

Chapter 2 Basic Data Collection of Basin and Flood Control Plans and Countermeasures

2.1 Natural Conditions

2.1.1 Topography/ Geology

(1) Location

Republic of Fiji (hereinafter Fiji) is located in the middle of southwest Pacific Ocean, between east longitude 174° and 177° and the south latitude 15° and 22°, about 3,200 km north east of Sydney in Australia and about 2,100 km north of Auckland in the New Zealand. Fiji is an archipelago of more than 300 islands, and the total territory including the territorial seas is about 700,000 km² while the total land area is 18,333 km² (almost same area of Shikoku of Japan) accounting for about 3% of the total territory.

The largest island is Viti Levu (area 10,389 km²) and the second largest island is Vanua Levu, accounting for 90% of the total land area. The total population is 837,271 (source: 2007 census, Fiji Bureau of Statistics: FBS). Viti Levu is the center of politics and economy, Suva (the capital of Fiji) and Nadi (center of tourism) are located in the Viti Levu.

(2) Topographical Outline

Many of the Fiji Islands are mainly formed by volcanic activities and others are formed by coral reef. There are islands such as Taveuni (470 km²), Kadavu (411 km²), Gau (140 km²) and Koro (104 km²) other than Viti Levu and Vanua Levu. Generally, there are mountains of which altitude is more than 1,000 m with steep slope in the mountain range. On the other hand, there is flat area of land which is composed of coral reef.

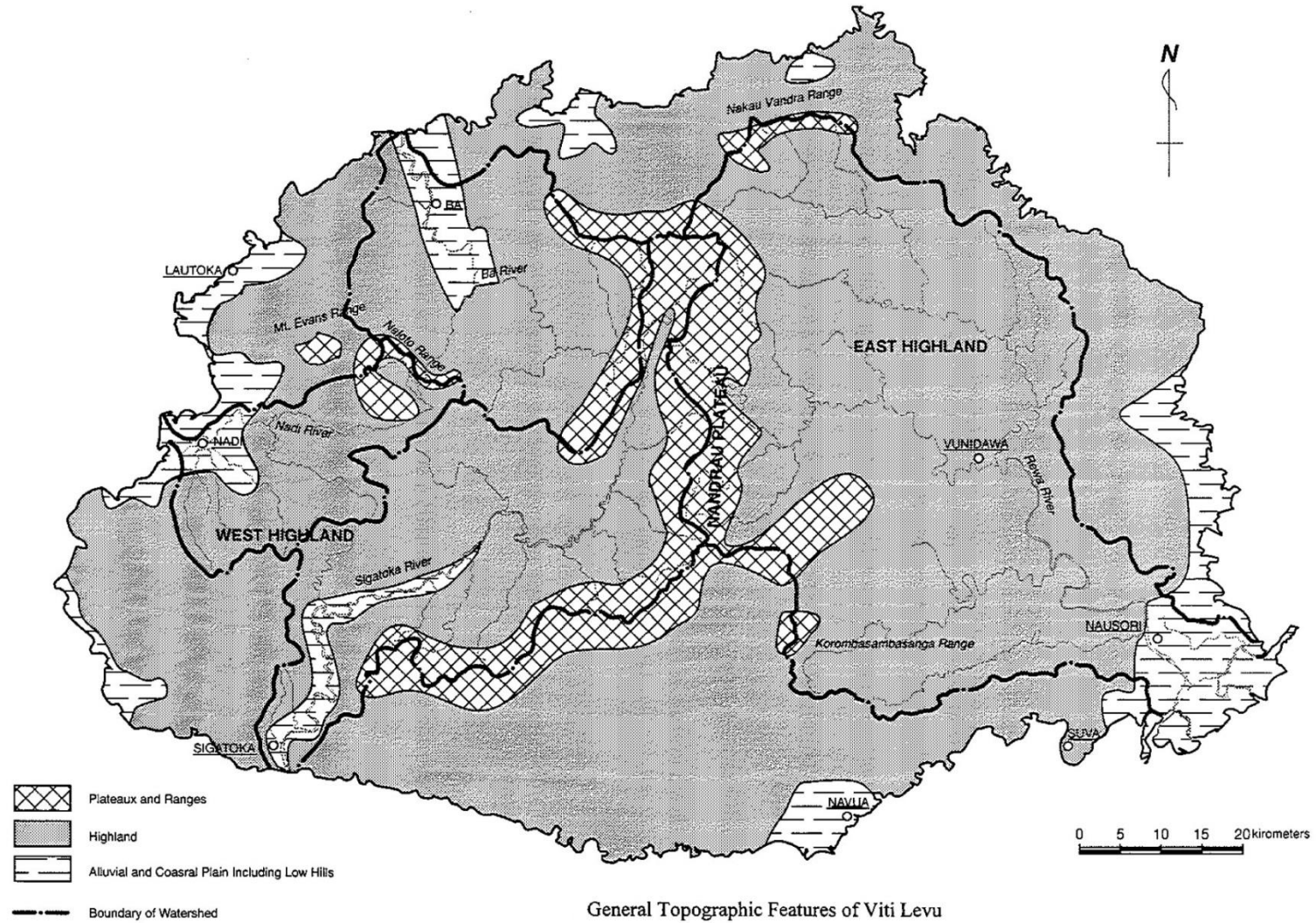
Viti Levu is one of the volcanic islands. The shape of the island is an ellipse with a length 146 km in the east-west direction and 106 km in the north-south direction. Geographical feature of Viti Levu is divided into two parts, west highland and east highland. The feature division is due to a central mountain range called Nandrau plateau. The highest mountain in the central mountain range is the Victoria Mountain (1,323 masl). West highland and east highland are mainly formed from plate-like terrain with 300 to 600 masl. The east highland is mainly covered with dense rainforest, and the west highland is covered with grass and shrubs. The width of alluvial plain and coastal plain is generally limited; therefore, the hilly terrain is close to the coastline. Figure 2-1 shows the general topographical feature of Viti Levu.

