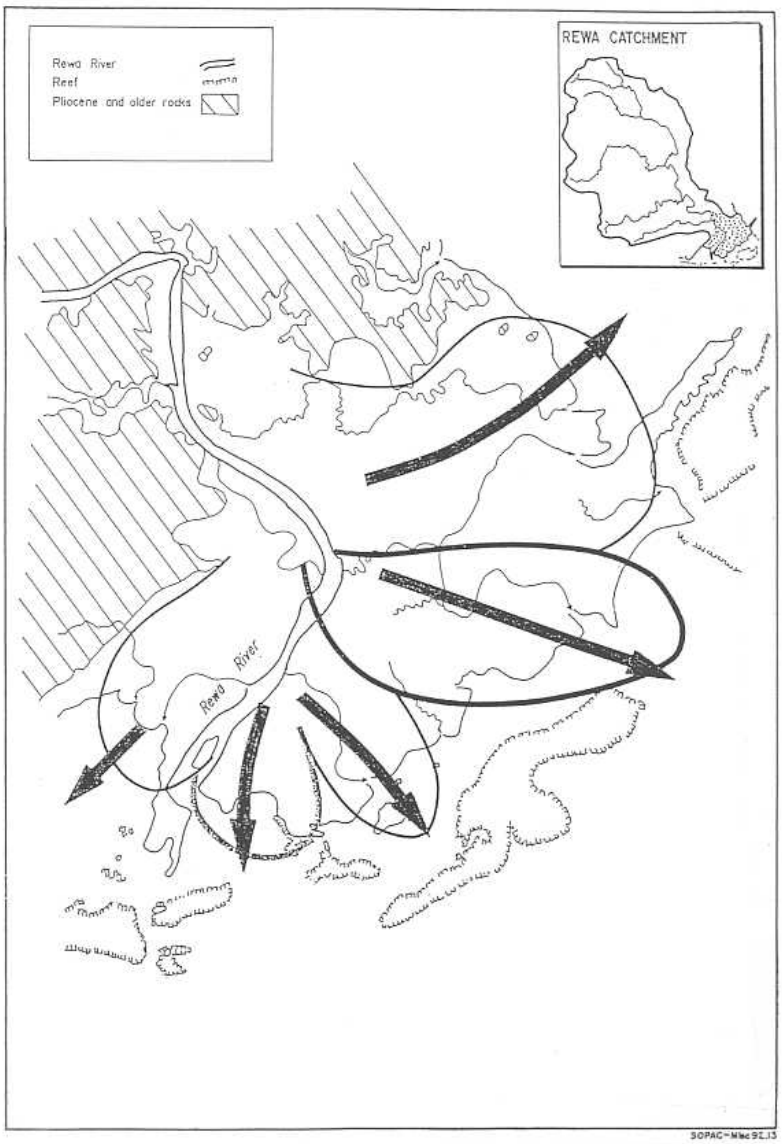


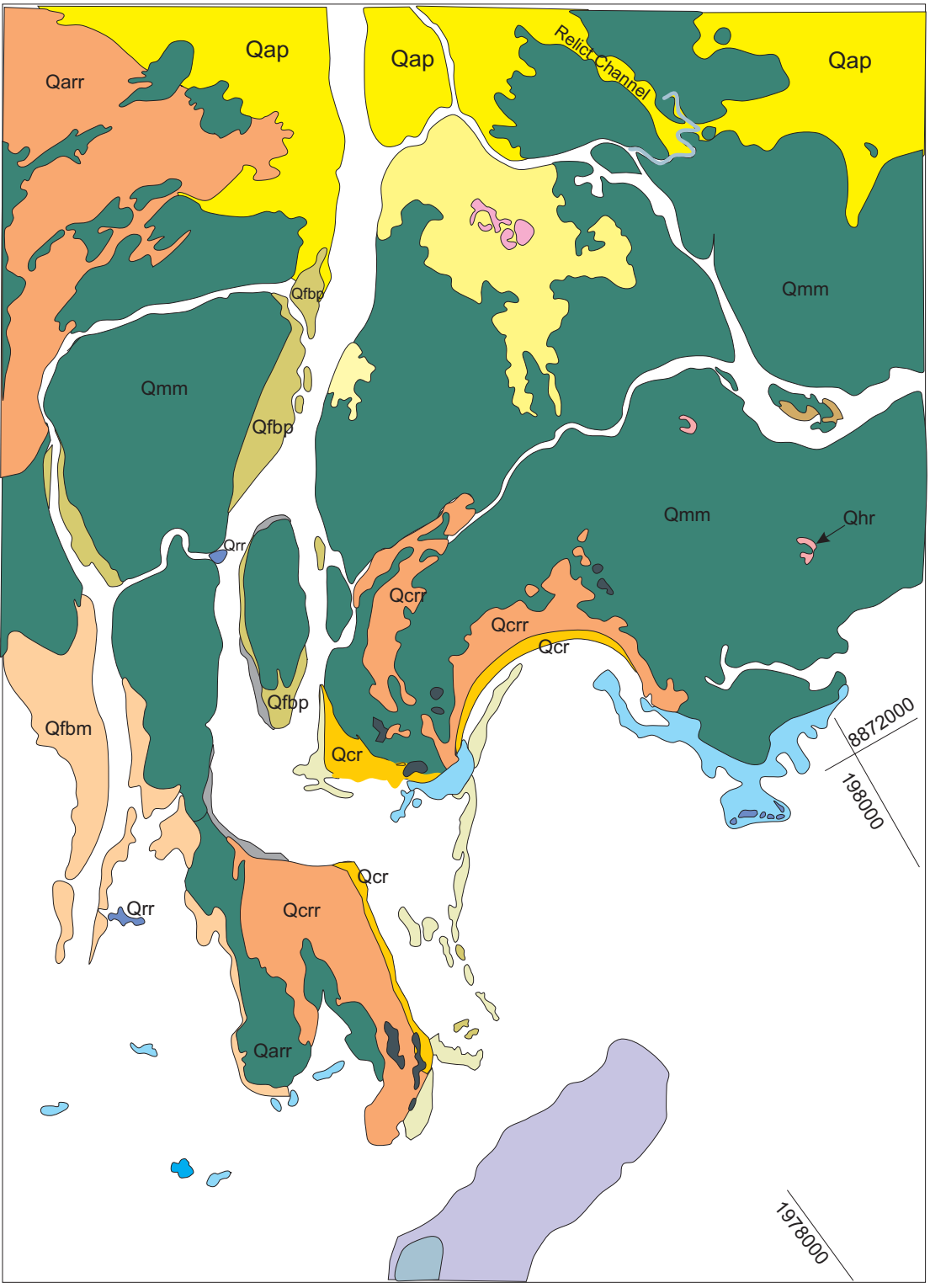
Figure 7. Map of the Rewa delta showing the principal lobes which constructed the present delta over the past 6000 years. Arrows indicate the main direction of discharge as each lobe was active. Note the position of present major channel and old channels, many of which are abandoned in normal flow conditions.

APPENDIX C – REWA RIVER DREDGING ENGINEERING DRAWINGS

- **C1:** Layout Plan of Design Dredge Channel – C/DR/RW 0426
- **C2**: Rewa River Main Cross Section - C/DR/RW 0427

APPENDIX D – REWA RIVER DELTA (Morphostratigraphic units, by Armstrong, 1993).

REWA DELTA and Estuary



Legend

River-dominated units

Qap/Qaf	Floodplain deposit/ crevasse splay fan
Qm	Mangroves
Qfbp	Point bar
Qfbm	Distributary mouth bar

Anthropogenic units

Qhr	Ring ditch fortification
Qhd	Dredge spoils

Wave-dominated units

Qcrr	Beach ridge (relict)
Qcr	Beach ridge (active)
Qab	Spit/ Sand bar
Qc	Back barrier swamp

Reef units

Qrr	Relict reef
Qrc	Sand cay
Qrp	Reef platform
Qrs	Submerged reef

0 1 2 km

Approx. Scale: 1 : 40 000

Rewa Estuary
Morphostratigraphic units

Date: 9/11/93

Drawn by: Jared Armstrong
Spheroid: WGS 72
Map Projection: Fiji Metric Grid

APPENDIX E – WATER QUALITY RESULTS

Appendix E : WATER QUALITY RESULTS

E1: October 14, morning, rising tide (raining for a few days prior to sampling)

WATER QUALITY AT 10 STATIONS ALONG REWA RIVER FOR REWA DREDGING EIA STUDY
Date: 14 October 2009 Weather: fine, partly cloudy.
Winds: calm with slight S.E. Trades in afterno Tides: 0851 - 0.4m; 1512 - 1.7m
Samples of water and sediment were collected from each of the ten sites.

GPS Easting	GPS Northing	STATION Name	SITE LOCATION	TIME AT SITE hrs	TEMP. °C	pH	Turbidity NTU	Diss.O_2 mg/L	Conductivity mS/cm	TDS g/L	Salinity ppt
661498	7991068	RW1	Nr Laucala Is.	1031	25.89	6.80	19.6	8.80	19.4	12.1	10.3
662421	7991108	RW2	Mid-Estuary Rewa	1044	25.73	8.01	13.1	7.46	27.3	17	15.6
663003	7991208	RW3	Towards Nukui Pt.	1057	25.67	8.18	16.1	5.77	30.5	18.6	17.8
661648	7995718	RW4	Spoil site-Laucala Is	1119	25.83	8.18	13.7	5.77	4.76	3	1.8
661372	7992771	RW5	Updrift Selo Is	1130	26.15	8.10	21.0	5.72	18	11.1	9.3
664245	7997779	RW6	Mth Nailili Crk	1149	26.16	8.19	34.6	6.93	1.45	0.921	0.4
665691	7999717	RW7	Nr Burebsg Villg	1202	25.37	8.09	9.3	6.75	0.145	0.091	0
665895	8001372	RW8	Wainibokasi	1211	25.60	7.94	5.8	6.47	0.09	0.059	0
664600	8003553	RW9	Old site near airport	1224	25.26	7.94	3.5	7.08	0.088	0.057	0
662083	8005155	RW10	Inlet to Toga Creek	1239	24.98	7.92	10.0	6.29	0.083	0.054	0
RANGE					**24.98 - 26.16**	**6.80 - 8.19**	**3.5 - 34.6**	**5.72 - 8.8**	**0.083 - 30.5**	**0.054 - 18.6**	**0 - 17.8**
Guidelines					**22 - 29 (Fiji)**	**5 - 9 ***	**6 - 50 ****	**> 5**	**0.03-0.35 *****	**1 ***	**varies**

Notes: * ANZECC 2000

** ANZECC 2000 range for estuaries - rivers; 0.5 NTU for marine

*** ANZECC 2000 range for fresh water (0.03) to upland rivers (0.35); for marine, >1 mS/cm

E2: Water Quality Laboratory Results – 14 October 2009

RESULTS OF LABORATORY TESTS ON WATER SAMPLES COLLECTED ON 14 OCTOBER 2009

GPS Easting	GPS Northing	STATION ID Name	SITE LOCATION	TIME AT SITE hrs	BOD mg/L	TSS mg/L	Lead (Pb) u/L	Tot.coliform c/100mL	F. coliform c/100mL
661498	7991068	RW1	Nr Laucala Is.	1031	<18	7	<2.5	967	10
662421	7991108	RW2	Mid-Estuary Rewa	1044	<18	2	<2.5	214	27
663003	7991208	RW3	Towards Nukui Pt.	1057	<18	7	<2.5	438	31
661648	7995718	RW4	Spoil site-Laucala Is	1119	<18	4	<2.5	TNTC	TNTC
661372	7992771	RW5	Updrift Selo Is	1130	<18	10	<2.5	TNTC	<1
664245	7997779	RW6	Mth Nailili Crk	1149	<18	15	<2.5	TNTC	176
665691	7999717	RW7	Nr Burebsg Villg	1202	<18	1	<2.5	TNTC	8
665895	8001372	RW8	Wainibokasi	1211	<18	<1	<2.5	TNTC	31
664600	8003553	RW9	Old site near airport	1224	<18	3	<2.5	TNTC	123
662083	8005155	RW10	Inlet to Toga Creek	1239	NR	NR	NR	TNTC	446
RANGE						**<1 - 15**		**214 - TNTC**	**<1 - TNTC**
Guidelines					**< 15 ***		**< 50 ***		**< 150 ****

Notes: **NR - No Results due to breakage of sample botlle**

* ANZECC 2000

** ANZECC 2000, for bathing waters; < 1,000 for 2^{o} contact waters

E3: Water Quality onsite, 14 October afternoon

WATER QUALITY AT 7 STATIONS ALONG REWA RIVER FOR REWA DREDGING EIA STUDY -Sampled at mid-tide (rising)
Date: 14 October 2009 **Weather: fine, partly cloudy.**
Winds: calm with slight S.E. Trades in afternoon **Tides: 0851 - 0.4m; 1512 - 1.7m**
NOTE: Sations RW1 - RW 3 could not be visited due to choppy, rough seas and strong S.E. Trades in the afternoon

GPS Easting	GPS Northing	STATION ID Name	SITE LOCATION	TIME AT SITE hrs	TEMP. °C	pH	Turbidity NTU	Diss.O_2 mg/L	Conductivity mS/cm	TDS g/L	Salinity ppt
661498	7991068	RW1	Nr Laucala Is.	ROUGH SEAS PREVENTED TESTING AT SITES RW1, RW2 AND RW3							
662421	7991108	RW2	Mid-Estuary Rewa								
663003	7991208	RW3	Towards Nukui Pt.								
661648	7995718	RW4	Spoil site-Laucala Is	1348	26.24	8.11	31.2	5.72	12.4	7.97	6.6
661372	7992771	RW5	Updrift Selo Is	1341	24.63	8.04	21.3	6.42	33.7	20.3	19.7
664245	7997779	RW6	Mth Nailililli Crk	1330	26.16	7.62	17.2	6.69	6.84	4.35	2.9
665691	7999717	RW7	Nr Burebsg Villg	1326	25.73	7.66	19.9	5.84	1.18	0.752	0.3
665895	8001372	RW8	Wainibokasi	1323	25.64	7.82	11.2	5.74	0.145	0.095	0
664600	8003553	RW9	Old site near airport	1318	25.23	7.74	5.9	6.39	0.087	0.056	0
662083	8005155	RW10	Inlet to Toga Creek	1313	25.34	7.74	9.4	6.36	0.083	0.054	0
RANGE					**24.63 - 26.24**	**7.62 - 8.11**	**5.9 - 31.2**	**5.72 - 6.69**	**0.083 - 33.7**	**0.054 - 20.3**	**0 - 19.7**
Guidelines					**22 - 29 (Fiji)**	**5 - 9 ***	**6 - 50 ****	**> 5**	**0.03-0.35 *****	**1 ***	**varies**

Notes: * ANZECC 2000

** ANZECC 2000 range for estuaries - rivers; 0.5 NTU for marine

*** ANZECC 2000 range for fresh water (0.03) to upland rivers (0.35); for marine, >1 mS/cm

E4: Water Quality on-site, 16 October 2009

WATER QUALITY AT 10 STATIONS ALONG REWA RIVER FOR REWA DREDGING EIA STUDY
Date: 16 October 2009 **Weather: fine, partly cloudy.**
Winds: calm with slight S.E. Trades in afterno **Tides: 0424 - 1.8m; 1035 - 0.4m; 1652- 1.9m**
No samples collected on this day.

GPS	GPS	STATION ID	SITE	TIME AT	TEMP.	pH	Turbidity	Diss.O_2	Conductivity	TDS	Salinity
Easting	Northing	Name	LOCATION	SITE hrs	^oC		NTU	mg/L	mS/cm	g/L	ppt
661469	7990716	RW1	Nr Laucala Is.	1110	25.99	8.07	8.3	7.57	30.2	8.4	17.5
663480	7991451	RW2	Mid-Estuary Rewa	1129	26.05	8.19	10.2	7.43	29.3	18.1	17.1
664847	7991261	RW3	Towards Nukui Pt.	1132	25.87	8.21	8.9	7.5	37.6	23.5	23
661394	7995745	RW4	Spoil site-Laucala Is	1334	25.8	7.91	18.3	9.94	4.51	2.87	1.7
661419	7992846	RW5	Updrift Selo Is	1352	25.95	8.05	19.9	8.1	11	6.79	5.1
664115	7997846	RW6	Mth Nailili Crk	1346	25.67	7.83	23.3	6.41	0.238	0.155	0
664770	7999150	RW7	Nr Burebsg Villg	1355	25.64	7.9	14.6	5.7	0.125	0.081	0
665810	8001005	RW8	Wainibokasi	1358	25.71	7.81	10.1	5.5	0.092	0.6	0
664496	8003614	RW9	Old site near airport	1407	25.66	7.76	4.7	5.94	6.08	6.052	0
663140	8004549	RW10	Inlet to Toga Creek	1414	25.67	7.7	3.3	5.37	0.08	0.052	0
RANGE					**25.64 - 26.05**	**7.7 - 8.21**	**3.3 - 23.3**	**5.37 - 9.94**	**0.08 - 37.6**	**0.052 - 23.5**	**0 - 23.0**
Guidelines					**22 - 29 (Fiji)**	**5 - 9 ***	**6 - 50 ****	**> 5**	**0.03-0.35 *****	**1 ***	**varies**

Notes: * ANZECC 2000

** ANZECC 2000 range for estuaries - rivers; 0.5 NTU for marine

*** ANZECC 2000 range for fresh water (0.03) to upland rivers (0.35); for marine, >1 mS/cm

E5: Water Quality on-site, 29 October 2009

WATER QUALITY AT 10 STATIONS ALONG REWA RIVER FOR REWA DREDGING EIA STUDY

Date: 29 October 2009 **Weather sunny with few clouds**

Winds: calm wind **Tides: 0424 - 1.8m; 1035 - 0.4m; 1652- 1.9m**

10 samples were collected from all the sites.