(3) Geological Outline

Figure 2-2 shows the geological outline of the Viti Levu Island

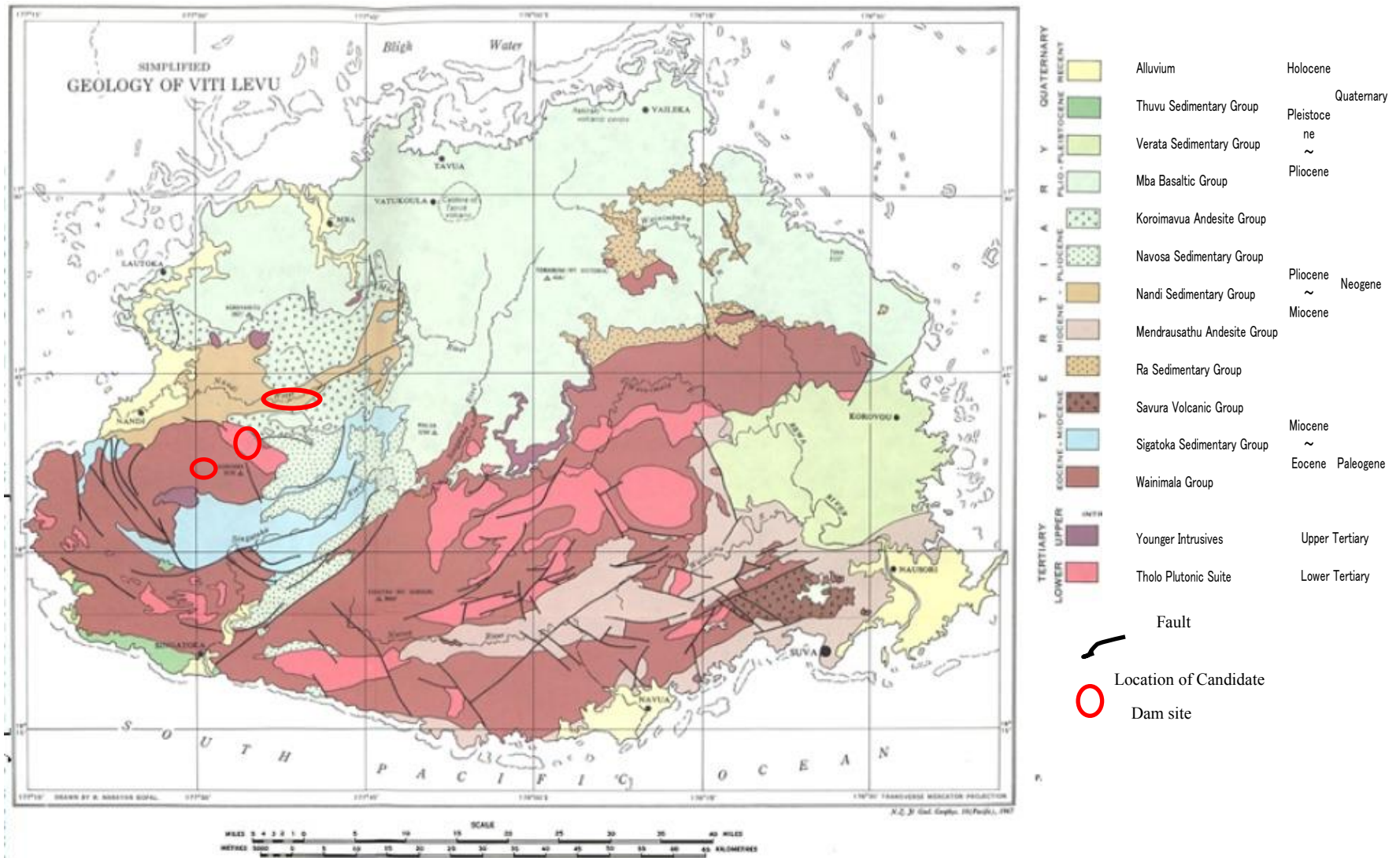
Geology of the Fiji Islands including Viti Levu Island was formed in the Cenozoic era. The oldest geological formation is the Winimala group and Sigatoka sedimentary group which were formed from the late Eocene epoch in the Paleogene period to the middle of Miocene in the Neogene. Thereafter, the Colo Orogeny took place in the middle to late Miocene then the Colo Plutonic rocks were formed. After the Colo Orogeny, Fiji Islands started to emerge/uplift and volcanic activities, in intensity and frequency, increased. As a result, sedimentary rocks and volcanic rocks were formed.

As shown in Figure 2-2, distinguished existing fault system can be seen in the southern part of the island while in the northern part of the island remarkable fault system cannot be seen because volcanic rocks which was formed in the Pliocene epoch widely covers the northern part of the island. Distinguished fault system with NE-SW and NW-SE direction can be seen in the southern part of the Viti Levu Island.



Source: JICA (1998)

Figure 2-1 Topographic Features of Viti Levu



Source : Outline of Geology of Viti Levu. New Zealand Journal of Geology and Geophysics (2011)

Figure 2-2 Geological Map of Viti Levu

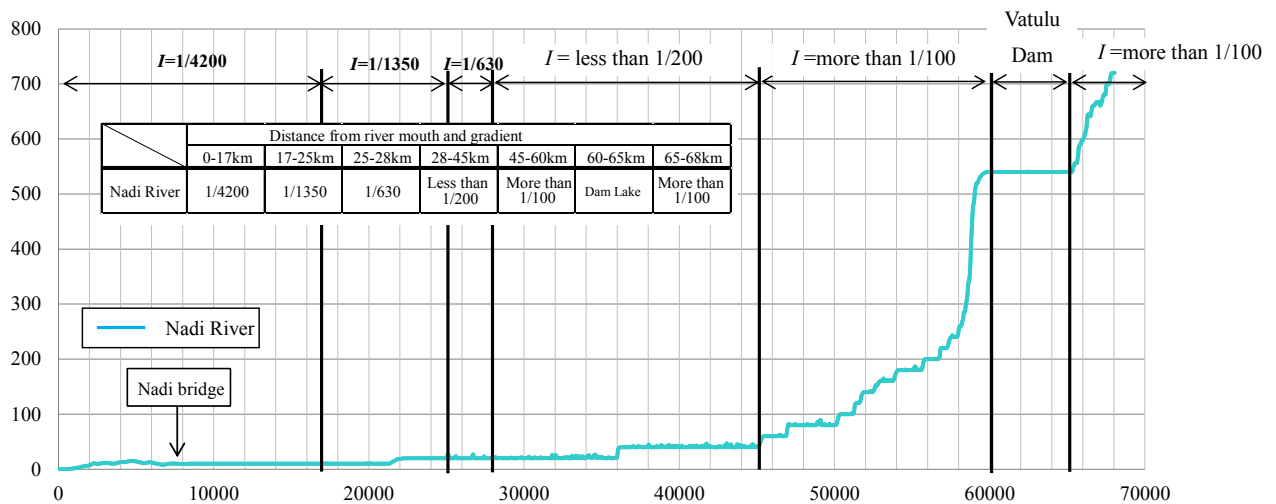
2.1.2 Rivers and Basins

(1) Rivers and Basins

In the Viti Levu, there are several river basins which have relatively large watershed area such as Rewa, Sigatoka, Nadi, Ba and Navua. Generally, these rivers have relatively steep river bed gradient their upstream area and relatively gentle in the section between the mouth and the middle reach.