GPS Easting	GPS Northing	STATION I Name	SITE LOCATION	TIME AT SITE hrs	TEMP. °C	pH	Turbidity NTU	Diss.O_2 mg/L	Cond. mS/cm	TDS g/L	Salinity ppt	Clarity-secch disk m
661469	7990716	RW1	Nr Laucala Is.	1002	26	6.10	1.6	8.14	38.20	23.200	23.30	3.5
663480	7991451	RW2	Mid-Estuary Rewa	1014	26.3	8.21	2.8	8.48	32.60	7.800	20.90	3.5
664847	7991261	RW3	Towards Nukui Pt.	1027	26.42	8.34	2.2	6.77	32.90	20.100	19.50	3.0
661394	7995745	RW4	Spoil site-Laucala Is	1053	26.23	8.13	5.8	7.01	6.76	6.450	2.90	2.0
661419	7992846	RW5	Updrift Selo Is	1040	26.52	8.28	5.9	6.37	16.10	9.860	7.90	2.0
664115	7997846	RW6	Mth Nailili Crk	1118	26.05	8.01	5.1	6.58	4.59	2.970	1.90	2.0
664770	7999150	RW7	Nr Burebsg Villg	1131	26.32	8.05	2.8	5.43	2.12	1.360	0.70	1.5
665810	8001005	RW8	Wainibokasi	1146	26.2	8.02	2.2	6.04	0.70	0.447	0.20	2.5
664496	8003614	RW9	Old site near airport	1204	26.4	7.88	1.8	6.19	0.09	0.058	0.00	3.5
663140	8004549	RW10	Inlet to Toga Creek	1239	26.05	7.92	2.7	5.25	0.09	0.058	0.00	2.5
RANGE					**26 - 26.52**	**6.1 - 8.34**	**1.6 - 5.9**	**5.25-8.48**	**0.09-38.2**	**0.45-23.2**	**0 - 23.0**	**1.5 - 3.5m**
Guidelines					**22 - 29 (Fiji)**	**5 - 9 ***	**6 - 50 ****	**> 5**	**0.03-0.35 *****	**1 ***	**varies**	

Notes: * ANZECC 2000

** ANZECC 2000 range for estuaries - rivers; 0.5 NTU for marine

*** ANZECC 2000 range for fresh water (0.03) to upland rivers (0.35); for marine, >1 mS/cm

E6: Water Quality Laboratory Results, Samples collected on 29 October 2009

RESULTS OF LABORATORY TESTS ON WATER SAMPLES COLLECTED ON 29 OCTOBER 2009

GPS Easting	GPS Northing	STATION I Name	SITE LOCATION	TIME AT SITE hrs	BOD mg/L	TSS mg/L	Lead (Pb) u/L	Tot.colif. c/100mL	F.coliform c/100mL	E.coli
661498	7991068	RW1	Nr Laucala Is.		<18	9	<2.5	<1	ND	ND
662421	7991108	RW2	Mid-Estuary Rewa		<18	20	<2.5	<1	ND	ND
663003	7991208	RW3	Towards Nukui Pt.		<18	8	<2.5	<1	ND	ND
661648	7995718	RW4	Spoil site-Laucala Is		<18	2	<2.5	<1	ND	ND
661372	7992771	RW5	Updrift Selo Is		<18	11	<2.5	<1	ND	ND
664245	7997779	RW6	Mth Nailili Crk		<18	5	<2.5	3.1 x 103	617	<1
665691	7999717	RW7	Nr Burebsg Villg		<18	7	<2.5	440	<1	<1
665895	8001372	RW8	Wainibokasi		<18	7	<2.5	750	<1	<1
664600	8003553	RW9	Old site near airport		<18	4	<2.5	315	79	79
662083	8005155	RW10	Inlet to Toga Creek		<18	1	<2.5	<1	ND	ND
Guidelines					**< 15 ***		**< 50 ***		**< 150 ******	

Notes: **ND - not determined as not necessary**

* ANZECC 2000

** ANZECC 2000, for bathing waters; < 1,000 for 2^{o} contact waters

APPENDIX F – SEDIMENT QUALITY RESULTS

APPENDIX F : SEDIMENT QUALITY RESULTS (2 pages)

F1: Results for sediments collected 14 October 2009

ANALYTICAL RESULT(S)

(results apply to samples as received)

Customer : Bale Tamata Sample Type : sediment

Report No : RS2009/975 Date received : 14/10/09

Sample delivered by Customer Date reported : 21/12/09

Customer I.D. Lab No.	RW 1 2009/3263	RW 2 2009/3264	RW 3 2009/3265	RW 4 2009/3266	RW 5 2009/3267	RW 6 2009/3268	RW 7 2009/3269	RW 8 2009/3270	RW 9 2009/3271	RS 10 2009/3272	Method Ref. No.	Intern. Guidelines
pH (Units)	8.2	8.0	7.4	7.7	6.6	6.4	7.1	6.7	6.3	5.8	SPACENET	5 - 9
Total Kjeldahl Nitrogen(g/100g)	<0.01	0.10	0.13	<0.1	<0.1	0.17	<0.1	<0.1	<0.1	0.14		Varies with particle size etc.
Total Phosphorus (mg/kg)	10.8	26.9	29.8	6.12	4.71	16.6	4.42	4.81	7.31	12.0		Varies with particle size etc.
Lead (mg/kg)	2.63	3.99	4.91	2.92	4.10	5.91	6.34	6.99	6.69	6.93		< 50 (CSIRO, 2005)

Note 1 : SPACNET = Recommended Methods for Soil, Plant and Water Analysis

F2: Results for sediments collected on 29 October 2009

ANALYTICAL RESULT(S)
(results apply to samples as received)

Customer : Bale Tamata Sample Type : sediment

Report No : RS2009/9765 Date received : 29/10/09

Sample delivered by Customer Date reported : 21/12/09

Customer I.D. Lab No.	RW 1 2009/3579	RW 2 2009/3580	RW 3 2009/3581	RW 4 2009/3582	RW 5 2009/3583	RW 6 2009/3584	RW 7 2009/3585	RW 8 2009/3586	RW 9 2009/3587	RW 10 2009/3588	Method Ref. No.	Intern. Guidelines
pH (Units)	9.0	8.2	8.0	7.0	6.5	7.5	6.9	6.4	6.7	6.2	SPACENET	5 - 9
Total Kjeldahl Nitrogen (g/100g)	0.10	<0.1	<0.1	<0.1	<0.1	0.23	<0.1	<0.1	0.12	0.13		Varies with particle size etc.
Total Phosphorus (mg/kg)	17.6	13.7	24.5	8.52	3.90	22.8	2.89	3.52	12.3	11.2		Varies with particle size etc.
Lead Pb (mg/kg)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		< 50 (CSIRO, 2005)

Note 1 : SPACNET = South Pacific Agricultural Chemistry Laboratory Network

APPENDIX G

Terrestrial vegetation and flora survey

by Marika Tuiwawa

Institute of Applied Sciences
USP

Botanical Environmental Impact Survey for the Dredging of the Rewa River and Estuary.

Executive Summary

The two Principle Vegetation Types assessed during the survey were the coastal or Littoral Forest and the Mangrove Forest.

Seven Habitat or Forest Types were found and assessed within these principle vegetation types and these included the Rhizophora-Bruguiera Forest Type, the Rhizophora-Bruguiera and Mixed Forest Type, the *Xylocarpus* Forest Type, the *Inocarpus fagifer* Forest Type, the Littoral or Coastal Forest Type, the Coastal Strand Forest Type, and the Brackish-water Swamp Forest Type.

The most common forest type was the Rhizophora-Bruguiera and Mixed Forest Type. None of the forest type observed were unique to Fiji as these could be found elsewhere in similar systems on Viti Levu and Vanua Levu and other larger islands in Fiji.

A lot of human induced activities occurred in all these forest types and these ranged from harvesting of fisheries resources (crabs, mud lobsters, fish and prawns) to gardening, logging activities and even human habitation.

Dumping of the dredged materials along the river embankment is commendable as it creates new habitats for organism found in the study site. It also stabilize sections of the river embankment where grazing and gardening can take place.

The greatest threat to these forest system is the over exploitation of resources in the area by the locals and the erosion of the river bank throughout the entire study area.

A total of 142 taxa were recorded during the survey. 51% of the species recorded were native species out of which six species were endemic to Fiji. The only species of conservation concerns is the mangrove orchid *Gramatophyllum elegans* which is a localized endemic restricted exclusively to the mangrove forest from the Rewa to the Navua River delta. This species is cultivated and sold widely in the Nausori, Suva and Navua markets thus its conservation status remains intact. All other plant taxa are common and occur in abundance elsewhere in Fiji.

Introduction

River estuaries especially those associated with mangroves are amongst the most productive ecosystems (Watling 1985). They provide breeding sites for hundreds of marine species 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. For people who live along the river mouth and embankment economic livelihood is obtained from both the terrestrial and aquatic resources found in this ecosystem.

The survey was carried in the months of August and September 2009 and 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 in the proposed dumpsites. 3). To compile baseline checklists of the flora for the area.

Methods

Two forms of surveys were deployed for the area assessed.

Quantitative survey was deployed in the study area where vegetation of ecological and national importance was located. This were in areas along the river system that had good stands of native vegetation like mangrove forest, littoral strand and or coastal forest (Mueller-Dombois *et. al* 1998) and back-of the mangrove vegetation or forest. Within a study (dump) site a series of 2- 4 quadrants were placed along a line transect running perpendicular from the river edge back "inland" for not more than 100m. The first two quadrants were laid out side by side and the third and fourth quadrant 5 m apart (thus on a 50m transect 4 10m X 10m quadrant were used). Thereafter additional quadrants were placed 10m apart where deemed necessary or when there continued to be changes in the vegetation make up.

All vascular plants with diameter at breast height (DBH) greater than 5cm were recorded in each 10m X 10m quadrant. Within each 10m X 10m quadrant a smaller 5m X 5m quadrant was randomly placed within and all herbs, shrubs and seedling were accounted for. Ground cover was also recorded for creepers and lianas. The crown cover for the canopy layer was documented with all epiphytes observed in the quadrant. For the detailed analysis (dominant, common species etc.) of the plant community only trees with dbh greater than 10cm were considered.

The survey would enable density, diversity and distribution data for important plants species encountered documented and more importantly allowed for detailed survey of plants for the area. The primary targets for the survey were the rare and threatened species followed by other native plant species of economic importance especially the endemic species. For this method of survey the assessment was carried out on all proposed dump sites from Navalili School to the Rewa River mouth or opening.

The second form of survey was more qualitative and based on observation in nature. This was carried out for all dumpsites from Navalili School to the NWLR station at Luvuluvu. This involved documenting major weeds and invasive plants and native plants of economic importance found in the area.

A checklist of vascular plants would be compiled based on both survey types mentioned above and from field observations whilst trekking through the area and from the detailed 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 were those used by Smith 1979-1991 for the higher vascular plants and by Brownlie 1976 for ferns and their allies.

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

Results

Dumpsites 1-5

These dumpsites were not quantitatively assessed. The areas (Fig 1 see map) were either used for farming and pastures or both thus the plant compositions (see Table 1 Appendix A) were those associated with such activities and these were mostly grasses (*Brachiaria mutica* (paragrass), *Paspalum conjugatum* (t-grass), *Panicum maximum* (ginni grass), *Ischaemum indicum* (batiki blue grass)); weeds (*Wedelia biflora, Ageratum conyzoides, Merremia peltata*); shrubs (*Lantana camara, Solanum torvum*); and or exotic trees (*Albizia saman* (rain tree), *Lagerstroemia speciosa* (pride of india), *Citharexylum spinosum* (fiddle wood)). The general lack of native plants, especially trees was obvious. Also noticeable was the extensive erosion of the river banks. In areas where trees literally line the river banks, some of these trees were noticed fallen over.

Dumpsite 6 – Yalewa Island

Vegetation

The island (Fig 1 see map) was previously used as a dump site and currently used by the locals for raising cattle that were let loose on the island. The island overall was covered with only a few tree and shrubs that were mostly exotic.

A transect placed along a section of the vegetation that appeared to have some resemblance of a native forest. For plants with diameter at breast height (dbh) >10cm the dominant tree species was *Albizia saman* comprising 51% of the total basal area of trees(See Table 2 in Appendix A). The largest tree was also *Albizia saman* which had dbh of 40cm and the most common tree species was *Hibiscus tiliaceus* making up 43% (6/14) of all trees found in the area assessed. A total of nine tree species were recorded from the area which included *Annona glabra, Dysoxylum richii, Terminalia catappa, Bruguiera gymnorrhiza* and *Barringtonia racemosa*. Several creepers and lianas were observed and these included *Entada phaseoloides, Derris malaccensis, Epipremum pinnatum, Ipomoea indica* and *Merremia peltata*. Some weedy shrubs observed included *Clidemia hirta, Lantana camara, Piper aduncum* and *Solanum torvum* (see Table 1 in Appendix A).

Dumpsite 7

Vegetation

The vegetation along the entire dumpsite (Fig 1 see map) was best described as mixed river-flat vegetation associated with brackish water. Three types of forest were observed along the dumpsite area: Mangrove Forest, Brackish-water Swampland Forest and Grass/shrub land Vegetation. Only the Mangrove and Brackish-water Swampland Forests were quantitatively assessed (see Table 2 in Appendix A).

Mangrove Forest

Half the entire dumpsite, starting from near Selo Island or Dumpsite 10 was covered with Mangroves. The zonation pattern of Rhizophora-Bruguiera-Mixed species Forest vegetation was observed and this was consistent along the length of the river where mangroves grew.

The Rhizophora zone was made up entirely of *Rhizophora samoensis* and covered the first 15m of the transect. The trees on average had dbh of 17cm (range of 16-18cm) with heights of 4 to 8m. The crown cover was 100%. The next zone was made up of *Bruguiera gymnorrhiza* found along the 15-30m mark of the transect with trees attaining heights of 12m with an average dbh of 27cm (range 10 to 46cm). Canopy cover was about 75%. Beyond the 40m mark the vegetation became a mixed-forest type with trees like *Hibiscus tiliaceus, Inocarpus fagifer, Cocos nucifera, Barringtonia edulis, Cerbera manghas* and *Xylocarpus granatum*(see Table 1 in Appendix A)..

Overall the dominant tree species was *B. gymnorrhiza* with 40% total basal area. The largest tree is also *B. gymnorrhiza* with dbh of 46cm. and other large tree in the transect was *I. fagifer* with 42cm dbh. At the 40m mark the ground was above the high tide mark and as such domestic gardens were observed and this included Pandanus gardens for weaving, and abandoned gardens of Cassava. Coconuts were collected regularly for sales from the area and there was also evident of logging of mangrove from stumps observed.

Two interesting habitat types were observed behind the Bruguiera zone. The habitat types were not common and included the *Xylocarpus granatum* Forest and *Inocarpus fagifer* Forest types.

> ***Xylocarpus granatum* Forest**
> Within a 100m^2 quadrant 5 trees with an average dbh of 38cm was observed. On average the trees were about 15m tall and the canopy cover was about 75%. No other tree species grew in the area.
>
> ***Inocarpus fagifer* Forest**
> Also within another 100m^2 quadrant 5 trees with an average dbh of 34cm was observed. The trees were about 20m tall and the canopy was closed. No other trees grew in the area except for the lianas and creepers like *Entada phaseoloides, Epipremum pinnatum* and *Passiflora auretum* and the shrubby sedge

Brackish-water Swampland Forest

This forest type was observed along the Rewa riverbank downstream from the settlements south of Nailili village. It stretched for about 800m only to be segmented by patches of grass and shrubland made up mostly of *Brachiaria mutica* commonly called paragrass with the fern *Acrostichum aureum* before the mangrove forest mentioned above began.

A transect used to assess this forest type indicated that the dominant tree species was *Inocarpus fagifer* comprising 54% of the total basal area for trees >10cm dbh. The largest tree in the assessed area is also *I. fagifer* with dbh of 35cm. Trees ranged in size from 13cm to 35 cm with an average dbh of 18cm. A total of 6 species of trees was recorded and the most common tree species was *Annona glabra* comprising 29% (10/35) of all

trees assessed and overall they were generally smaller with an average dbh of 14cm ranging from 10 to 18cm(See Table 2 in Appendix A).
Most of the ground cover plants were the common and widespread species like *Epipremum pinnata, Entada phaseoloides, Ipomoea indica, Cyathea lunulata* and *Morinda citrifolia.* Plants associated with human habitation were found in the area and these included *Cyrtosperma chamissonis* (giant swamp taro), *Manihot esculenta* (cassava), *Musa paradisica* (banana), *Bambusa vulgaris* (bamboo), *Cocos nucifera* (coconut), *Citrus limon* and *Annona muricata* (sour sop).
An obvious feature about the area was that it was regularly used by the locals as source of food. Several mud lobster traps were observed and coconuts were processed (husked) for the markets in Suva and Nausori.

Dumpsite 8
Vegetation
The site (Fig 1 see map) was covered with good mangrove forest with no evidence of previous dumping observed. Two types of habitats were observed on the site: Rhizophora-Bruguiera Forest type and Bruguiera-mixed Forest type.
The Bruguiera-Mixed Forest type was quantitatively assessed using a single transect (See Table 2 in Appendix A). For plants >10cm dbh the forest type was dominated by *B. gymnorrhiza* comprising 53% of the total basal area of trees. The species also had the largest tree in the area assessed with a dbh of 49 cm (range 20 to 49 cm) average of 26cm. It was also the most common tree species making up 43% (14/33) of all tree species assessed. Other tree species observed included *Xylocarpus granatum, Excoecaria agallocha, Annona glabra* and *Pandanus tectorius.*
Several creepers and lianas were observed and these included *Entada phaseoloides, Derris trifoliate, Davallia solida,* and some weedy shrubs included *Clidemia hirta, Lantana camara, Piper aduncum* and *Solanum torvum*(See Table 2 in Appendix A).
In the unaccessed *Rhizophora-Bruguiera* habitat type forest found along the shoe-like section of the northern part of the dumpsite (see Fig …) the typical *Rhizophora* followed by *Bruguiera* zonation pattern was observed. The Rhizohora zone extended inland for up to 20m and then followed by the *Bruguiera* stand. The ground was very soggy making trekking into the forest very difficult. On average the *Bruguiera* were about 15cm in dbh with heights of 8 -10m with a closed canopy cover. A noticeable feature was that recent logging of both *Bruguiera* and *Rhizophora* was evident and that the ground was literally covered with young *Bruguiera* and *Rhizophora* seedlings.

Dumpsite 9
Vegetation
The proposed dumpsite (Fig 1 see map) has a good forest cover and it had not being previously used as a dumpsite. The principle vegetation type (Mueller-Dombois et. al 2005) observed was Mangrove Vegetation. The zonation pattern of Rhizophora – Bruguiera was noticed but was not consistent throughout the entire length of the area proposed as a dumpsite. Where the Rhizophora formed the outermost (adjacent to the river edge) layer, it was only a narrow strip ranging from 2-6m wide, before a mixed

stand of Xylocarpus-Excoecaria-Annona and at times Heritiera-Pandanus replacing the Rhizophora.

This mangrove forest was quantitatively assessed using two transects. The forest was dominated (based on total basal area) by Bruguiera gymnorrhiza making up 59% of the tree biomass for the area. It was the most common tree with a total of 34 trees with dbh greater than 10cm out of a total of 73 trees made up of 7 other tree species. A pure stand ($100m^2$) of Bruguiera had 9 trees with an average dbh of 43cm ranging from 17-75cm. The largest tree in the area assessed was Exocaeria agallocha with a dbh of 82cm.

Between the 8-25m strip of this mixed forest type the locals set up traps to catch *Thalassina anomala* (mud-lobster (mana)). The substrate was raised and drier and as such the lobster favoured the area as its habitat. There were natural water ways which allowed the free movement of water in and out of the Mangrove Forest during the respective high and low tides. It should be ensured that these natural water ways were not used as dump sites as they might result in the water directed elsewhere with devastating effects.

At the 20-40m mark from the river edge the vegetation composition changed to Bruguiera and Xylocarpus. This was where some of the largest Xylocarpus were found with average dbh of 47cm. and beyond the 40m mark Bruguiera dominated the forest type and became the most common tree. The trend was observed along the entire proposed dumpsite. A lot of Bruguiera seedlings were observed on the forest floor where crown cover was partially open and in other areas where the canopy was closed it was devoid of seedlings.

The same trend was also observed when Bruguiera formed the outermost layer instead of Rhizophora.

Dumpsite 10

The dumpsite (Fig 1 see map) was an island locally known as Selo. From the Rewa River the embankment appeared to be covered with Mangroves except for the northern and southern-most ends of the island which had no mangrove cover. These sections of the islands were covered with dredged materials during previous dredging activities resulting in vegetation being made up mostly of common grasses and shrubs and exotic trees like *Brachiaria mutica, Paspalum distichum, Clerodendrum inerme, Albizia saman, Cocos nucifera* and *Annona glabra.*

Unlike other mangrove systems visited no *Bruguiera* stands were observed immediately along the river edge. A clear zonation pattern of Rhizophora –Bruguiera zonation pattern was present along the entire mangrove strip. A single transect was used to assess the species composition. The Rhizophora zone covered the first 15m of the transect followed by Bruguiera from 15 to 40m. Beyond this a mixed mangrove forest composed of *Bruguiera, Rhizophora, Xylocarpus* and *Heritiera* follows. The habitat type was dominated with Bruguiera and it was also the most common tree species although the largest tree was Xylocarpus with a dbh of 12cm. On average the canopy was 6m tall with a closed canopy. Beyond this the area was used a lot for harvesting coconuts and trapping of mud lobster as evident in the husks of coconuts and the traps respectively observed. Some edible ferns were also observed and indication of their being harvested was also evident. Last but not the least there was also evidence of logging of mangroves on the area from the many stumps observed.