Topographical feature of whole Nadi River Basin can be recognized by a 1/50,000 scale topographical map and of downstream area of Nadi River Basin can be recognized by a map based on the survey result of LiDAR. Figure 2-4 and Figure 2-5 show topographical feature of each map, respectively. According to those maps, hilly land that continues from the Nandrau Plateau to the Nadi Town and the Back Road which is located in the lower reach of the Nadi River. In this section, the ground elevation of hilly land gradually decreases. Then ground elevation from the Nadi town to the mouth of Nadi River is about two to five masl.

Based on the survey result of LiDAR, as shown in the Figure 2-3, the river bed gradient of Nadi River is about 1/4,200 in the downstream area and more than 1/100 in the upstream area.



Source: JICA Study Team

Figure 2-3 Longitudinal Gradient of Nadi River

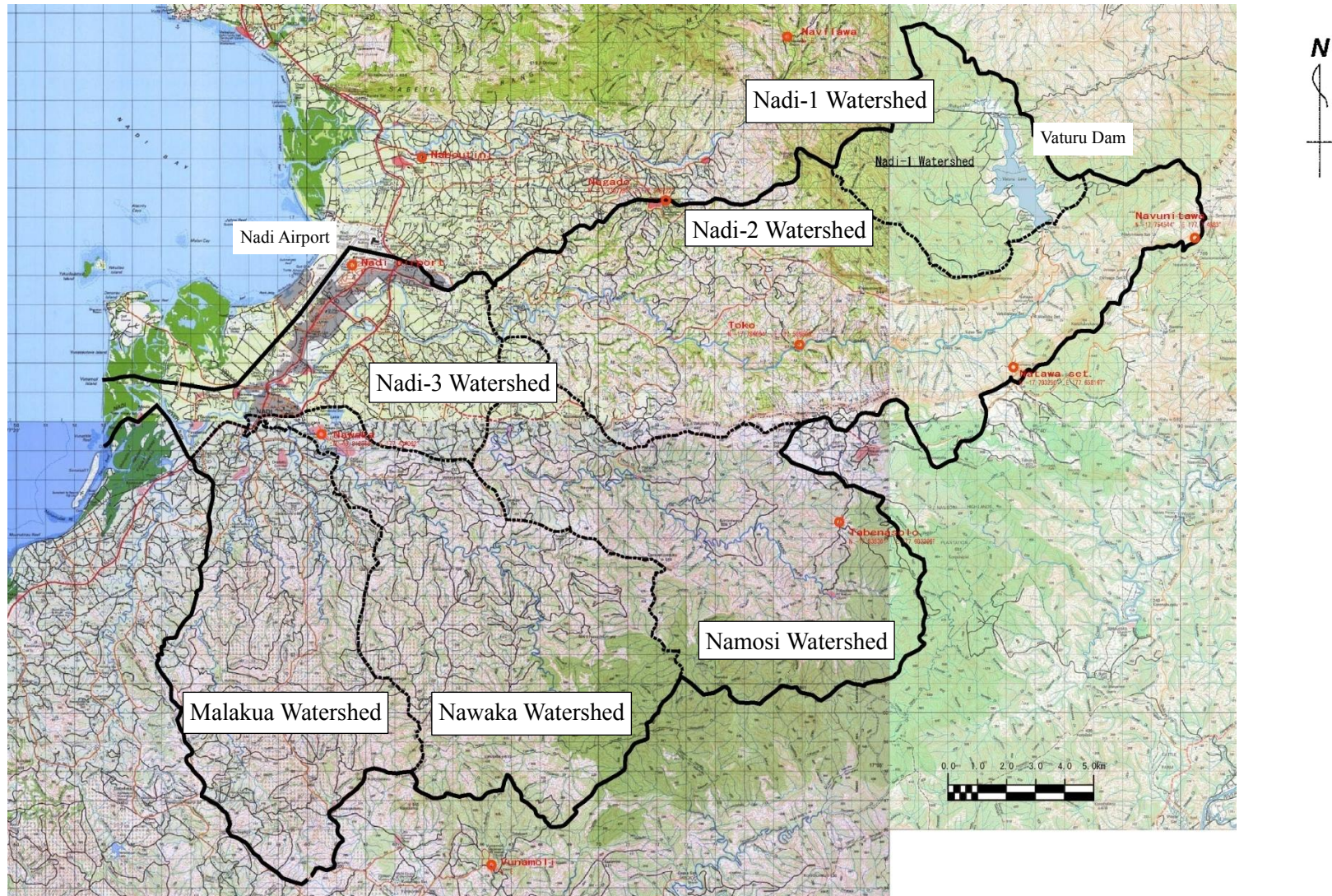
(2) Vegetation and Land Use in the Nadi River Basin

Vegetation in the Nadi River Basin is distinguished by the pine forest and grass land from the middle to upper reach, patch-like sugarcane field in the flat area in the lower reach and mangrove forest in the lower most area. The lower most area in the Nadi River Basin is used for Nadi international airport, urban development of the Nadi Town and resort development, e.g. hotel, and golf course.

(3) Hydrogeology

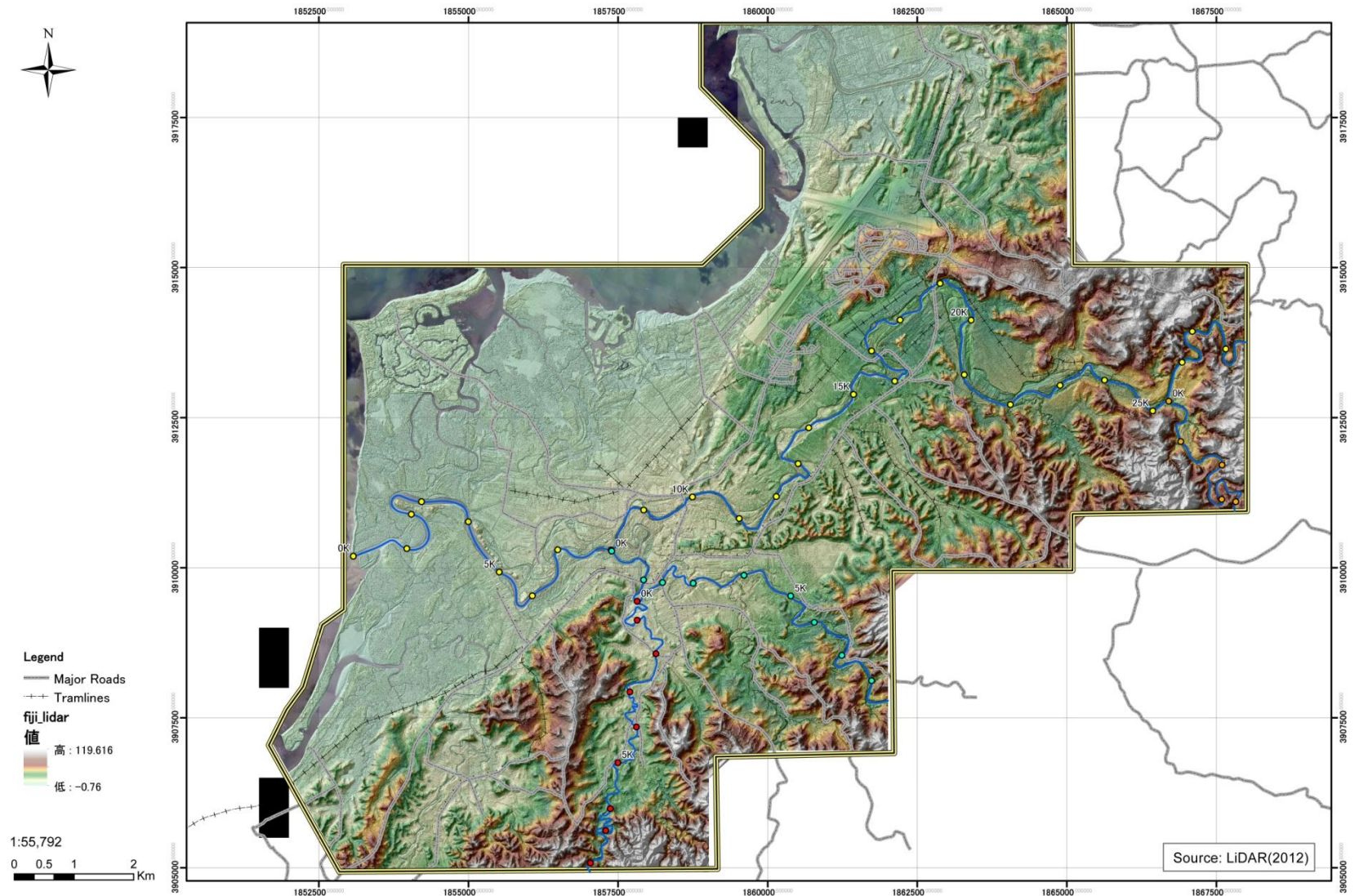
Aquifer in the Nadi River Basin is formed and limited to the alluvium in the alluvial plain. The main water recharge source of the Meigunya aquifer is assumed to be from flood plain and river channel. There are no regulations on the development of groundwater, implementation of boring and construction well. Therefore, the current status of groundwater usage cannot be grasped.