Trekking through the site pockets of old dumpsites were observed. These were in areas between the Rhizophora and Bruguiera zones. These dumpsites had unique microhabitats, creating pockets of back of the mangrove vegetation, composed of plants like *Intsia bijuga* (vesi), *Kingiodendron platycarpum* (moivi), *Inocarpus fagifer, Terminalia littorea* (tavola), *Cocos nucifera* and *Barringtonia edulis* (vutu kana).

Dumpsite 11

Vegetation

The entire dumpsite (Fig 1 see map) has a relatively good forest cover. It had previously being used as a dumpsite and on these built-up lands small scale agricultural activities were observed. A noticeable feature about the coastline was the extensive erosion along its length beginning from the small settlement (with 4 houses) and onward towards the river opening to where young coconut groove were (distance of about 1km). Large trees (*Calophyllum inophyllum*, *Cocos nucifera*) were noticed uprooted and submerged in the river from the eroding embankment.

The principle vegetation type (Mueller-Dombois *et. al* 2005) for the dumpsite was Coastal Vegetation. Three distinctive forest or habitat types were noticed (See Table 2 in Appendix A) and this included:

Mixed shrub-grassland

The habitat type was not quantitatively assessed and was restricted to lower lying areas that were regularly inundated with water especially during the king tides. The ground was swampy with lots of pumice and was covered with a rather difficult to access mass of vegetation composed of the shrubby *Vitex trifolia*, *Leucaena leucocephala*, *Hibiscus tiliaceus*, *Annona glabra*, *Acrostichum aureum*, *Clerodendrum inerme* and grasses *Brachiaria mutica* and *Paspalum distichum.* This habitat type was part of a land form that occures as long rectangular strips extending perpendicular from the river's edge for some distance (several hundred metres) inland (see Fig…). It acted as a drainage system and several of these were observed along the dumpsite. It is crucially important that such system was NOT blocked during the dumping process.

Coastal Forest

This habitat type was quantitatively assessed and was found along the section of the dump site immediately adjacent to the river's edge that was heavily eroded. The vegetation was dominated (based on total basal area) by *Callophyllum inophyllum* (dilo) although the largest tree measured was *Albizia saman* with a dbh of 95cm. Another large tree recorded was *Inocarpus fagifer* (ivi) with a dbh of 60cm The most common large tree was *Cocos nucifera* (coconut) with an average dbh of 26cm. The regeneration potential of the native trees was low compared to that of the exotic species especially *Spathodea campanulata* (African Tulip) which was relatively high.

Littoral Strand Vegetation

The habitat type was quantitatively assessed and was restricted beyond the coastal forest to the southern-most tip of Laucala Island. Erosion of the coastline was not evident but a sandy beach was obviously present. The usual zonation of different vegetation forms inland from the high tide mark was evident.

Immediately above the high tide mark the vegetation was restricted to creeping plant with *Ipomoea pes-caprae* (morning beach glory) being the only plant present providing a 75% ground cover. Further inland (20m) additional low growing plants and seedling of a few coastal plants were noticed and these included the creepers *Canavalia rosea, Wedelia biflora* and *Brachiaria mutica* (paragrass) and seedlings of *Cocos nucifera, Annona glabra, Pandanus sp., Barringtonia asiatica* and Albizia saman.
Hereafter the plant form changed to become more dominated by shrubs and this included *Annona glabra* and *Calophyllum inophyllum* both not more than 2m tall and lots more saplings of *Pandanus, Annona* and *Hibiscus tiliaceus*. Ground cover (50%) was dominated by the grass *Pennisetum polystachyum*. Also preset were the creepers *Wedelia biflora* and *Entada phaseoloides, Caesalpinia bonduc* and Cassytha *filiformis.*
In the last quadrant, 50 from the high tide mark, *Inocarpus fagifer* was the most common tree species followed by *Neisosperma oppositifolium, Barringtonia asiatica*, *Terminalia catappa* and *Spathodea campanulata* respectively. *Cocos nucifera* had the highest number of saplings recorded.
The young *Cocos nucifera* provide a lot of stability to the sand dominated substrate in particular in providing a wind-break.

Flora

A total of 140 taxa was recorded from the entire area during the survey (see Table 1 in Appendix A). Of these 137 taxa was identified to the species level. Almost half (46%) of the plant species recorded were either recent introductions to Fiji , exotics, or were brought in by the early indigenous settlers, Aboriginal introduction- only a few representatives of the later were included.
There were 71 (51%) native species recorded out of which 6 species were endemic (only found in Fiji and nowhere else in the world). This included;
Dysoxylum richii (tarawau kei rakaka), *Ficus prolixa* (baka ni viti) *Ficus vitiense* (lololo) *Gramatophyllum elegans* (mangrove orchid) *Rhizophora X selala* (selala). Overall none of these (6) native plants are threatened in any way as they are relatively common in other parts of Fiji where mangrove forests and similar habitats are found. The only two species that were exclusively found or were restricted to the mangrove forests, *Gramatophyllum elegans* and *Rhizophora X selala*, were of no immediate concern as they were also found in large numbers outside the earmarked dredging sites. i.e *Rhizophora X selala* was a hybrid of *R. Samoense* and *R. stylosa* and can be found in all mangrove forests in Fiji. *G. elegans* was an epiphytic orchid that was only restricted to mangrove forests from the Rewa delta to Navua.

Discussion and conclusions.

There were two vegetation types of national significance found in the study area: the Mangrove Vegetation (Dumpsites 7-10) and the Coastal Vegetation (Dumpsite 11).
The mangrove forests found in the study area were heavily impacted by human activities that ranged from logging for fuelwood and local construction material to fisheries and agricultural activities.
For logging and construction the targeted species for these activities were *Bruguiera gymnorrhiza* (dogo) and *Rhizophora* spp. (tiri). A few *Xylocarpus granatum* (dabi) were

also noticed being logged. These had resulted in fewer larger trees found closer to the river and creek edges but were restricted further inland. Recruitment was greater here also compared to where more of the matured (larger dbh) forest stands were.
Fisheries associated with trapping the mud lobster *Thalassina anomala* (mana) was also a very common activity for dumpsites 7, 8, 9 and 10. This was carried out on a regular basis as evident in some fisherwomen encountered during the survey and the many traps (old and new) observed in the sites.
The back of the mangrove forest were also used for some agricultural activities and where coconuts occurred were regularly collected and processed for the local markets.
Of interest were pockets of previous dumpsites observed on sites 6, 7 and 10 where new habitats were created and where some back of the mangrove vegetation were now established. These new habitats have not only increased the biodiversity of the area but have provided habitats for some organisms found in the area.

The Coastal Vegetation found along dumpsite 11 was typical of such systems found along major river mouths (Ba, Navua, Sigatoka, Nadi and Qawa) (Watling 1985) in Fiji. Overall these systems were very dynamic thus the plants associated with such systems were very resilient. Along the more wind-exposed coastline towards Laucala Point a young and very thick groove of coconut trees managed to establish itself. This provided a relatively stable environment for the establishment of young saplings of *Calophyllum, Inocarpus, Terminalia* and *Barringtonia*. On the other hand a lot of erosion of the river embankment along the northern half of dumpsite 11 was evident. Large trees were noticed fallen over and this would appear to continue to do so. The inland section of this part of the river was heavily used as gardens by the locals. Areas previously used as dumpsites were now used as gardens. Also noticed along this section of the river were partially dried up swamps whose vegetation remained and were mostly composed of some of the more common grasses and shrubs like *Brachiaria mutica, Paspalum distichum, Clerodendrum inerme, Acrostichum aureum* and *Annona glabra.* This was a very important system in that during the very high tides water would be able to flow in and out easily. The systems were easy to identify as these were strips of land that were 15-20m wide near the river bank and extend inland for up to 600-800m. It was important that these natural drains were not filled-up during the dredging process.

All the plant species recorded during the survey were not of any national or international significance as none of them were listed under the IUCN Red Listed (1994) or CITES listed.

Recommendations
In a mangrove system dredged materials are to be dumped at least 10m from the edge of the river and or preferably where the Rhizophora zone ends and the Bruguiera zone begins.

The natural waterways including streams and creeks should be allowed to let the water in and out of the mangrove forest during the changing tides. This is important as it will avoid water being locked inland during the ebbing tide and also allows free movement of aquatic organisms in the mangrove forest during changing tides.

At the upper portion of Dumpsite 11 it is crucial that the natural waterways lying perpendicular inland for up to 800m be kept open to allow drainage of water out of Laucala Island.

It may not be advisable to dump dredged materials on the upper portion of Dumpsite 11 since its most likely that within a year or two these materials may erode back into the channel.

The cutting or logging of mangroves along the entire riverbank should be stopped and redirected to other parts of the Rewa River away from the dredging site. This should be properly managed.

As in previous dredging activities the benefits of the dredged materials used for converting otherwise would be soggy areas into ideal arable lands for farming and human habitation should be supported and continued.

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Appendix A

Table 1. Checklist of vascular plants recorded from the 4th August to 1st September 2009 for the Rewa River Dredging EIA survey. The distribution (Distrib.) data include indigenous (Ind.), Exotic (Exo.), Aboriginal Introductions (Abo. Intro.), and Endemic (End.) species. Local and common names are common Fijian names or English names the plant is known by and the Dumpsites (DS) are numbered accordingly from 1-11 to the sites where dredged materials from the river will be dumped onto.

Family	Botanical Name	Distrib.	Local/Common name	DS 1-5	DS 6	DS 7	DS 8	DS9	DS 10	DS11
Adiantaceae	*Acrostichum aureum*	Ind.	Borete	X	X	X	X	X	X	X
Amaranthaceae	*Achyranthes aspera*	Ind.		X	X	X			X	X
Anacardiaceae	*Dracontomelon vitiense*	Ind.	Tarawau						X	
Anarcadiaceae	*Mangifera indica*	Exo.	Mango	X		X				X
Annonaceae	*Annona glabra*	Ind.	uto ni bulumakau	X	X	X	X	X	X	X
Annonaceae	*Annona muricata*	Exo.	sour sop	X					X	X
Apocynaceae	*Cerbera manghas*	Ind.	Vasa							X
Apocynaceae	*Neisosperma oppositifolium*	Ind.	Vao						X	X
Apocynaceae	*Parsonsia laevis*	Ind.				X			X	
Araceae	*Alocasia indica*	Abo. Intro.	Via	X	X				X	X
Araceae	*Colocasia esculenta*	Abo. Intro.	Dalo	X	X	X				X
Araceae	*Cyrtosperma chamissonis*	Abo. Intro.	Giant swamp taro			X			X	
Araceae	*Epipremnum pinnatum*	Ind.	Yalu		X	X	X	X	X	X
Arecaceae	*Cocos nucifera*	Ind.	niu, coconut	X		X		X	X	X
Aspleniaceae	*Asplenium australasicum*	Ind.	bird's nest		X	X		X	X	X
Asteraceae	*Ageratum conyzoides*	Exo.	Bote	X	X	X			X	X
Asteraceae	*Mikania micrantha*	Exo.	Wabosucu	X	X	X			X	X
Asteraceae	*Sida acuta*	Exo.	Deniose	X	X	X			X	
Asteraceae	*Sida rhombifolia*	Exo.		X	X	X			X	X
Asteraceae	*Synedrella nodiflora*	Exo.		X	X	X			X	X

Asteraceae	*Vernonia cinerea*	Ind.	Kaukamea	X	X	X			X	X
Asteraceae	*Xanthium pungens*	Exo.		X					X	
Asterateraceae	*Wedelia trilobata*	Exo.		X	X	X				X
Athyriaceae	*Diplazium harpeoides*	Ind.	Lalabe			X			X	
Bignoniaceae	*Spathodea campanulata*	Exo.	african tulip	X	X	X			X	X
Boraginaceae	*Cordia subcordata*	Ind.	Nawanawa							X
Caesalpiniaceae	*Intsia bijuga*	Ind.	Vesi						X	X
Caesalpiniaceae	*Caesalpinia bonduc*	Ind.	sili, soni				X		X	X
Caesalpiniaceae	*Chamaecrista nictans*	Ind.							X	
Caesalpiniaceae	*Inocarpus fagifer*	Ind.	Ivi	X	X	X	X	X	X	X
Caesalpiniaceae	*Kingiodendron platycarpum*	End.	moivi							
Caesalpiniaceae	*Senna occidentalis*	Exo.		X	X	X				X
Caesalpiniaceae	*Senna tora*	Exo.		X	X	X			X	X
Caricaceae	*Carica papaya*	Exo.	Pawpaw	X	X	X			X	X
Cassythaceae	*Cassytha filiformis*	Ind.		X	X	X			X	X
Clusiaceae	*Calophyllum inophyllum*	Ind.	Dilo						X	X
Combretaceae	*Barringtonia asiatica*	Ind.	vutu rakaraka		X	X	X	X	X	X
Combretaceae	*Barringtonia edulis*	End.	vutu kana			X			X	
Combretaceae	*Barringtonia racemosa*	Ind.	vutu wai	X	X	X		X	X	X
Combretaceae	*Terminalia catappa*	Ind.	Tavola	X		X		X	X	X
Combretaceae	*Terminalia samoense*	Ind.				X				X
Commelinaceae	*Commelina diffusa*	Exo.		X	X					
Connaraceae	*Connarus pickeringi*	Ind.	wa vutu			X			X	
Convolvulaceae	*Ipomoea obscura*	Ind.		X	X	X				X
Convolvulaceae	*Ipomoea pes-caprae*	Ind.	wa bula						X	X
Cucumbiraceae	*Coccinia grandis*	Exo.		X	X	X			X	X
Cyatheaceae	*Culcita straminea*	Ind.				X			X	X

Cyatheaceae	*Cyathea lunulata*	Ind.	Balabala			X			X	X
Cyperaceae	*Cyperus rotundus*	Exo.		X	X					X
Cyperaceae	*Cyperus stoloniferus*	Ind.		X						X
Cyperaceae	*Scirpodendron ghaeri*	Ind.	vulu, misimisi			X	X		X	
Davalliaceae	*Davallia solida*	Ind.			X	X	X	X	X	X
Euphorbiaceae	*Excoecaria agallocha*	Ind.	Sinugaga			X	X	X	X	
Euphorbiaceae	*Macaranga sp.*		Dava	X	X	X			X	X
Euphorbiaceae	*Manihot esculenta*	Exo.	Cassava	X		X			X	X
Euphorbiaceae	*Ricinus communis*	Exo.	Castor's oil	X	X	X			X	
Fabaceae	*Abrus precatorius*	Exo.	Lera	X	X	X	X	X	X	X
Fabaceae	*Adenanthera parvonina*	Exo.	red bead tree	X		X			X	X
Fabaceae	*Albizia saman*	Exo.	Vaivai	X	X	X			X	X
Fabaceae	*Canavalia rosea*	Ind.								X
Fabaceae	*Crotalaria pallida*	Exo.		X	X				X	X
Fabaceae	*Derris malaccensis*	Exo.	duva niukini	X		X			X	X
Fabaceae	*Derris trifoliata*	Ind.	Duva			X	X	X	X	X
Fabaceae	*Entada phaseoloides*	Ind.	wa lai		X	X	X	X	X	X
Fabaceae	*Indigofera suffruticosa*	Exo.		X	X	X				X
Fabaceae	*Indigofera trita var. scabra*	Exo.		X						X
Fabaceae	*Pongamia pinnata*	Ind.	Vesiwai			X				X
Fabaceae	*Vigna marina*	Ind.				X				X
Goodinaceae	*Scaevola sericea*	Ind.	Vevedu							X
Lamiaceae	*Hyptis pectinata*	Exo.		X	X	X				X
Lomariopsidaceae	*Lomagramma cordipinna*	Ind.	creeping fern		X	X	X	X	X	X
Lycopodiaceae	*Lycopodium sp.*		tassel fern					X	X	
Lythraceae	*Lagerstroemia speciosa*	Exo.	Pride of india	X	X					
Malvaceae	*Hibiscus tiliaceus*	Ind.	Vau	X		X	X	X	X	X

Malvaceae	*Urena lobata*	Exo.		X	X				X	X
Marattiaceae	*Angiopteris evecta*	Ind.	Basovi						X	
Melastomataceae	*Clidemia hirta*	Exo.	koster's curse	X	X	X			X	X
Meliacea	*Vavaea amicorum*	Ind.	Cevua						X	
Meliaceae	*Azadirachta indica*	Exo.		X						
Meliaceae	*Dysoxylum richii*	End.	Tarawau kei rakaka		X	X			X	X
Meliaceae	*Xylocarpus granatum*	Ind.	Dabi			X	X	X	X	
Mimosaceae	*Leucaena leucocephala*	Exo.	Vaivai	X	X					X
Mimosaceae	*Mimosa pudica*	Exo.	Cogadrogadro	X	X				X	X
Moraceae	*Artocarpus altilis*	Exo.	uto	X		X				X
Moraceae	*Ficus prolixa*	End.	baka ni viti			X			X	X
Moraceae	*Ficus vitiense*	End.	Lololo	X	X	X			X	X
Myrtaceae	*Psidium guajava*	Exo.	Quawa	X	X	X				X
Myrtaceae	*Syzygium malaccense*	Abo. Intro.	Kavika	X		X			X	X
Ophioglossaceae	*Ophioglossum pendulum*	Ind.				X		X	X	X
Orchidaceae	*Gramatophyllum elegans*	End.	mangrove orchid			X	X	X	X	
Orchidaceae	*Hetaeria oblongifolia*	Ind.				X				X
Orchidaceae	*Oberomia sp*					X			X	X
Oxalidaceae	*Oxalis corniculata*	Exo.		X	X					X
Pandanaceae	*Pandanus adorantinus*	Ind.	Voivoi	X		X			X	X
Pandanaceae	*Pandanus tectorius*	Ind.	Vadra		X	X		X	X	X
Passifloraceae	*Passiflora auretum*	Ind.			X	X	X	X	X	X
Passifloraceae	*Passiflora foetida*	Exo.		X	X	X			X	X
Passifloraceae	*Passiflora suberosa*	Exo.		X						X
Piperaceae	*Piper aduncum*	Exo.	Onalulu	X	X	X			X	X
Poaceae	*Axonopus affinis*	Exo.		X			X		X	
Poaceae	*Bambusa vulgaris*	Abo. Intro.	bitu ni vavalagi	X		X				

Poaceae	*Brachiaria mutica*	Exo.	Paragrass	X	X	X				X
Poaceae	*Digitaria ciliaris*	Exo.		X						
Poaceae	*Echinochloa colona*	Exo.								
Poaceae	*Eleusine indica*	Exo.	Covatu	X	X	X				X
Poaceae	*Ischaemum indicum*	Exo.		X						
Poaceae	*Ischaemum indicum*	Exo.	batiki blue grass	X					X	
Poaceae	*Panicum maximum*	Ind.		X	X				X	X
Poaceae	*Panicum maximum*	Exo.	ginni grass	X					X	
Poaceae	*Paspalum conjugatum*	Exo.	T- grass	X					X	
Poaceae	*Paspalum distichum*	Ind.		X	X	X			X	
Poaceae	*Pennisetum polystachyon*	Exo.		X		X				X
Poaceae	*Sporobolus diander*	Exo.		X	X	X				X
Poaceae	*Sporobolus indicus*	Exo.		X						
Polygalaceae	*Polygala paniculata*	Exo.		X		X			X	X
Polypodiaceae	*Phymatosorus grossus*	Ind.	Vativati	X	X	X	X	X	X	X
Polypodiaceae	*Pyrrosia adnascens*	Ind.			X	X		X	X	X
Pontederiaceae	*Eichhornia crassipes*	Exo.	Water hyacinth	X	X	X			X	
Pteridaceae	*Pteris pacifica*	Ind.		X		X			X	
Rhamnaceae	**Alphitonia zizyphoides*	Ind.	Doi	X	X	X			X	X
Rhizophoraceae	*Bruguiera gymnorrhiza*	Ind.	Dogo		X	X		X	X	
Rhizophoraceae	*Rhizophora samoensis*	Ind.	Tiri			X	X	X	X	
Rhizophoraceae	*Rhizophora stylosa*	Ind.	Tiri					X		
Rhizophoraceae	*Rhizophora X selala*	End.	Selala			X		X	X	
Rubiaceae	*Morinda citrifolia*	Ind.	Kura	X	X	X		X	X	X
Rutaceae	*Citrus limon*	Abo. Intro.	moli karo	X	X	X				X
Sapindaceae	*Pometia pinnata*	Ind.	Dawa	X		X				
Sapotaceae	*Planchonella grayana*	Ind.							X	X

Solanaceae	*Capsicum frutescens*	Exo.	chilli, boro	X	X	X			X	X
Solanaceae	*Physalis peruviana*	Exo.	tukitukiyadre	X						X
Solanaceae	*Solanum torvum*	Exo.	Pricklysolanum	X	X	X			X	X
Sterculiaceae	*Heritiera littoralis*	Ind.	Sagale		X		X	X	X	
Taccaceae	*Tacca leontopetaloides*	Ind.	Yabia			X			X	X
Verbenaceae	*Citharexylum spinosum*	Exo.	Fiddle wood	X	X	X				
Verbenaceae	*Clerodendrum inerme*	*Ind.*	verevere		X	X	X	X	X	X
Verbenaceae	*Lantana camara*	Exo.	Lantana	X	X	X			X	X
Verbenaceae	*Premna serratifolia*	Ind.	Yaro					X		X
Verbenaceae	*Stachytarpheta urticaefolia*	Exo.	Blue rat's tail	X	X	X			X	X
Verbenaceae	*Vitex trifolia*	Ind.	vulokaka	X	X				X	X
Vittariaceae	*Vaginularia angustissima*	Ind.				X		X	X	

Appendix A

Table 2. Summary of the Dumpsites and Transects numbers used where the plots (four 10m X 10m) were established in the study area. A brief description of the "Habitat or Forest type" was given for each transact. The following information was summarized from each plot: number (#) of individuals with diameter at breast height (DBH) ≥ 10 cm (including multi-stemmed individuals); number of tree species (sp.); largest, most common tree species (see full name ** of the plant species at the end of the table) ; average (Av.) DBH and range; Sum Basal (B.) area (cm^2) of stems; Dominant (Dom.) species/ relative (Rel.) dominance; ground covered by plants generally that are less than 1m in height (herbs, seedlings, shrubs) and estimated crown cover of the canopy.

Dump Sites	Transect #	* Habitat (Forest) Type	# ind. ≥ 10 cm	# tree spp.	** Largest trees / Most common spp.	Av. DBH; Range (cm)	B. area (stems ≥ 10cm DBH	Dom. sp./ Rel. Dom. (%)	Ground cover (%)	Crown cover (%)
1-5	None	Pasture and Agricultural land	-	-	Alb/ Alb	-	-	Alb	75	<25
6	1	River flat	13	7	Alb/Hib	16 10 - 40	3899	Alb/35	50-75	75-100
7	1	Mangrove Forest	34	6	Ino/ Ino	16 10 -35	8845	Ino/ 54	25 - 50	75-100
	2	Inocarpus fagifer Forest	5	1	Ino/Ino	34 20 to 42	4219	Ino/100	<25	>75
	3	Xylocarpus granatum Forest	5	1	Xyl/Xyl	38 25 - 45	5420	Xyl/100	<25	>75
	4	Mangrove forest	20	5	Bru/Bru	17 10-46	-	Bru/	<25	>75
8	1	Mangrove forest	29	5	Bru/Bru	10-49	13504	Bru/55	<25	.>75
9	1	Mangrove Forest	35	6	Xyl/Xyl	10 - 82	20010	Xyl/51	<25	.>75
	2	Mangrove Forest	38	7	Bru/Bru	10 - 75	25485	Bru/87	<25	.>75
11	1	Coastal Forest	20	11	Alb/Coc	31 10 - 95	19685	Alb/36	>75	50-75
	2	Coastal Strand Forest	11	10	-	-	-	-	25-50	<25

Abbreviations of plant names: Alb = *Albizia saman*; Hib = *Hibiscus tiliaceus*; Ino = *Inocarpus fagifer*; Xyl = *Xylocarpus granatum*; Bru = *Bruguiera gymnorrhiza*; Coc = *Cocos nucifera*

APPENDIX H

Terrestrial vertebrate and bird survey

by Dr. Dick Watling

Environment Consultants Fiji

INSTITUTE OF APPLIED SCIENCES,
UNIVERSITY OF THE SOUTH PACIFIC

REPORT ON THE BIRDS AND TERRESTRIAL VERTEBRATES OF THE REWA DELTA DREDGE SITES

September 2009

Environment Consultants Fiji

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ABBREVIATIONS AND ACRONYMS

IAS Institute of Applied Sciences, University of the South Pacific

1 BACKGROUND TO THIS REPORT

1.1 PERSONNEL & PREPARATION

This report is prepared by Environment Consultants Fiji for the Institute of Applied Sciences (IAS), University of the South Pacific. The report details the work undertaken by Dick Watling (DW) of Environment Consultants Fiji in the Rewa Delta in September 2009. Environment Consultants Fiji are subcontracted by IAS to undertake a baseline survey of the birds and terrestrial vertebrates of the proposed spoil sites for the dredging of the Rewa River.

1.2 STRUCTURE OF THE REPORT

This report is structured such that it can be lifted and pasted as easily as possible into the combined report on the biodiversity survey to be produced by IAS.

2 METHODS

2.1 REVIEW OF EXISTING INFORMATION

Environment Consultants Fiji have significant unpublished information on the vertebrates and mangroves of the Rewa delta based on previous fieldwork carried out there. The birds and terrestrial vertebrate section of Thaman *et al.* (2005) was also prepared by DW. Morgan and Morgan (1965) first identified a site at the mouth of the Rewa River as a high tide migratory wader roost more than 40 years ago and it has been in constant use since (DW pers. obs.)

2.2 PROPOSED DREDGE DISPOSAL SITES

A figure of the proposed dredge disposal sites was provided by IAS, Figure 1.

2.3 FIELD ASSESSMENT

2.3.1 Timing and Weather

Fieldwork was undertaken in the week of 7-11th September , and 29th September. Weather during the survey work was generally fine, strong southeasterly winds during 7-11th September with brief rain squalls.

2.3.2 Habitat Assessment

The habitat requirements of Fiji's terrestrial vertebrates is well known – the most important variable being forest cover. The majority of Fiji's native terrestrial vertebrate species are forest or forest-edge restricted species and within the forest, they tend to be generalists, there being no altitudinal or other distribution variables. Mangroves are a distinctive habitat and there are no terrestrial vertebrate species restricted to mangroves or reliant on them in any way, other than the mangrove heron *Butorides striatus*.

The fauna of habitats adjacent to mangrove reflect the nature of those habitats, where good lowland forest occurs, then the more diverse forest birds and other vertebrates will be found immediately adjacent to the mangroves and some forest species will visit mangroves from time to time. Much more commonly, converted secondary or agricultural habitats occur on the inland of mangroves. Such habitats are of very little conservation significance for Fiji's native and endemic birds or herpetofauna.

A habitat assessment of the proposed dredged sites will therefore provide a good indication of the birds and herpetofauna which are found on the sites.

The introduced mongoose *Herpestes auropunctatus* is found on Viti Levu, it has devastated the terrestrial herpetofauna and ground-dwelling birds, as such these groups are either extirpated or occur only at very low densities. The mongoose is a common inhabitant of mangroves and secondary habitats adjacent to them.

Additional important observations were required to determine if the proposed sites may be feeding or roosting sites for migratory waders or seabirds.

2.3.3 Survey Methods

The habitat of each site was assessed by either a walk over, visual inspection from a boat together with a review of Google images. Three sites were selected for intensive survey.

Bird survey work was initially timed to view the proposed dredge sites at high tide when important roosts for migratory waders would be observed. Elsewhere birds were surveyed on unstandardised transects and incidental observations in mangrove and other habitats as and where possible. Three of the major dredge disposal sites were selected for field survey, the remaining dredge areas were assessed on the basis of their habitats (refer Table 1;Figure 1).

For the herpetofauna, opportunistic diurnal surveys were conducted along trails in mangroves and the adjacent terrestrial habitats. Searches were made in known microhabitats for cryptic geckos. GPS coordinates of target species were recorded using a Garmin etrex Legend HCX. The coordinates were recorded in WGS 84

Site	Intensive Survey Sites	GPS coordinates South	GPS coordinates East
Laucala Island	All along the SE coast to the southern end of the island		
	Wader Roost 1	S 18 08.996	E 178 31.603
	Wader Roost 2	S 18 09.190	E 178 31.641
Island Mid Stream	Southern Survey Site	S 18 08.045	E 178 31.469
	Northern Survey Site	S 18 07.314	E 178 31.972
Site 1	Southern Survey Site	S 18 07.013	E 178 32.360
	Northern Survey Site	S 18 06.850	E 178 02.704

Table 1: Rewa Delta - Location of Intensive Survey Sites

Photo 1: High tide roost site for migratory waders on the eastern coast of Laucala Island (S 18 08.996 E 178 31.603)

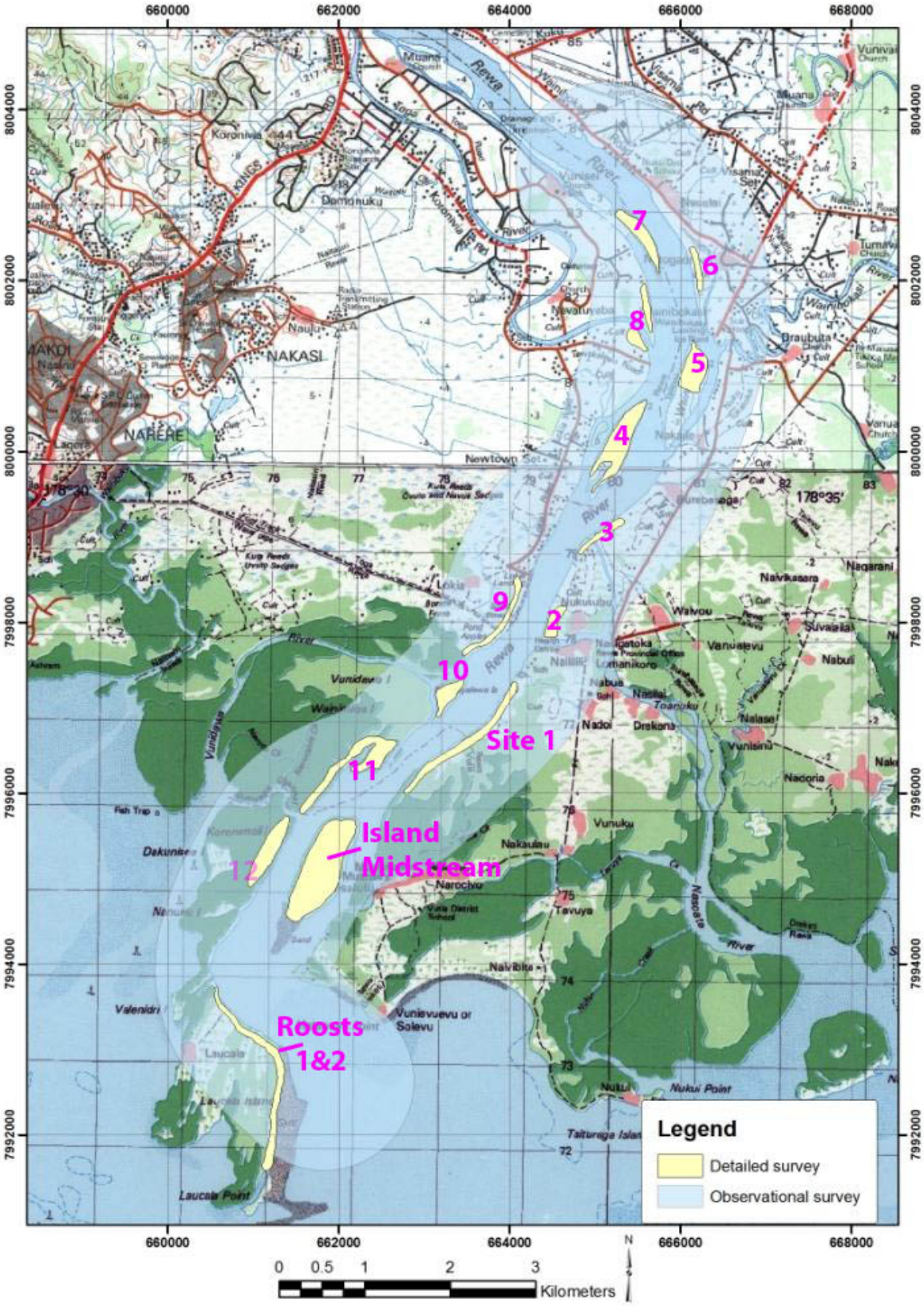

Figure 1: Rewa River Mouth with Potential Dredge Sites Migratory Wader Roosts; Intensive Survey Locations and Habitat Assessment Sites

3 RESULTS

3.1 BIRDS

3.1.1 Land & Freshwater Birds

There are 49 land and freshwater bird species occurring on Viti Levu[1] that are potentially present at the study area. However, as noted above, the majority of Fiji's native and endemic species are forest residents and are absent from mangroves and converted, open habitats. Of the 49 species, 13 were recorded during the survey (refer Table 4). All of the 13 species recorded are common, generalist species and not of conservation significance.

A further 9 species have been recorded in the Rewa Delta and could potentially be recorded at the dredge sites. Only one of these, the Collared Lory *Phigys solitarius* is an endemic species but it is widespread and common, and not a threatened species.

3.1.2 Migratory Shore Birds

Sixteen migratory shore bird species have been recorded in the Suva Lagoon – Rewa Delta area (Watling 2006). Migratory shore birds feed almost exclusively in the inter-tidal flats. At high tide they find roosting/loafing areas where they are safe from disturbance and predators. Different species tend to use different locations. The playing fields on the Suva foreshore are used when possible by the Pacific Golden Plover, but other species use other sites, often quite some distance away.

There are two very important high water roosts on the eastern shores of Laucala Island which were first recorded in 1964 (Morgan & Morgan 1965) and are still in active use (Watling *pers. obs.*). The sites (about 150 m apart) were surveyed at high tide on 10th and 11th September. Table 2 summarises the species using the sites at that time. The site is most important for the Bar-tailed Godwit which at the time of the visit had not yet arrived back in Fiji – they are expected at the end of September or early October. These numbers are low - when

Species		10th Sept	11th Sept	ECF Database Records
Pacific Golden Plover	*Pluvialis fulva*		40	Often used
Wandering Tattler	*Heteroscelus incanus*	50	45	Usually used
Whimbrel	*Numenius phaeopus*	1	9	Usually used
Turnstone	*Arenaria interpres*	6	6	Usually used
Bar-tailed Godwit	*Limmosa lapponica*			Extensively used

Table 2: Migratory waders at the Laucala Island High Tide Roost 10-11 Sept. 2009

3.1.3 Herpetofauna

Three species of herpetofauna were recorded from the survey sites, while three others are known to occur in the Rewa Delta. The Green Tree Skink is endemic but is widespread and common in Fiji and is not of conservation significance (refer Table 3).

[1] Breeding species (with one annual migrant). This figure excludes 8 species regarded as extinct or extirpated on Viti Levu (the latter being ground nesting species predated by the introduced mongoose *Herpestes auropunctatus*).

3.1.4 Mammals

Only two mammals were recorded during the survey, the sign of Mongoose *Herpestes auropunctatus* was seen everywhere at the edge of mangroves. The Pacific Flying Fox *Pteropus tonganus* was seen on three occasions on different, a single each time. There was no sign of a flying fox roost.