Furthermore, groundwater is managed by the Department of Mineral Resources (DMR). DMR has started the investigation of groundwater by constructing monitoring wells (three or four wells) for the purpose of study of the groundwater resources; however, the result of investigation has not been published as of February 2015, in our study period.



Source: Assembled by JICA Study Team based on the MOL Topographic Map (1/50,000)

Figure 2-4 1/50,000 Topographic Map of Nadi River Basin



Source: JICA Study Team based on the data from SPC/SOPAC “Aerial LiDAR and Photographic Survey Nadi Integrated Flood Management Project October 23rd 2012” (2012)

Figure 2-5 Result of LiDAR Survey (Lower Nadi River)

The Project for the planning of the Nadi river flood control structures

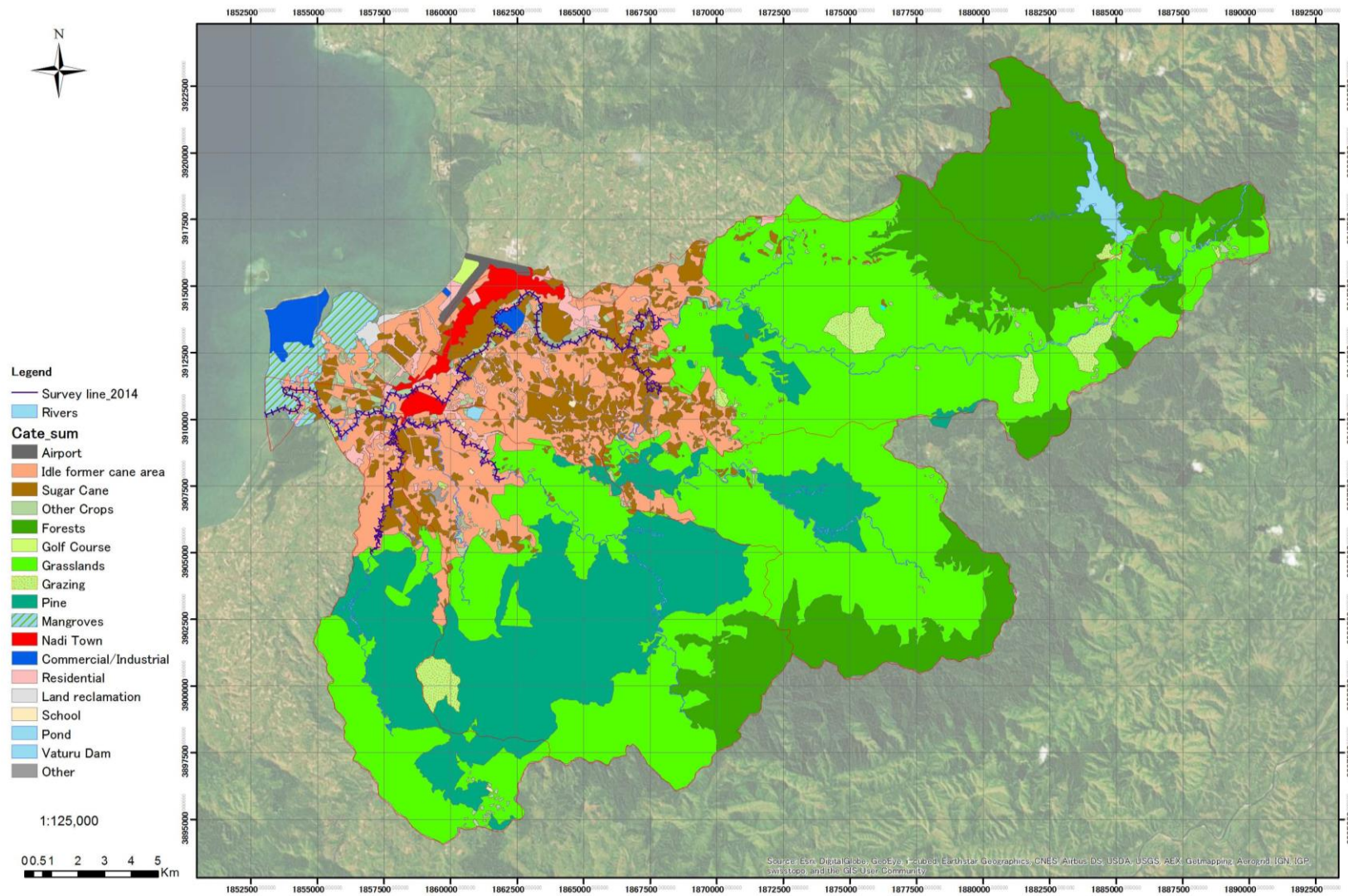
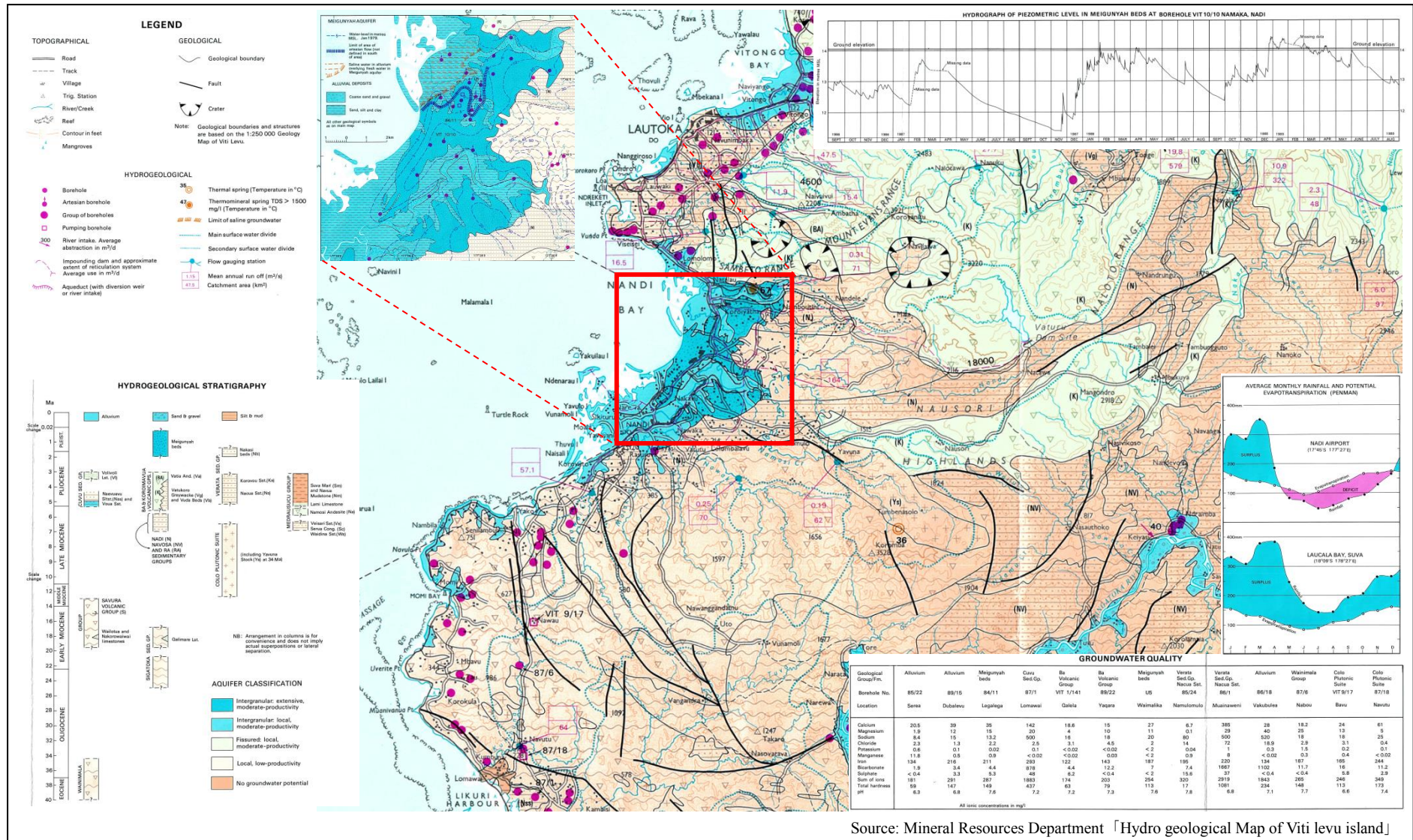