English name	Scientific name	Conservation Status	X – This Survey; Literature or ECF Database Record
REPTILES			
Pacific boa	*Candoia bibronii*	Native	Recorded swept down by floods (ECF Database)
Oceanic gecko	*Gehyra oceanica*	Native	X
Mourning or Pacific gecko	*Lepidodactylus lugubris*	Introduced	X
Green tree skink	*Emoia concolor*	Endemic	ECF Database
Blue-tailed Copper-striped skink	*Emoia impar*	Native	X - but which of these two species not determined
Brown-tailed Copper-striped skink	*Emoia cyanura*	Native	
AMPHIBIANS			
Marine or Cane toad	*Bufo marinus*	Introduced, Invasive	ECF Database

Table 3: Herpetofauna recorded from the Rewa Delta and at the Potential Dredge Sites surveyed

Table 4: Bird Observations - Rewa Dredge Sites

	Common Name	Scientific Name	Origin	Endemicity	Threat Status	Laucala Island	Island Mid Stream	Site 1	Literature & ECF Database Record
	Land & Freshwater Birds								
1	Pacific Black Duck	*Anas superciliosa*	N			X			X
x	Wandering Whistling Duck	*Dendrocygna arcuata*	N		X				(X)
2	Reef Heron	*Egretta sacra*	N				X	X	X
3	White-faced Heron	*Ardea novaehollandiae*	RI			X			X
4	Mangrove Heron	*Butorides striatus*	N						X
5	Fiji Goshawk	*Accipiter rufitorques*	N	E		X		X	X
6	Pacific Harrier	*Circus approximans*	N			X		X	X
7	Peregrine Falcon	*Falco peregrinus*	N		AR				
	Collared Petrel	*Pterodroma brevipes*	N		X				
x	Barred-wing Rail	*Nesoclopeus poeciloptera*	N	E	X				
x	Banded Rail	*Gallirallus philippensis*	N		X				
x	White-browed Crake	*Poliolimnas cinereus*	N		X				
x	Spotless Crake	*Porzana tabuensis*	N		X				
x	Purple Swamphen	*Porphyrio porphyrio*	N		X				
8	Feral Pigeon	*Columba livia*	I	I					
9	White-throated Pigeon	*Columba vitiensis*	N						X
10	Spotted Turtle-dove	*Streptopelia chinensis*	I						X
11	Friendly Ground-dove	*Gallicolumba stairii*	N	RE	V				
12	Barking Pigeon	*Ducula latrans*	N	E					
13	Many-coloured Fruit-dove	*Ptilinopus perousii*	N	RE					
14	Golden Dove	*Chrysoenas luteovirens*	N	E					
15	Collared Lory	*Phigys solitarius*	N	E					X
16	Red-throated Lorikeet	*Charmosyna amabilis*	N	E	CE				
17	Masked Shining Parrot	*Prospeia personata*	N	ES	NT				
18	Kadavu/Red Shining Parrot	*Prospeia spp*	I	I					
19	Fan-tailed Cuckoo	*Cacomantis flabelliformis*	N						
20	Long-tailed Cuckoo	*Eudynamis taitensis*	M						
21	Barn Owl	*Tyto alba*	N						X
x	Eastern Grass Owl	*Tyto capensis*	N		X				
22	White-rumped Swiftlet	*Aerodramus spodiopygia*	N			X			X
23	Pacific Swallow	*Hirundo tahitica*	N						
24	White-collared Kingfisher	*Todiramphus chloris*	N			X	X	X	X
25	Polynesian Triller	*Lalage maculosa*	N	RE*					
26	Red-vented Bulbul	*Pycnonotus cafer*	I						X
27	Island Thrush	*Turdus poliocephalus*	N						
28	Fiji Bushwarbler	*Vitia ruficapilla*	N	E					
29	Long-legged Warbler	*Trichocichla rufa*	N	E	E				
30	Streaked Fantail	*Rhipidura spilodera*	N	RE*					
31	Slaty Monarch	*Mayrornis lessoni*	N	E		X			
32	Lesser Shrikebill	*Clytorhynchus vitiensis*	N	RE				X	X
33	Black-faced Shrikebill	*Clytorhynchus nigrogularis*	N	E	V				
34	Vanikoro Broadbill	*Myiagra vanikorensis*	N	RE*		X		X	X
35	Blue-crested Broadbill	*Myiagra azureocapilla*	N	E					
36	Scarlet Robin	*Petroica multicolor*	N						
37	Golden Whistler	*Pachycephala pectoralis*	N						
38	Fiji White-eye	*Zosterops explorator*	N	E					
39	Silvereye	*Zosterops lateralis*	N			X			X
40	Orange-breasted Myzomela	*Myzomela jugularis*	N	E		X			X
41	Wattled Honeyeater	*Foulehaio carunculata*	N	RE*		X	X	X	X
42	Giant Forest Honeyeater	*Gymnomyza viridis*	N	E					
43	Fiji Parrotfinch	*Erythrura pealii*	N	E					
44	Pink-billed Parrotfinch	*Erythrura kleinschmidti*	N	ES	V				
45	Red Avadavat	*Amandava amandava*	I						X
46	Polynesian Starling	*Aplonis tabuensis*	N	RE*					
47	Common Mynah	*Acridotheres tristis*	I						X
48	Jungle Mynah	*Acridotheres fuscus*	I						X
49	Fiji Woodswallow	*Artamus mentalis*	N	E					X
	Migratory Waders								
1	Pacific Golden Plover	*Pluvialis fulva*				X			
2	Wandering Tattler	*Heteroscelus incanus*				X			
3	Whimbrel	*Numenius phaeopus*				X			
4	Turnstone	*Arenaria interpres*				X			

KEY:

Origin: N - native; I - introduced

Endemicity: E - Fiji endemic; ES - Endemic to a single island (and offshore islets); RE - Regional endemic (F,T,S,AS,Tu,N,To,W&F); RE* - regional endemic as above with outliers in other neighbouring island nations

Threat Status IUCN Red List 2008 CE - Critically Endangered; E - Endangered. V - Vulnerable; NT - Near Threatened. Fiji National Status: AR - At Risk; CC - Conservation Concern. X - Extinct or Extirpated on Viti Levu

4 SUMMARY OF IMPACTS AND CONSERVATION VALUES

4.1 WILDLIFE

The bird surveys confirmed existing knowledge about the avifauna of the Rewa Delta. Not all the species known to occur in the delta were observed on the sites. There are no birds of conservation significance recorded during the survey or known from such habitats in the delta. Similarly, no herpetofauna or mammal species of conservation significance were recorded during the survey, nor are they known to inhabit such habitats in the delta.

4.2 WADER ROOSTS.

Two important wader roosts are currently located on the east coast of Laucala island, above a little disturbed, generally windswept beach. This roosting area has been known for nearly 50 years and the significant population of Bar-tailed Godwits which feed mainly on the Suva Point tidal flats use the site each high tide.

4.3 DREDGE DISPOSAL IMPACTS FOR TERRESTRIAL WILDLIFE

There will be temporary loss of habitat following dredge disposal. Provided the disposal sites are restricted to those shown in Figure 1 – comprising existing dredge disposal sites or adjacent secondary or open habitat areas, then the temporary loss of habitat will have no significant impact on the terrestrial wildlife of the Rewa delta.

Depositing dredge spoil on the east coast of Laucala Island will disturb and modify an important wader roosting area. Waders are using this site, not for any special habitat attribute other than because it is a little disturbed coast line and there are good views of anything which may approach along the coast. Elevating the coastline a meter or more with dredge spoil is unlikely to result in any habitat change which will materially affect the site as a wader roost. There will be temporary disturbance which will result in the waders having to leave the area during the operation, but there are other potential roosting sites, including recently dredge deposits upstream which will provide a similar, little-disturbed and open site with good all-round views.

4.4 RECOMMENDATION

It is recommended that the dredging operation around the wader roost sites be undertaken as quickly as possible with the mobilisation, dredging and demobilisation being accelerated to minimise the disturbance time at the roost site.

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APPENDIX I

Fisheries and Aquatic Resources Survey

by Semisi Meo and Ron Vave

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SURVEY OF FISHERIES AND AQUATIC ECOLOGICAL RESOURCE USE BY THE LOCAL COMMUNITIES IN REWA FOR THE REWA RIVER DREDGING EIA

DECEMBER 2009

By

Semisi Meo and Ron Vave
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1.0 Introduction

This report is a product of ecological survey work undertaken by the Institute of Applied Sciences (IAS) Environment Unit, led Semisi Meo and Ron Vave with assistance of a field assistant, which documents the biological diversity of flora and fauna of the main Rewa River channel in determining possible impacts of the proposed dredging project and associated spoil sites.

2.0 Structure of report

The report is structured to provide the information on biological diversity and potential impacts of dredging as one of the components of the Environmental Impact Assessment study, and is a simple "cut and paste" provision to incorporate to the full report that will be submitted by IAS.

3.0 Purpose of the survey

The main purpose of the survey is to obtain a river ecological resources composition, the associated use patterns (specifically those that are commercial/subsistence) - the levels of dependency on the resources through targeted fishermen interviews and describing possible impact on these resources by the dredging project.

4.0 Methodology

Site Selection

Twenty three villages located within 1km of river bank. Fishermen interviews were undertaken in twelve representative villages (upper, mid and lower).

Community interview

There was synergizing of efforts to maximize our survey objectives based on the availability of communities hence the biological and the socioeconomic research team simultaneously conducted interviews together. The interview on the assessment of the biological information need was conducted in plenary so there could be levels of confidence in claiming a statement which is verified by all of the communities. During the interview, the communities were asked to map out their main fishing areas,

enumerate the target species which they catch, identify species that have become rare over the past years, their comparison of their efforts over time, the natural characteristic changes and formations in the river system and the major resource use pattern of their catches.

Figure 1: Community interview in Nukutubu

Over the interviews the village headmen's were notified to alert communities on visit of the team to assess fisherman catch in-situ on the purpose of ascertaining information on their target catches and species.

Figure 2: Net fishing along the river tributaries

In-situ fisherman interview

Figure 3: Fisher folks for interview

Over a period of two days, the team traveled in a boat from the Marine Science Campus in USP starting from the reef crest edge to the river mouth and traveling to the upper reaches and interviewing individual fisherman working in that point in time. The team enumerated the catch by species, the gear and instruments used, recorded their fishing time span, the frequency of their fishing in the area and their reflection on the catch and effort over the years.

Reconnaissance survey

Selected sites along the river edges were snorkeled in which visible fish and invertebrate species were identified recorded and consequently the benthetic substrate determined and recorded. At these sites the benthetic composition was assessed in its texture and rigidity. The sites were selected according to its visibility and notable tucked adrift tree remnant and log debris in the middle of the river. As mentioned by communities in the village interview they dive and spear fish in this type of habitat.

Figure 4: Snorkel surveys around bamboo plant

In areas which were deeper with low visibility, a sediment grabber was used, not only to obtain bottom sediments, but for determination of its composition and associated bottom floral species. The sediment grabber used in the survey was relatively small in size (as in photo) and it was not workable in areas of high rigidity sediment bottom.

All other minor and major attribution and characteristics of the area observed were noted.

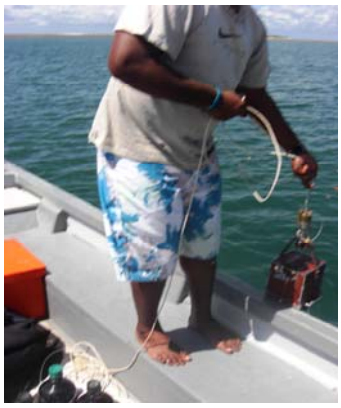

Figure 5: Sediment grabber in use

5.0 Results

1) Map & history of marine resource use/dependence

The first map below (Figure 6) shows areas frequented by community folk for fishing and an area known to be a good 'kai' bed. This was a result of interviews with fisher folk in twelve villages. Good fishing areas are concentrated around mangrove areas and also at river mouths, although fishing was also occurring in other places.

It should be noted that a majority of community reps interviewed feel that dredging will have minimal impact on fishing in the short term, and improve it in the long term. The improvement is attributed by some fishermen to more fish occupying a 'deeper' water column as a result of 'more space'. 'Kai' beds were noted to be all along the river banks, but some fisherwomen indicated the area marked in red below, to be a really good area for getting 'kai'. This area is located directly across the Nuku District School

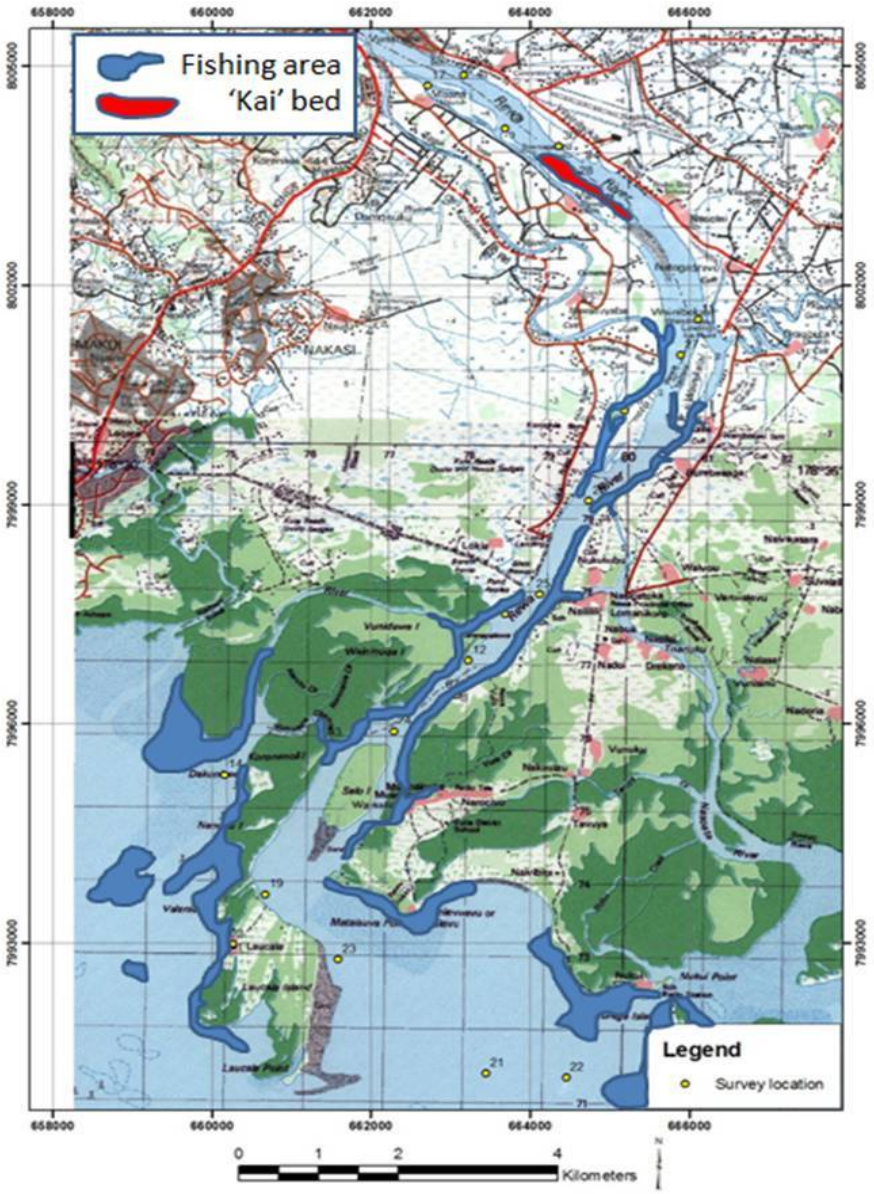

Figure 6: Map showing good fishing areas & kai beds (by fisherfolk)

The second map, Figure 7 below shows, snorkel survey stations including locations of bottom grab samples – for habitat surveys (yellow circles)) and also the areas (red circles), where fisherfolk were sighted and catch recorded during the course of our survey.

Figure 7: Map showing snorkel survey and/or benthic grab sample locations (yellow cirles) and fisherfolk location (red circles)

Appendix 1 contains descriptions of benthic habitat types and catches from fisher folk who were interviewed along the Rewa river.

Figure 9: Ladies gleaning 'kai' from a bamboo raft

Figure 8: A bull shark caught in the Rewa river bay

Figure 10: Fish & invertebrate catches are very small in size

Tabulated in Appendix 2 is a list of fish and invertebrates noted by fisher folk (through interviews) as a composition of their catch, and is split by village. From this table (Appendix 2) is extracted the most commonly caught fish (four types) and also two invertebrates, which is tabulated on the next page (Table 1.0). This commonly caught fish and invertebrates were also characterized by its importance, both economically, as well as subsistence wise – for consumption at home.

Table 1.0: The most common fish and invertebrates caught by fisher folk that were interviewed are:

Local name	English common name	Scientific name	Preferred habitat
Molisa/Kanace	Bluetail mullet	*Valamugil scheli*	Inhabit coastal waters but enters estuaries and rivers where they feed on microalgae, filamentous algae, forams, diatoms, and detritus associated with sand and mud. Form schools.
Damu or Drami	Mangrove snapper	*Lutjanus argentimaculatus*	Mangrove coasts to steep outer reefs. Juveniles and young adults occur in mangrove estuaries, the lower reaches of freshwater streams and tidal creeks. Adults are often found in groups around coral reefs. Eventually migrate offshore to deeper reef areas, sometimes penetrating to depths in excess of 100 m.
Malea	Tilapia	*Tilapia mossambica*	Inhabits reservoirs, rivers, creeks, drains, swamps and tidal creeks; commonly over mud bottoms, often in well-vegetated areas. Most common in blind estuaries and coastal lakes, but usually absent from permanently open estuaries and open sea and from fast-flowing waters. Grows and reproduces in fresh-, brackish and seawater. Juvenile carnivorous/ omnivorous, adult tends to be herbivorous or detritus feeder. Reaches sexual maturity at 15 centimeter length, but stunted fish may breed at 6-7 centimeters and at an age of just over 2 months. Somewhat aggressive toward other species

Qitawa Uruuru	Reve	*Mesoprites kneri*	Freshwater and brackish preference throughout its life stages and grows to size of 50cm. They feed along coastal mangroves areas habitats and estuary areas.
Kai	Freshwater mussel	*Batissa violacea*	two ecomorphs (kai buli and kai bukuvula) of the species *Batissa violacea* are present in Fiji. It has been reported also that the occurrence of kai is restricted to the lower freshwater reaches of rivers, between the upper limit of tidal influence and the upper limit of salt penetration (Raj, 1981; & Lewis, 1985a). The clam is free living, burrowing to 10 cm in river beds and capable of substantial movements.
Moci	Mangrove prawn	*Palaemon concinnus*	Preliminary sampling shows that prawns accumulate in edges of mangrove trees. It is very euryhaline, specimens being found in fresh, brackish and salt water.

6.0 DISCUSSION

Kai (*Batissa violacea*):

There are rich kai beds in the mid and upper stretches of the Rewa river, which could be impacted by the proposed dredging operations. Women who glean kai, do so in the shallow river beds (up to about 1.5m water depth) which are immediately adjacent to the river bank. Dredging this shallow, river bank portions would result in destruction of some rich *kai* beds, and therefore affect the livelihoods of people that depend on it.

The kai larvae are known to have limited movement, which results in very short distances travelled before settling.

A recommendation would be to restrict dredging operations to the center of the river. This would ensure the protection of the kai beds and possibly prevent erosion of river banks.

7.0 MITIGATION OPTIONS

1) BREEDING GROUND

The river system is a breeding ground for most marine fish species such as travellys, groupers, sharks etc in their respective breeding seasons. The fish seasons and time is well known by local traditional fisherman. There has been a regular sighting and catch of macro fishes in the upper trophic chain in the river system by local fisherman which maneuvered the area for brooding its young ones. Over the survey the team came across two bull sharks which was caught by a local fisherman. Gutting of the larger female bull shark revealed 15 juvenile sharks which jumped out into the water and all swam away alive. Hence the Rewa river system is rich in supporting the transverse of brackish and freshwater reliant species at different stages of their live cycle especially in their re-productivity stages.

Recommendation

The river system is a productive one in terms of ecological support and services to freshwater and marine species and the ecological balance needs to be intact so it continues to serve its role. The dredging activity will get rid of alluvial deposits and other inland debris that is clogging and causing instability in the system. A proper dredging design is to be undertaken to maintain constant flow of water and low destruction on the ecological integrity of the system to support reproduction of freshwater-marine species.

2) ZERO SALINITY SHIFT

Over dry seasons the zero salinity shifts further upstream hence brackish water fish species migrates further upstream as well. Over these periods the communities towards the mouth of the river would record catches of marine species as the salinity would be considerably higher. The higher salinity in the river mouth brings about abrupt changes in the species composition and low catch abundance. They would have to travel long ranges either to the reef crest or travel to upper reaches of the river to get a good catch. However after every flood the zero salinity level shifts towards the river mouth and then the lower reaches consequently becomes productive for fishing. The main cause of the shift is the clogging and instability in the river system that does not regulate or maintain main the zero salinity towards the lower ranges.

Recommendation

Dredging is to be well designed to consider the constant flow of the river system and minimize alluvial deposits that would cause clogging or bottlenecks into the system. Transverse fish species dependent of salinity would be more ecologically reproductive in their respective habitats such as the mangrove zones rather than to move about based on salinity shifts.

3) FISHING COMPLIANCE AND ENFORCEMENT

There are some form of management in place on the river system by the Fisheries Dept placing a ban on gillnet fishing along the river system. The ban enriches the river with brackish water fish species such as mullets and snappers. However there were some fishermen that were using gillnets and had quite considerable catches of the fishes.

Recommendation

The enforcement of the management actions needs to be given to community so they would take greater responsibility in managing their areas of jurisdiction. This would also enrich the species abundance and biomass in the river system and making them more resilient to any form of disturbance in the river zone.

8.0 CONCLUSION

The site is similar in character to many areas of alluvial delta in Fiji. Habitat-wise, the area includes eroded bank areas, grass grassy bank zones, riparian green vegetated tree coverage, mangroves thickets and natural water bodies. Although a number of endangered and rare species were identified by the

communities as being present in the study area, which extended for 5 km, none of the species present at the site are believed to be locally, nationally, or internationally rare or threatened.

The dredging will have the most potential for impacts as a result of habitat loss and physical disturbances. The proposed site has a relatively moderate ecological value since it is not quite ubiquitous in Fiji. Furthermore, its value is moderate in relation to both species diversity and productivity. None of the species believed to be present have any special value conferred upon them as a result of rarity or protection status. Given the semi-urban nature of the site, most of the fish species present would be expected to have behavioral and physiological adaptations that suit them to an existence in close proximity to the new geomorphogical river bed. The communities, speaking over their experience over previous dredging undertaking, are confident that a significant impact upon local flora and fauna are not expected however those projects deemed smaller scale compared to the current undertaking.

Appendix 1: Habitat types along the Rewa river

Site # (Ref: map)	Station type	Locality	Number of fishers	Habitat type	Flora	Fishing method	Fish	Invertebrate	Where fishermen were from?	Average fishing hours	Comments
22	Benthic grab survey	Near reef (outside river mouth)		Sand, no silt	Seagrass (*Halophila ovalis* & *Halodule uninervis*)	--	--	--	--	--	
21	Benthic grab survey	Near reef (outside river mouth)		Sand, no silt	Chlorophyta species	--	--	--	--	--	
	Snorkel survey										
28	Fisher location		Six fijian women	Mud and silt layer		Gleaning for 'kai'	--	Kai (*Batissa violacea*)	Vunisei village	3 hours	The six women were able to fill 14 (50Kg) bags with *kai* in three hours
18	Fisher location	Mid portion of Rewa river	Two fijian women	Mud and silt layer		Fishing line, cast net and gleaning for 'kai'	Grunt fish (Qitawa), uru-uru and vo	Kai (*Batissa violacea*)	Nakaile	3 hours	This two ladies go fishing on a weekly basis
4	Fisher location	Mouth of river near Nailililli village	Two men (Indo-fijian)	Sand, silt combination		Cast net					
16	Fisher location	Mouth of river near Nailililli village (by mangrove side)	One Indo-fijian fishermen	Sand, silt combination		Crab traps		Crabs			

Site # (Ref: map)	Station type	Locality	Number of fishers	Habitat type	Flora	Fishing method	Fish	Invertebrate	Where fishermen were from?	Average fishing hours	Comments
13	Fisher location	Mouth of Vunivadra river		Rocky floor with bit of mud					Nadera		Catches between 5-20 bundles of fish, with larger fish sold, whilst the rest are consumed by the household
14	Fisher location	Vunidawa river mouth (by mangrove & near fish trap)	One fijian man	Sand, silt combination		Cast net (placed adjacent to traditional fish trap)		Crab			

Appendix 2: Rewa River Fauna Species List

Listed in the two tables below are the fish and invertebrates that local communities harvest from the Rewa river.

Local Name	Common Name	Latin Name	Muana/ Vunisei	Naselai	Natogadravo	Navatuyaba	Lokia	Burebasaga	Nukutubu	Vujia	Nukui
Badamu	Snake eel	*Anguilla obscura*						**			
Dadarikai	Snake eel	*Gymnothorax polyuranodon*						**			**
Damu/Drami (juv)	Mangrove snapper	*Lutjanus argentimaculaus*	**		**	**	**	**		**	**
Diria	Freshwater eel	*Anguilla marnorata*									
Donu	Grouper	*Plectropomussp.*								**	**
Draunibua/Kodro	Juv Saqa	*Caranx sp.*		**						**	**
Duna	Freshwater	*Anguilla marnorata*		**							
Grass carp	Grass carp	*Ctenopharyngodon idella*		**							
Ika droka	Flagtail	*Kuhlia rupestris*									
Ika susu	Grass carp	*Ctenopharyngodon idella*				**					
Ikasa	Pike eel	*Muraenesox cinereus*									
Jago/Regua	Snapper	*Lutjanus rivulatus*								**	**
Kabatia	Emperor	*Lethrinus sp.*									**
Kaikai ni Saqa	Ponyfish		**					**	**	**	
Kake damu	Snapper	*Lutjanus fulvus*								**	
Kavu	Potato Grouper	*Ephinephelus tukula*							**		
Kawakawa	Grouper	*Epinephelus sp*								**	

Kela	Milk trevally	*Lactarius lactarius*									
Ki	Goatfish	*Upeneus vittaus*							**	**	
Koto	Sea mullet	*Mugil cephalus*									
Kurukoto	Kurukoto	*Bunaka gyrinoides*			**			**			
Louwalu	Louwalu	*Anguilla obscura*							**		
Maleya	Tilapia	*Tilapia mossambica*	**	**	**	**	**	**	**		
Mataba	Flagtail	*Kuhlia bilumulata*						**			
Molisa or Kanace	Bluetail mullet	*Valamugil seheli*	**		**		**	**	**	**	
Nuqa	vermiculated rabbitfish	*Siganus vermiculatus*								**	**
Qio	Bull shark	*Carcharhinus leucas*							**		
Qitawa Uruuru	Reve	*Mesoprites kneri*	**		**	**	**		**		
Rewai		*Anguilla obscura*			**	**		**			
Sabutu	Snapper	*Lutjanus sp.*							**		**
Sakelo	Flagtail	*Kuhlia marginata*									
Saqa	Travelly	*Caranx sexmaculatus*		**					**	**	**
Tautaubale	Tautaubale	*Anguilla marmorata*									
Tei Mavi					**						
Uculuka	Threadfin	*Polydactylus plebeius*									
Udolu									**		
Vetakau	Spotted Scat	*Scatophagus argus*		**	**			**		**	
Vo, Deke	Gurdgeons	*Awaous guamensis*			**						
Vuvula	Herring	*Megalops cyprinoides*									
Saukelo		*Zenachopterus dispar*									

Local Name	Common Name	Latin Name	Muana/ Vunisei	Naselai	Natogadravo	Navatuyaba	Lokia	Burebasaga	Nukutubu	Vujia	Nukui
Dio	Barnacles	*Cirripedia*								**	
Moci	Mangrove prawn	*Palaemon concinnus*			**	**	**	**	**	**	
Tuba	Land crab	*Cardisoma carnifex*								**	
Qari	Green mangrove crab	*Scylla paramamosain*									**

APPENDIX J

Archeological survey and socio-cultural study

by Elia Nakoro

Fiji Museum

Socio-Cultural Environment Report for Archaeological and Historical Sites

Rewa River, Fiji

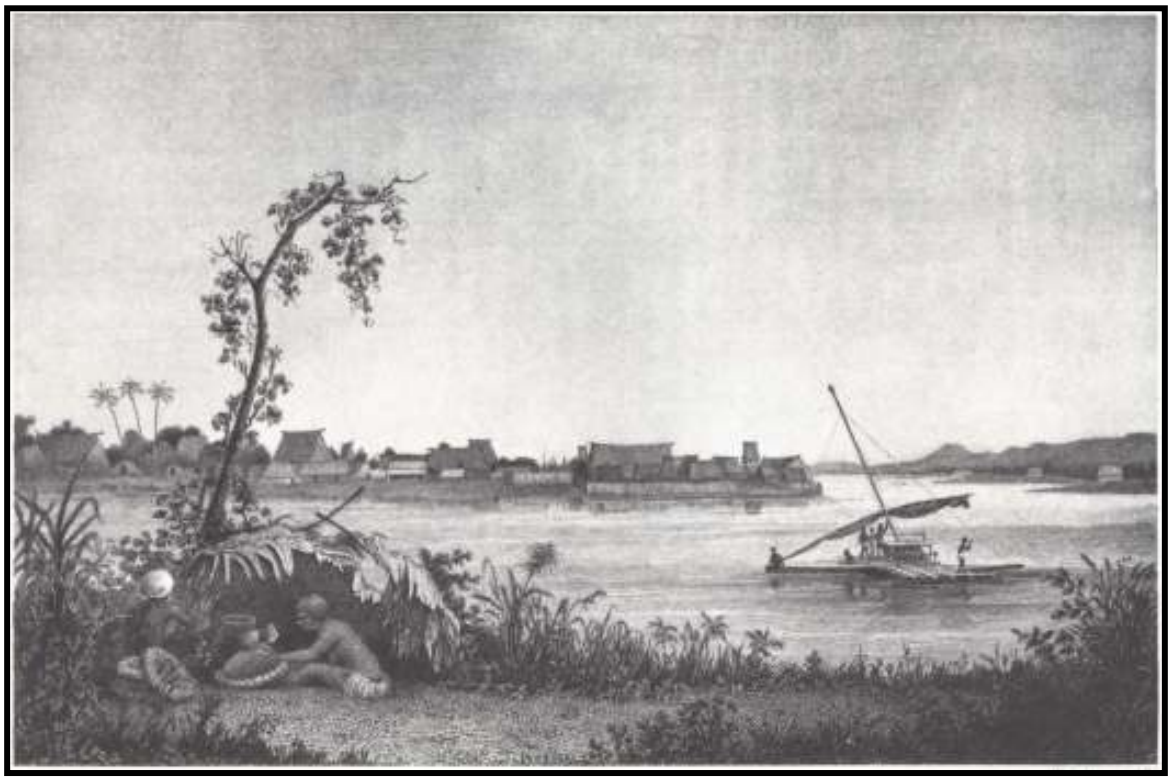

Figure 1: The town of Rewa. Picture taken from the "Narrative of the United States Exploring Expedition III"

Report prepared for Land and Water Resources Management
Fiji Museum Archaeology Department
2009

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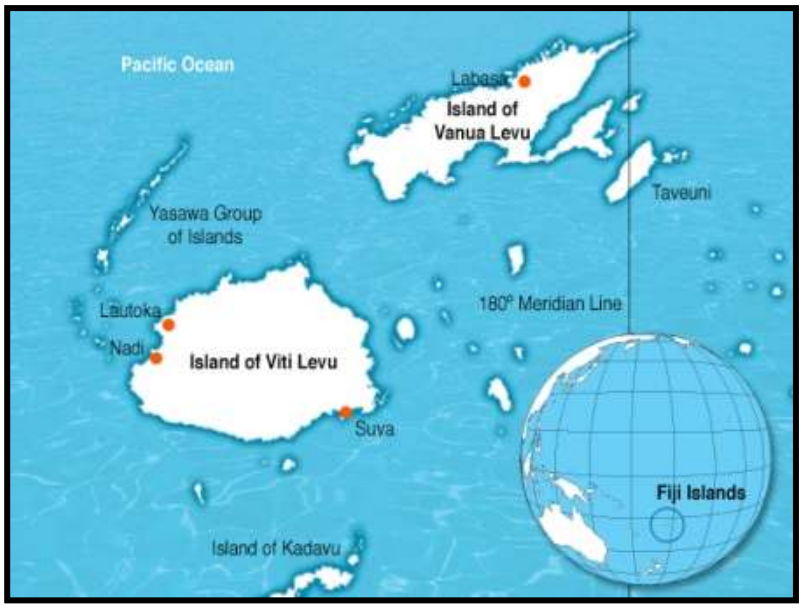
1.0 INTRODUCTION



Located on the island of *Viti Levu*, the *Rewa* River is the widest river in *Fiji* and originates from the highlands of the main island. Flowing diagonally to the south coast for approximately 145km, the river drains about one third of *Viti Levu*.

Figure 2: The *Rewa* River [inset]

The *Rewa* River is fed by two large tributaries, the *Wainibuka* and the *Wainimala* and it is joined by several other rivers of importance like the *Waidina* and the *Waimanu* tributaries in the lower reaches before discharging to the sea by a delta of many mouths [refer to appendix].

Accessible by small boats from the river mouth, its basin is enriched by a deep deposit of alluvial soil, rich and fertile for agricultural practices. There are more than 200 native villages situated on its banks.

This report embodies a study conducted along the main river delta on the September and October, 2009 to identify potential sites of archaeological importance.

1.1 AIMS

The undertaken survey was a request to outline areas of historical interest along the stretch of the Rewa River where a proposal of spoils dump sites are to be located. This assessment report aims to highlight the results of the survey and its implications on sites of historical significance.

1.2 BACKGROUND

1.21 Legislative Framework

The Fiji Museum Act-- POAPI

The Fiji Museum is a statutory body that is governed by the Fiji Museum Act[1] and the Preservation of Object of Archaeological and Palaeontogical Interest Act[2]. The Archaeology Department at the Fiji Museum utilizes the Acts in all its operations with the aim of identifying, protecting and conserving archaeological and cultural heritage for the current and future generation.

1.22 Brief History

The *Rewa* River has a rich history in folktale and legend- from tribal war fare narrations to stories of shark infestation and accounts of exploration by the early Europeans who wanted to study the culture and environment of the *Colo* tribe.

The most well known story is that of *Cakobau*'s great war canoe that has been documented to have taken place on an early June morning, 1845. *Cakobau*'s great war canoe, the *Ra Marama* entered the main arm of the Rewa followed by some sixty double canoes of the Bau fleet. This event which is widely known as a clear illustration of *Ratu Cakobau*'s deceitful ways [*vere vaka Bau*], saw the killing of the *Tui Dreketi* [the chief of *Rewa*] and the burning of the town of *Rewa* [refer to map in appendix].

Other events such as those described by Wilkes, the exploration of the *Rewa* also saw horrific experiences with the natives. One such event was the effort to capture the notorious *Veidovi*, who is the brother of the *Tui Dreketi*. In doing so, the expedition invited all the *Rewan* chiefs on board the "Peacock" hoping that *Veidovi* would also accompany them. Unfortunately things did not work out according to plan.

1.22 Physical Attributes

Legend holds that the flat alluvial plains of the *Rewa* are supposed to have originated in a great flood, which was the work of *Degei*- the snake God. As is the case with many legends, there is an important element of truth in the myth. The estuarine delta of the *Rewa* is the product of the flood waters of the river and the sediment root holding mesh of the coastal mangrove. Though it is not the product of a single great flood, it is the result of repeated flooding over several thousand years [Parry, 1977].

[1] Fiji Museum Act (Laws of Fiji, chapter 263)
[2] Preservation of Objects of Palaeontological Interest Act: (Laws of Fiji, chapter 264)

The *Rewa* Delta occupies an area of approximately 250 square kilometers and geologically is very recent. The alluvial deposits are a relatively thin veneer overlying grey-green, sandy marine sediments, which form the floor of the delta [FAO UNDP, 1972].

Inland up the *Rewa* valley, paired terraces are evident which is obviously the product of marine processes operating over a lengthy period when sea level was relatively higher than at present [Nunn, 1998].

The *Rewa* River has a relatively large discharge range, varying from a dry weather base flow, when the river is essentially tidal as far as Nausori, to a typical weather flood discharge with the gauge height at Nausori of 4 meters above mean sea level.

River levels at this height may or may not cause flooding in the lower part of the delta depending on the state of the ground and the amount of local antecedent rain. For instance in 1969 [FAO UNDP, 1972], the river reached the 4 meter level on three occasions, but only one of these high water levels produced flooding in the lower Rewa.

High river levels occur at least once every year, and major floods occur but once every ten years. During this century, three very large floods have been recorded, in 1931, 1964 and 1965. During the 1965 flood, the river reached a maximum height of 7 meters at Nausori, and a water level above three meters was maintained for three days. There are no adequate details of the 1931 floods; however, it is recorded that most of the delta below Nausori was inundated to a depth of at least a meter.

1.3 METHODOLOGY

Prior and subsequent to the field survey, an in-house reference research was conducted. The Fiji Museum library contains a large number of historical references of early European explorers and scholars where most of the texts used in this report was taken from.

During the field assessment, the department was assisted tremendously by the Institute of Applied Sciences: South Pacific Regional Herbarium [fauna and flora survey team]. In collaboration with the fauna and flora survey team, the group was able to visit all the proposed locations for the dredged materials dump sites.

In the field, field assistants were required and these villagers provided knowledge on whether the dump sites had some sort of cultural significance or not.

Instruments used during the survey include a Global Positioning System [GPS] receiver, camera and a printed Google Earth Map [refer to appendix].

1.4 FIELD SURVEY

The Fiji Museum is an inadequately funded institute therefore transportation to and from the survey site was a hindrance. Fortunately, links forged between the Museum, the Institute of Applied Sciences and the Regional Herbarium has merged efforts to promote and conserve biodiversity with the identification of nature reserves around the country with archaeological surveys to be undertaken simultaneously.

The archaeological survey was carried out and centered mainly along the main Rewa River on the proposed dump sites that have already been identified. Field guides played a crucial role in this fieldwork being familiar with the area and possessing traditional knowledge of the location and brief histories of cultural sites within the boundaries of their land.

1.41 Results

All proposed dump sites were sighted during the field survey and for the purpose of this section; the sites have been assigned a letter as seen on the map in the appendix [figure 5]. Below is a brief description of the results:

Sites	Village guides	Guides	Current State	Previously used as dump site
A	Vunisei	Vereniki Batiyaki	An agricultural terrace together with a grassy field with guava trees and shrubs	√
B	Natogadravu		An agricultural terrace and also an unused space filled with water lilies	√
C	Vunisei	Vereniki Batiyaki	Shrubs on the terrace and swampy along the river filled with water lilies	√
D			Shrubs on the terrace and swampy along the river filled with water lilies	√
E			Small island with eroded sides and currently used for farming	√
F			Thick mangrove swamp	√
G			Terrace vegetated with some big trees and a ground cover of grassland	√
H			Terrace vegetated with some big trees and a ground cover of grassland	√
I			An old river terrace which is	√

			being used for crop farming	
J			Mangrove swamp	√
K			Mangrove swamp	√
L			Mangrove swamp	√
M	Laucala	Beniamino	Mangrove swamp on most parts of the island except towards the southern end of the island which has a secondary vegetation resulting from the previous dredging works	√
N	Laucala	Beniamino	Mangrove swamp	√
O	Laucala	Beniamino	Vegetable gardens on some parts of the site with coconut trees and hibiscus tiliaceus as tree cover and vine thickets	√

1.5 Recommendations & Conclusion

During the course of the field survey, the team did not encounter any significant cultural remains nor does the location hold any historical account or records of any significance. Informal discussions with villagers also revealed the same sentiments. It is therefore our recommendation that the development of the proposed dump sites on the said locations (refer to the appendix) by Land and Water Resources Management [LWRM] go ahead as planned.

However, should development extend to the opposite bank particularly Northeast of the river mouth (refer to appendix; Fig 5) additional investigation will be required as this area houses several interesting cultural sites. .

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Appendices

Figure 3: The Rewa River System [SOURCE: Derrick, 1938]

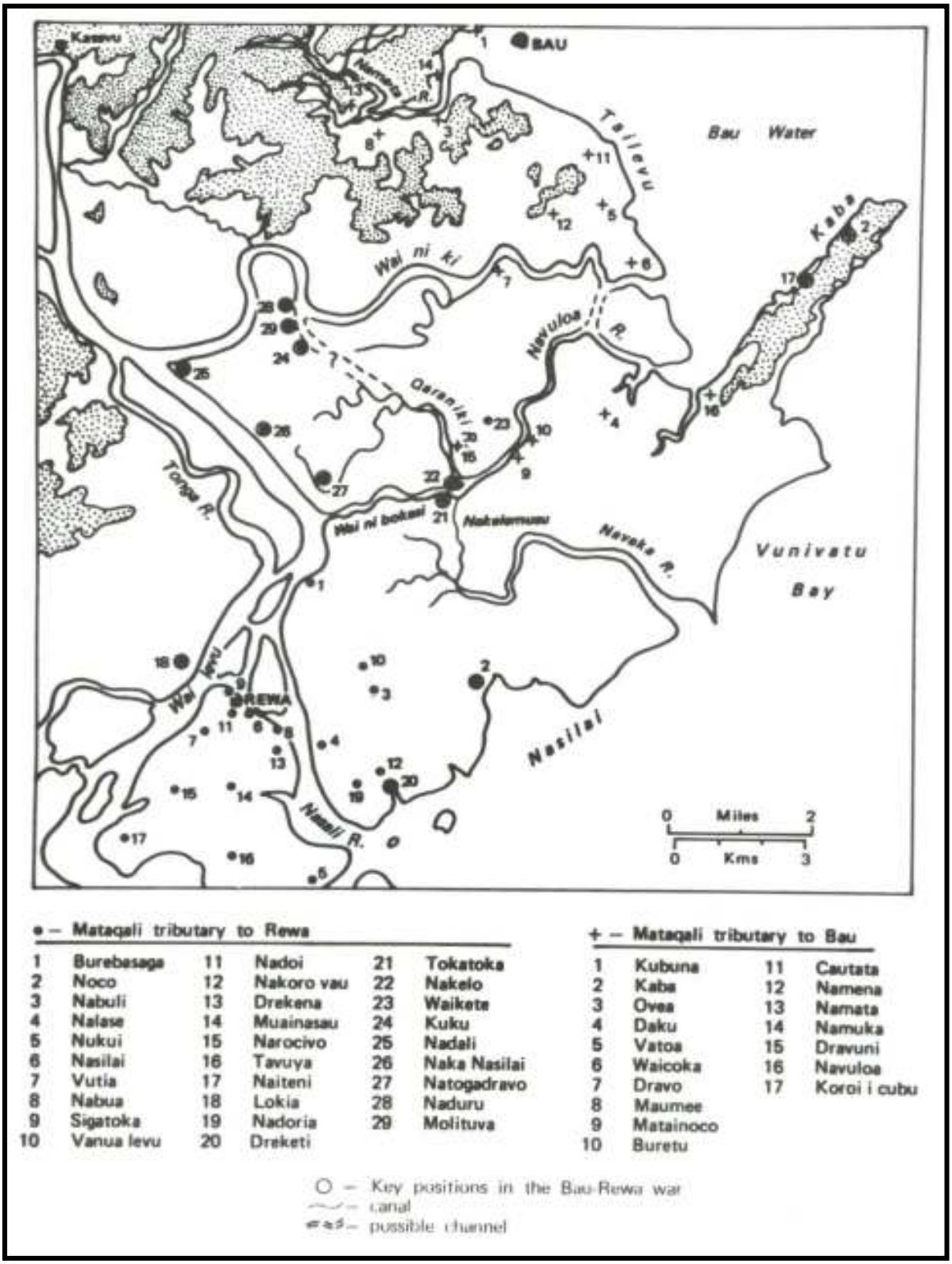

Figure 4: The settlement pattern of the Rewa delta in the mid-nineteenth century [SOURCE: Parry, 1977]. This figure shows two sites which are closely located to the proposed sites whereas the proposed locations have nothing or are clear of any historical settlement.

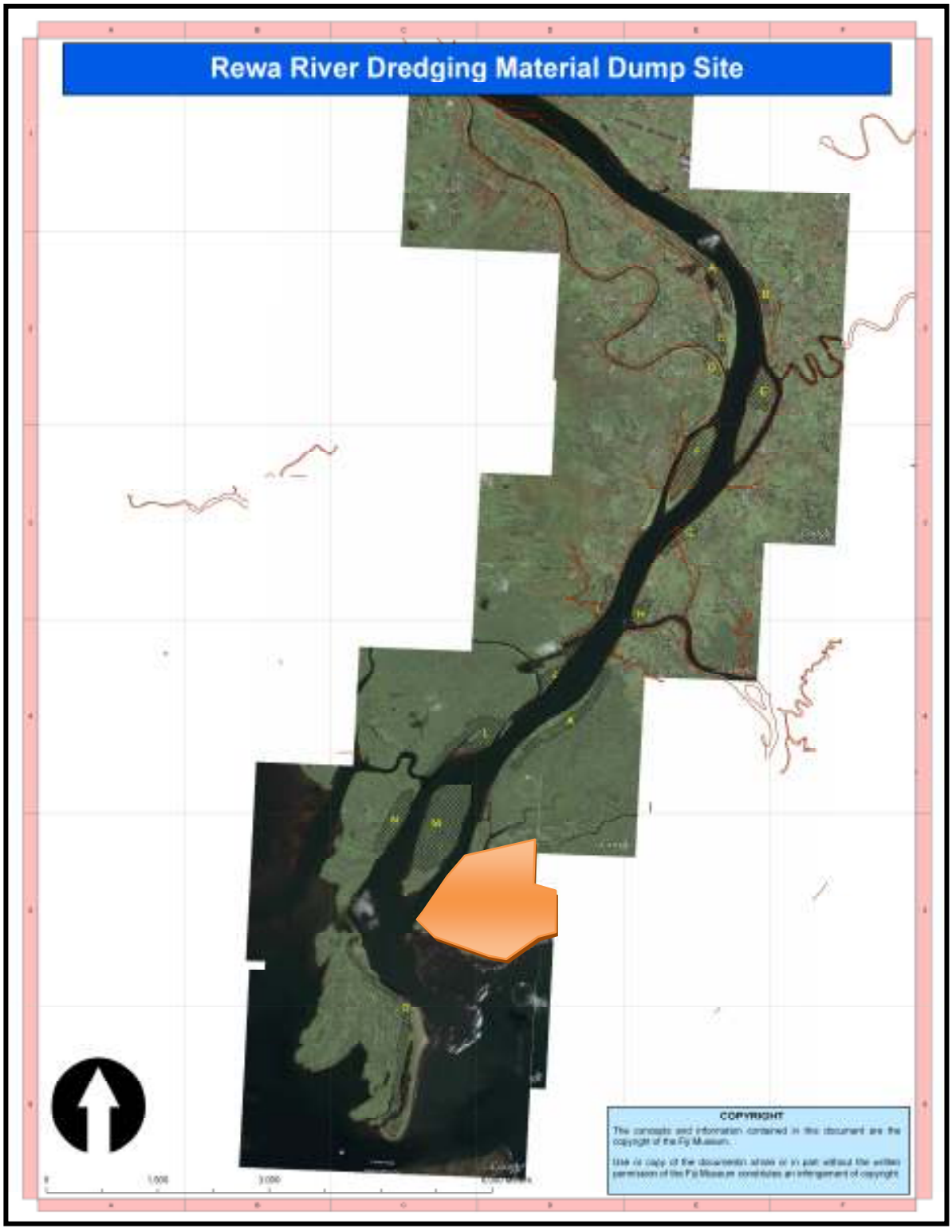

Figure 5: This is the map used as a guide during the field assessment. The demarcated orange territory holds several sites of cultural importance and requires further investigation.

APPENDIX K

Socio-cultural survey of relevant stakeholders

by Patrick Fong

Institute of Applied Sciences
USP

Social Impact Assessment of the Rewa River Dreading

Introduction and Background

A social impact assessment was conducted in 22 villages that have customary fishing rights area along the proposed dredge area and also settlements and businesses along the same area of the Rewa River. The assessment was made to gather the views of the local people and businesses on the proposed project and to gauge for their support of the project. Part of the assessment was the suitability of the proposed dump sites and the effect of the proposed development project on surrounding local residents and business during the construction stages of the development and as a result of the finished project. Communities' concerns and proposals to the project were also gathered and clustered together. The social demographics, community development and significance of the Rewa River and infrastructure of the area have been located, identified and described.

Aims and Objectives

The primary objectives of the social impact assessment are to:

- provide a description of the social demographic setting of the villages that have fishing rights area along the proposed dredged site and also the settlements along the same site
- provide a description of the public health, employment and community current and proposed development of the area and also provide information on the significance of the proposed dredged site to the local people
- gauge the views of the local people on their support for the project and also to note their concerns on certain aspects of the project
- provide information of the proposed project to the various *turaga ni koro, mata ni tikina* and *Turaga ni vanua* along the project site in the presence of the staff from the Rewa and Tailevu Provincial Office. Presentations were made and feedbacks were received from several villages regarding some specific concerns or requests

Methodology

Community consultations in the form of a focus group interview using unstructured questionnaire were conducted in the villages along the Rewa River (see table below). The villages were first informed through the village headman prior to these gatherings to ensure the full participation and availability of representatives from all social units and groups within the village.

Qoliqoli Ownership	**Villages surveyed**
Yavusa Buregadro and Maraki	Naselai
Yavusa Natogadravu, Nuku, Muana and Natavea	Natogadravu and Nataveya
Vanua of Toga	Navatuyaba, Vunisei and Muana
Vanua Vutia	Muanaira, Muanaicake and Laucala
Vanua of Burebasaga	Narocivo, Nukui, Burebasaga, Nukutubu, Nadoi, Waivou, Vunuku, Tavuya, Nasilai, Nasigatoka, Nabua, Drekena and Lokia

Also, key informants in these villages were interviewed in order to get information on proposed community development programs and how they feel the proposed project will affect the local people and the at the village level. An open-ended questionnaire was used for this interview and the list of some of the key informants is given below:

1. Village headman
2. Village chiefs
3. Head of village committees (e.g. Development Committee, Health Committee
4. Women's group rep
5. Youth group rep
6. Head of religious body
7. Village advisors

Also, household interview using semi-structured questionnaire was conducted in the 22 villages and also in the settlements, housing and satellite households along the Lokia road, Tawakelevu road, Toga road, Koronivia road, Naselai road and Wainibokasi road. A sample size to represent the total households in this region was determined and the households interviewed were selected using the random sampling method. In total, 270 household interviews were conducted representing 30% of the total households in the region.

RESULTS

Demographic information

The population directly affected by the project consists of villages that have fishing rights area along the Rewa River and also settlements along the bank.

Background information and social structure

The proposed project site covers part of the Rewa Province and also a small portion of Tailevu Province. However, these communities are linked traditionally for Fijian villages and tenancy arrangement for Indo-Fijian settlements. To highlight the existence of the traditional social relations of these villages, the villages of Naselai and Natogadravu of Nuku district in Tailevu belong to the Methodist Church Division of Rewa. The Methodist Church of Fiji clustering these communities into Church Divisions was based on traditional social links.

Housing and public health

The interviewers recorded two characteristics of the premises of the households: the material used for the wall (e.g., bamboo, wood, corrugated iron, or concrete) and the materials used for the roofing (e.g., thatch/leaves, tiles, corrugated iron or concrete). All the households interviewed have corrugated iron roof. The majority (40%) of houses along the study site have corrugated iron wall followed by wooden wall (34%), cement wall (25%) and a few wooden wall (1%) as shown in Figure 2.

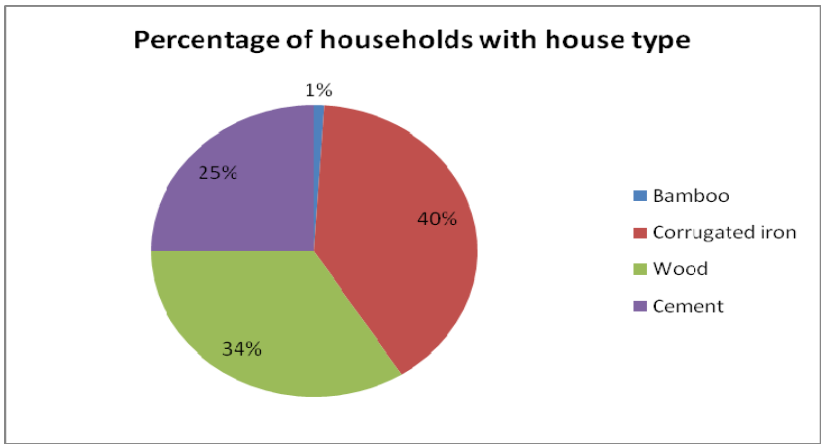

Figure 2: House wall type for the households along the project site

In terms of toilet type, the majority (74%) of the respondents have flush toilet either inside or outside of their house, some (22%) have water seal and a few (4%) with pit toilets as shown in Figure 3. According to the survey, all the households have a proper toilet system.

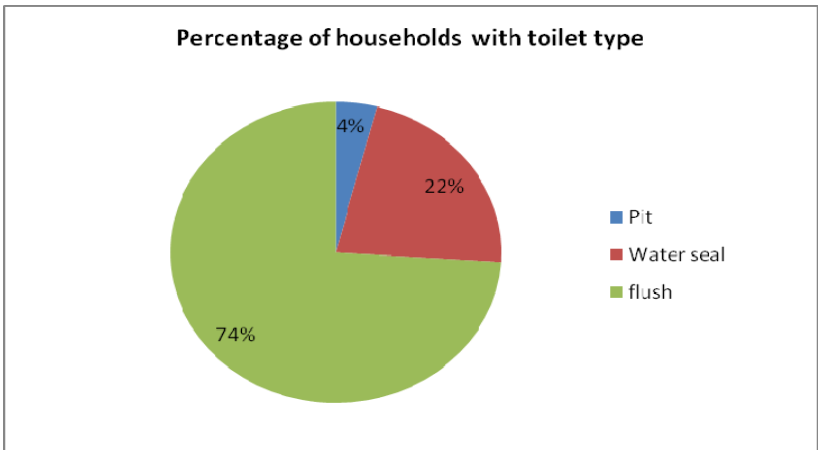

Figure 3: Toilet type for households along the project site

Overall, the housing standard in this region is on average level and people have adequate housing facilities. Being situated close to Nausori Town and Suva City whereby, various housing assistance scheme is easily available, some have paid employment and accessibility to information and advice is easy, the households in this region have better housing facilities compared to some other parts of Fiji Islands. The majority (84%) of the respondents stated the seasonal fever as the main sickness that members of their households get while diarrhea and skin diseases are minor sickness which 7% and 9% of the respondents highlighted respectively.

Household economics and employment

From the survey, it was noted that the income source in the villages and settlements surveyed is diversified as shown in Figure 4. Also, most families do not depend on one particular sources of income but on more than one income source. Being situated along the fertile Rewa Delta and close to Suva and Nausori, the majority of the households interviewed depend heavily on paid employment and farming as the main source of income. Fishing, especially to those villages next to the river banks and those close to the river mouth, is also an important source of income. It was noted from the interviews that most households also depend on the social welfare funds that are given to the elders or the weak. Remittances from relatives living from other parts of Fiji and other overseas countries is also an important sources of income together with boat operation for those villages that are not accessible by road.

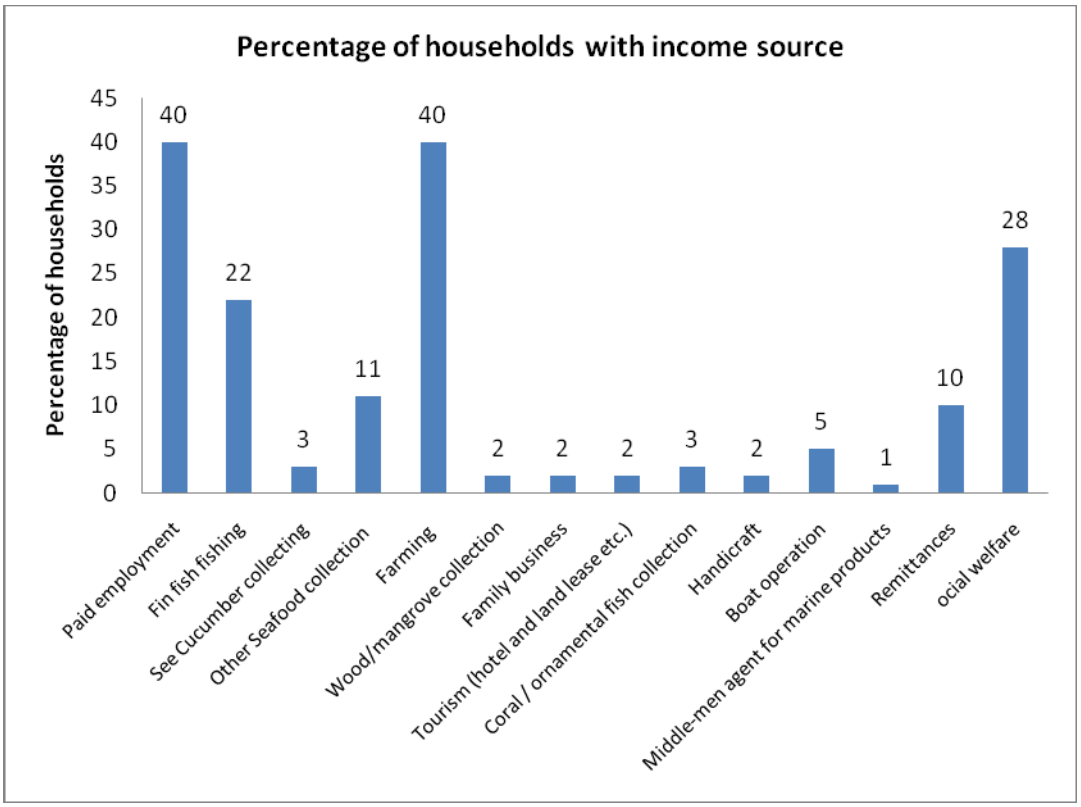

Figure 4: Percentage of households that depend on various income source

The average monthly household income in this study site is $496. The respondents also have a wide range of household monthly income with the lowest being $65 and the highest at $3500.

Significance of the Rewa River to local community

The Rewa River plays a pivotal role in the livelihood of the people that live along side it and is significant in the economy in this region and also in providing social services to the people. From the survey, it is identified that the local people use the river for fishing, recreational purposes, transportation, bathing, drinking and farming purposes. As shown in Figure 5, fishing is the main livelihood activity that most (63%) households take part in followed by transportation (54%), recreational purposes (53%), bathing (39%), drinking (3%) and irrigation purposes (2%). Several parts of the study area are not accessible by road as they are part of another island or landmass and this includes the villages of Lomanikoro, Nasilai, Nasigatoka, Nailili, Drekena, Nabua, Vunuku, Tavuya, Lokia, Narocivo, Muanaira, Muanaicake, Laucala and Nukui. Small punt and fiberglass boat with outboard powered engines is the main transportation mode in these villages.

There are several landing sites for those that travel by boat which include Nasali, Lokia, Vatuwaqa and Laqere. Nasali which is located close to the Rewa Provincial Office is the main landing site which housed several boats, known locally as "water taxis" that can be hired to transport people to their desired destinations. The

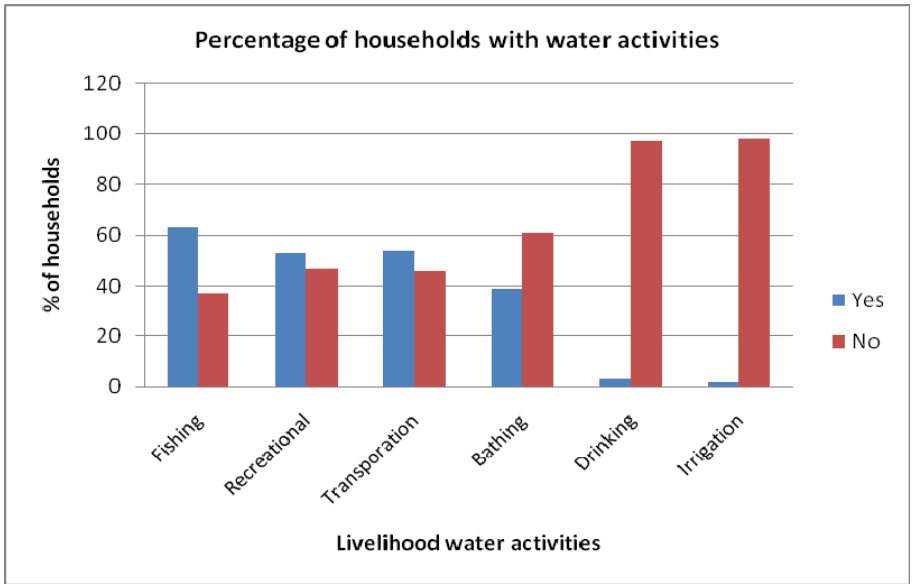

Figure 5: Percentage of households engaged in various water activities

Perception, attitude, concerns and requests for the proposed project

Through the survey, most respondents (60%) are unaware of the proposed project while the remaining 40% are aware through provincial, district or village council meetings, or from staff of relevant government department who visit the area or *word of mouth* from other fellow villagers.

In terms of supporting the proposed project, the majority (97%) of the respondents fully support it while a handful (3%) do not support. Also, the majority of the respondents (96%) stated that the project will not affect their daily activities during implementation while only a few (4%) mentioned otherwise.

For those who support the proposed project, the reasons for their support are clustered below:

- The river will be deeper which will help in reducing floodwater or totally stop flood in this region.
- It will ease village development as sand will be readily available for instance for those who want to construct concrete houses.
- Sand from dreading can be used to bury low-lying village area and reclaim more village or farming areas.
- Sand can be used to bury outskirts of villages therefore, village boundary can be extended.
- If done properly, fish and invertebrates stock within the river might increase
- Coastal erosion will be reduced
- The river mouth will be deeper which will improve the passing of water from the river towards the sea.

For the few who do not support the project or mentioned that the project will affect their daily activities, the reasons are clustered below:

- It will affect some daily activities such as fishing, especially when dreading is done on an important or famous fishing spot.
- The dreading machine and activity might cause noise pollution to nearby village or settlement.
- Deepen the river will affect some key resources such as *kai* for the people of Toga district or will affect the harvesting methods of these resources.

For the proposed dump sites, a map was shown to the respondents to gauge their views on the location. The majority of the respondents (94%) support the site while a few (6%) do not. There are a few concerns for the dump sites or proposals from the respondents which are clustered below:

- If the dump sites could be move in front of the village so that the people can use sand for some village development
- If the Nabuna river can be used as a dump site
- The dump sites can be brought to the edge of the nearby village to prevent overflooding and to level the village
- To dump sand on eroded river banks to reclaim area and prevent further erosions
- To dump sand on outskirts of nearby village so that the village can be extended for more houses and also more farming areas

- Proposed dump site to be brought to village for village use

Overall, there is overwhelming support from the various villages and settlements for the proposed project and the dump sites. There are some concerns or proposals though from the region and some are village or settlement specific for the whole project.

Overall project concerns or proposal:

- If, at least some of the unemployed youths in the villages to work in the various phases of the project. The community feels that the best approach to conduct the recruitment is through liaising with the Provincial Offices.
- The dredging or deepening of the river to be done in the middle of the river. This issue has been the center of discussions from the various villages and settlements that the team visited due to lessons learned from the previous dredging in the 1980s. In some villages, the last dredging has deepened the side of the river close to the village causing fast erosion of the river banks.
- Also, an informant who used to work as an engineer in the previous dredging of the Rewa River mentioned that some villagers used to bribe the workers in exchange for dumping of sand on their piece of land. This exercise resulted in the dredging of any part of the river to meet the request of the villagers rather than working according to the dredge plan.
- The dredging of the side of the river has also affected the collection of resources as local people; especially older women find it hard to fish in deeper dredged fishing grounds. It should be noted that fishing, transportation and other water activities along the Rewa River are concentrated on the sides of the river rather than the middle, therefore, any dredging activities should focus on the center of the river
- In the recent Cyclone Mick, the team revisited or contacted some of the villages and settlements and most highlighted that most proposed dump sites were flooded. This raises the concern of similar situations in future when sand is already dumped on the sites, which might result in the sand being washed back into the river. The dump sites with high elevation should be considered as the best spot for dumping dredging materials

Other specific requests from villages and districts

Rewa District

- A request from this district to also dredged the Nasali River, an important river in the economy of this district. Most of the water taxi operators highlighted that this river is becoming shallow and dredging the Rewa River might cause the Nasali River to be shallower.
- For the government to assist in constructing sand trap to prevent dredged sand from washed back into the river and also to reduce or stop coastal erosion

Burebasaga District

- The village of Burebasaga mentioned during the consultation meeting that about 50 acres of their farming land next to the river bank have been washed away into the river.

Therefore, they request that sand be dumped into these lost areas and retaining materials be constructed to stop further erosion of the river bank

Vutia District

- Muanaira village has offered part of an island opposite the village, known as Koronigone to be a dump site. This will enable them to have access for more land to build houses and extend the already very limited village boundary.

Toga District

- The river bank along Muana village has eroded at a faster rate as a result of the last dredging activity, according to a village member. To the community, this was the result of the dredging of the side of the river and a special request from this village for the center of the river to be dredged and sand to be dumped on the side to make it shallow

Tokatoka District, Tailevu

- Nakaile village made a special request for the dredge to be done according to the plan and that no dredging to be done along the Wainibokasi River as this is the main area that the villagers fish in for sustenance and income.

Nuku District, Tailevu

- Naselai village has offered a piece of land in fron of the village as dump site. The sand can be used to reclaim lost lands along the river banks and can also be used for community development such as building constructions

APPENDIX L – Nausori Town Council submission – Administrator Mr Napolioni Masirewa

NAUSORI TOWN COUNCIL

P.O. Box 72, Nausori, Fiji.
Phone: 347 7133, Fax: (679) 340 0048
Email:nausoritown@connect.com.fj

Address all correspondence to the Town Clerk
Your Ref:
Our Ref:

21st December, 2009

Rewa Project EIA Assistant Project Manager
Institute of Applied Science
University of the South Pacific
Lower Campus
SUVA

ATTENTION: MRS BALE TAMATA

Dear Madam,

REWA RIVER DREDGING

I have been asked to comment on the need for the dredging of the Rewa River to mitigate the impact of severe flooding, in the Delta. I believe it is urgent that such mitigation measures be continually undertaken in this part of the country.

There was an MPI Dredging Unit based in Luvuluvu about a decade ago. It ceased operations and transferred to the West. Given that other parts of the country are facing severe flooding as well (both in the Northern and Western Divisions) it is critical that resources be spread within each of the divisions to undertake regular dredging.

This last week, there was flooding in Waila and Dilkusha and even though the damage was not as substantial for the 135 affected families it could potentially be worse if any major flooding were to occur. Damages incurred in this last flood included road damages, water blockages, electricity and power lines disrupted and high tidal flow causing overflow into low lying areas.

The potential for future high water levels due to climate change should not also be discounted given that a substantial portion of the Rewa Delta is only a few feet above sea level. There is a need to construct dams and levees within the river system to ensure the flow of water within and out of the river system.

The banks of the Rewa within and around Nausori town is also vulnerable to erosion. Planting trees and vegetation on the banks have their limitation when the flood volume is high there is bound to be some erosion.

The construction of buildings on the river side have to recognize flooding as an occasional challenge. Already in Naiyala Subdivision closer to the airport, the Department of Town and Country Planning had recommended the construction of buildings on piles some years ago. Those that heeded that advice did not suffer last week's floods. There were victims of flood in Naiyala who built houses on the ground level.

In the long run Nausori will have to consider the construction of buildings on piles to mitigate the impact of the floods.

Overall the Rewa Delta will have to contend with the flood as an occasional aberration. We need to face this challenge as well as encourage the other government agencies to develop mitigating mechanisms. Dredging is a strategic measure to contain flood in Nausori. So is the construction of levees and dykes wherever possible and we seek the assistance of the Ministry of Agriculture and Forests in the;

- development of sound agricultural practices to prevent excessive erosion.
- Drainage of low lying areas
- Prevention of the extensive logging of the water catchment in the upper reaches of the Rewa River.

We will do our own hazard mapping of the town and identify potential vulnerable areas in terms of flooding, hurricane, fire damage etc.

We will also develop standard operating procedures for disaster management both before and after. We see a proper linkage between our procedures and of the need for river dredging as a means of controlling floods in the Rewa River.

I trust the authorities will consider this humble submission and be willing to able to discuss them if and when the need arises.

Yours Sincerely,

Napolioni Masirewa
Special Administrator – Nausori

CC: Permanent Secretary for Local Government, Urban Development, Housing and Environment.

APPENDIX M – Participants List – national stakeholder meeting at Rewa Provincial House, Lomanikoro, Rewa on 4 November, 2009.

MATAVEIVOSAKI ENA VUKU NI KELI NI UCIWAI (EIA) NA REWA

NO.	YACAMU	KORO/DEPARTMENT	SAINI
1	Raruana N	Tailevu Prov Office	
2	Dona. T. Tavakalaiyale	Lomainikoro, Rewa	
3	Ratu Meli Tedua	Navatuyaba, Toga	
4.	Viliame Yabaki	Muana / Toga	
5	R.T. Natava Vukivuci	Vunisei Toga	
6	Mitieli Kurusiga	Nasigatoka Rewa	
7	MANOA ROKOTUIRA	M/Tikina Rewa	
8	OSEA TAWAKE DONU	M/Tikina VUTIA	
9	KAVEKINI KOROI	TURAGA NI KORO / LAUCALA	
10	INOKE SERU	✓ ✓ ✓ (MATANIKAUKAU)	
11	JIOTA VUNIANI	✓ ✓	
12	Ponipate Rasusu	T.N. Koro-Muana (Sotomi)	
13	ERONI RASERU	T.N. KORO NAKAILE TOKATOKA	
14	NEMESIO BAKALI	NATA - LAUCALA	
15	Mesese Luveitasau	T.N. KORO / VUNISEI, TOGA	
16.	SUNIA RANAVUE	T.N. Koro. NASILAI	
17	VILIKESA TAVOLA	✓ NUKUTUBU	
18	SAMUELA.V. SAROGOE	NABUA	
19	PITA BARO	LOMANIKORO	
20	SAVENACA TIKINA	BUREBASAGA	
21	MALAKIA RAOMA	NASILAI (T.N.K)	
22	Peni Torowale	Toga (Navatuyaba)	
23.	PAULA RATUKALOU	NABUA.	
24	Ruveté. Gonelevu	Nukui (Rewa)	
25	ALIVERETI VATAKAYA.	TAVUYA (REWA)	
26	Raviuma Lalanibarau	VUTIA	
27.	Timoci Nalewakalou	Burebasaga.	
28	T. Tabukarawa	Rewa Prov Office	
29.	Kuli. Verebasaga	PA Rewa's Office	
30.	VATI KALOUNIVALU	REWA PROVINCIAL OFFICE	
31.	Viniana Rosuaki	Fisheries Dept	
32	Leba Tawake	Department of Environment	
33.	Larissa Brisbane	" "	
34.	JOJI SIVO	IAS/USP	
35	Savenaca Ralogi	NLTB	
36	Nemani [illegible]	FISHERIES DEPT	
37	K. M. CHO	LWRM	
38	Brown [illegible]	LWRM	
39	Bale Tamata	IAS/USP	
40	Semisi Meo	"	

41.	DANIELA TABUKARADSA	REWA PROVINCIAL OFFICE.	
42.	JOJI KALOUNIVALU	/ / /	
43.	KALESI QIOLEVU	/ / /	
44.	VINAYA NAMUDU	/ / /	
45.	SOVAIA YABAKI	/ / /	
46.	SULIANA SENILEBA	/ / /	
47.	VIERI TAKIRI	/ / /	
48.	SALUELA KOROVAVALA	/ / /	
49.	Petero Bai	Nuculau	
50.	Nanoa Rayawa	Koro	
51	Kini Vorawaqei	Dreketa	
55	Meli Kama	Dreketa	
56	Sarama	Nuculau	
57	Diana Bukatora	Tonavuto	
58.			

APPENDIX N

Agenda and Minutes of national consultation meeting – 4 November 2009 at Rewa Provincial House, Lomanikoro, Rewa

Appendix N : Agenda and Minutes of national stakeholder consultation held in Lomanikoro, Rewa at 10.00 am on 4 November, 2009

Agenda of the meeting

1. Welcome by the Roko Tui Rewa
2. Prayers to bless the meeting (delegated by the Roko)
3. Introductions by each participant present (name & organization/village)
4. Purpose of the stakeholder meeting - by Bale Tamata, EIA consultant
5. The Rewa Dredging Project – presentation by senior engineer Mr Cho of L&WRM
6. The EIA Process which required convening such a meeting – DoE staff (Leba)
7. Update on the EIA study, for awareness of the stakeholders – IAS team from USP
8. Questions from participants – Open discussions
9. Summarising main concerns raised, and invitation for submissions to be forwarded to EIA consultants at USP (Bale Tamata, IAS, USP).
10. End of meeting with prayers, followed by lunch prepared by Rewa Provincial Office

Minutes of the national stakeholder meeting held on 4 November, 2009.

1.0 Welcome

The Roko Tui Rewa welcomed everyone present at the meeting. He then delegated a representative from the Tailevu Provincial Office to pray and bless the meeting. The Roko then asked Bale Tamata (IAS, USP) to guide the meeting process.

2.0 Introductions

BT then asked each participant to introduce themselves. Representatives from the local villages, the provincial offices (Rewa and Tailevu), and government department representatives (Fisheries, Lands, Dept. of Environment etc.) were present.

3.0 Purposes of the meeting

BT briefed the meeting on the purpose of the stakeholder meeting – a requirement of the EIA process, and to inform the stakeholders about the project. The forum was also the opportunity to raise concerns with the project proponent – L&WRM.

4.0 The project – presentation by senior engineer, Mr Cho

The IAS team had taken their Power point projector to be used. Mr Cho the L&WRM senior engineer presented a power point presentation, about the government's dredging project. The presentation lasted about 25 minutes.

5.0 The Environmental Management Act (EMA) 2005

BT asked the Department of Environment representative (Ms Leba) to make their presentation on EMA. Leba had pamphlets explaining asbout the EIA process, in the vernacular language. The pamphlets were distributed among the participants, and were very much appreciated by the meeting participants, as most have never heard about EMA, or the EIA process. There were several requests for repeat presentations at other for a (village, tikina and provincial levels).

6.0 The EIA study for the Rewa dredging project

BT introduced the EIA team members present at the meeting (Meo, Saki, field assistants Joji, Apisai, and Simeli).

BT briefly explained what the EIA team intended to do or have done in the EIA study. Meo explained about the biological study, and Saki explained about the socio-cultural surveys.

BT invited the participants to write down any submissions they wished to be included in the EIA report. These were to be passed on to the Rokos who would then pass them on to BT. Although many indicated that they will prepare written submissions, none actually did. BT did call up the Roko Tui Rewa on a number of occasions asking for the written submissions, but none was submitted.

7.0 Questions

BT invited questions from the floor. There were a lot of questions about the dredging – when it will start etc. Many supported the proposed dredging, and requested that the spoil be made available to them, for reclamation and building purposes. The discussion was very lively and interesting, and had to be cut short because of time.

8.0 Conclusions

BT summarized the main issues that were being raised in the meeting, and reiterated the need to document these in submissions to be passed on to the Rokos.

9.0 End of meeting

The meeting ended at 1.00 pm, with prayers by the Tailevu provincial office representative again, before the participants were treated to a lunch.

APPENDIX O

Photographs from Water Quality sites (before cyclone Mick) and project site during Cyclone Mick, 14 December 2009

RW 1 –water quality site 1 facing Laucala Island

RW 2 – looking upstream from Rewa River estuary

RW 3 – Near Nukui Point

RW 5 - Near inlet into Vunivadra channel

RW 4 – eastern shore of Laucala Island

RW 6 – Nailililli

RW 7 – Near Burebasaga village

RW 8 – Near outlet from Toga creek into Rewa

RW 9 – Near L&WRM depot Nausori

RW 10 – Inlet into Toga creek, with metromix plant (yellow)

Photographs from the project site following cyclone Mick which hit Suva/Nausori on Monday 14 December, 2009)

(a)

(b)

(c)

(d)

(e)

(f)

Photographs in Appendix O:

(a) – Looking across flooded Rewa from Suva side

(b) - On new Rewa bridge looking north towards old Rewa bridge

(c) – Flooded metro mix cement plant on junction to Toga road

(d) - On new Rewa bridge looking south towards Toga, house partly under water

(e) – Partly submerged house in Waila, in upper Rewa river

(f) - Laucala Bay (breakwater and Nukulau Island in background) on Thursday 17 December, 3 days after cyclone Mick.

APPENDIX P – Attendance Lists from Community meetings, Rewa and Tailevu villages, November 2009

Burebasaga Participant List 22/10/2009

1) Ratu Luke Vuidreki (Roko Tuni)
2) Savenaca Tikina
3) Timoci Nayalewa (Turaganikoro)
4) Roland Smith
5) Saimoni Tikina
6) Netava Buke
7) Joji Nabalarua
8) Josevata Rokorobiau
9) Wame Qaluvutu
10) Manieta Drodrolagi
11) Neumi Lewenikuruwai
12) Joeli K
13) Eroni Modrau
14) Taniela
15) Savenaca Mataki
16) Peni Tuicake
17) Joeli Kavilo (2)
18) Timoci Rokomokoti
19) Seramaia Mataceva
20) Luke Rokobuta
21) Maikali Vuloko
22) Sakiusa Cala
23) Sitiveni (1)
24) Sunia Caumatalevu
25) Ratu Josefa Vuidreki
26) Mareta Biakusa (2)
27) Ravuama Bola
28) Unaisi Waqa
29) Ketesi Waqa
30) Ratu Alipate Vuidreketi

Naselai Participant lists 27/10/2009

1) Ralagi Koroi (Rokoduvucoko)
2) Saula ROkocakau (Mataki Burebasaga)
3) Ravuama Tavaga
4) Isireli Tava
5) Mosese Lauta (Mata ni tikina)
6) Simione Koroi
7) Savenaca Tuira
8) Sunia Ranavue (Turaga ni koro)
9) Rt Jone Salele
10) Manaini Rokodolo
11) Sunia Dua Vakacagi
12) Sitiveni Uluilakeba
13) Joeli Monalagi
14) Niko Rakaria
15) Epeli Ratunawaqe
16) Ilaisa Talairatu
17) Ilaitia Drotini
18) Kameli Racuaka (Rokisi)
19) Maika Ravetau (Mata ni tabagone)

Vunisei Participant list 27/10/2009

1. Rt Netava Vukivuki
2. Vereniki Batiyava
3. Kamanieli Tamanivalu
4. Kamanieli Tamanivalu (2)
5. Kamanieli Tamanivalu (3)
6. Peni Tamanivalu
7. Moseses Luveitasau

Nakaile Participant list 23/10/2009

1. Vilimoni Toaca
2. Tuvili Vueti
3. Eroni Raseru
4. Sikeli Vueti
5. Dolo Alivereti
6. Nikasio Nadavo
7. Onisimo Burekama
8. Rt Semi Komainaceva
9. Viliame Qelo
10. Jokaveti Eya
11. Alipate Rogo
12. Mikaele Adava
13. Akuila Leweni
14. Valetino Leweni
15. Samuela Cuvu
16. Solomone Qurai
17. Jone Gusuloa
18. Emosi Joeli
19. Josua Tukana
20. Jese Bulileka
21. Amani Tuimalabe
22. Laveni Naikaso
23. Eseta Ravia
24. Paula Raseru
25. Vilimoni Wainiqolo
26. Atunasa
27. Timoci Rokeva
28. Tuiqilai Leweni