Figure 2-6 Vegetation and Land Use of Nadi River Basin



Source: Mineral Resources Department 「Hydro geological Map of Viti levu island」

Figure 2-7 Hydro geological Map of Viti Levu island

2.1.3 Climate

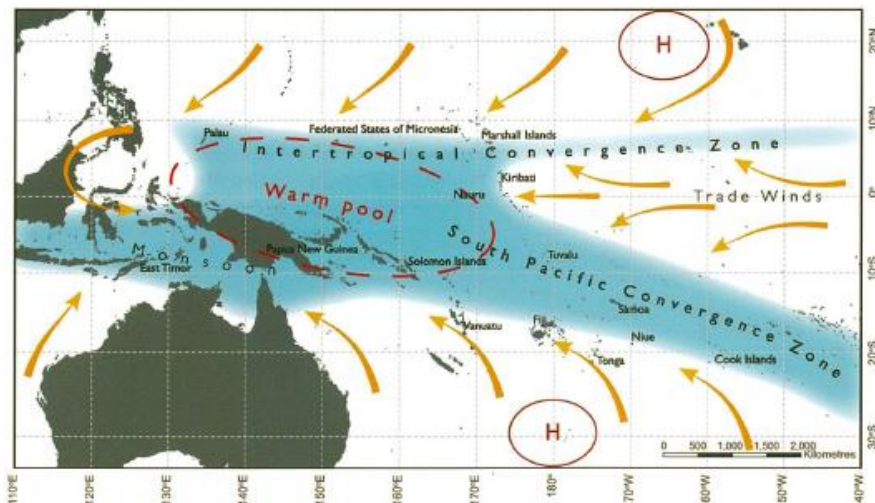
The republic of Fiji is located in the central part of southwest Pacific Ocean and has maritime tropical climate. The lowest average temperature of about 20 degrees is recorded in July and on the other hand it is the highest in January and February reaching near 30 degrees. Season in Fiji is divided into 2 seasons; summer season which is the rainy season from November to next April, winter season is from March to October. Generally a lot of rain falls in the summer season and the country is hit by tropical cyclone attack this country from January to March. Many cyclones occur especially in January and February. On the other hand, the winter is a comfortable season.

Climate in Fiji is greatly influenced by El Nino phenomenon, SPCZ, South Pacific Convergence Zone, which constantly exists in the South Pacific Ocean and trade wind.

ENSO, El Nino Southern Oscillation, is the most outstanding atmosphere oscillation in several years scale in tropical area, and it occurs every 2-7 year, or on average every 4 years. El Nino phenomena make Fiji dry condition and caused by determine of rainfall and drought in the serious case. On the other hand, in case of La Nina Phenomena, heavy rain occurs in rainy season and flood also occurs.

SPCZ is convergence zone constantly exist in the South Pacific Ocean, and it brings heavy rain in rainy season. The largest record flood occurred in 2012 was caused by SPCZ which brought heavy rain in western part of Fiji. SPCZ sometimes activate tropical cyclone and Cyclone Dani occurred in 1999 and heavy rain occurred in January, 2009 are activated by SPCZ.

The following figure shows positional relation with SPCZ, trade wind and high atmospheric pressure, which are the average climate change factor from November to April.



Source : Figure ES.2 in Australian Bureau of Meteorology and CSIRO 2011, Climate Change in the Pacific: Scientific Assessment and New Research, Volume1 Regional, Volume2 Country Reports

Figure 2-8 Average Climate Change Factor near the Equator (from November to April)

2.1.4 Weather and Hydrology

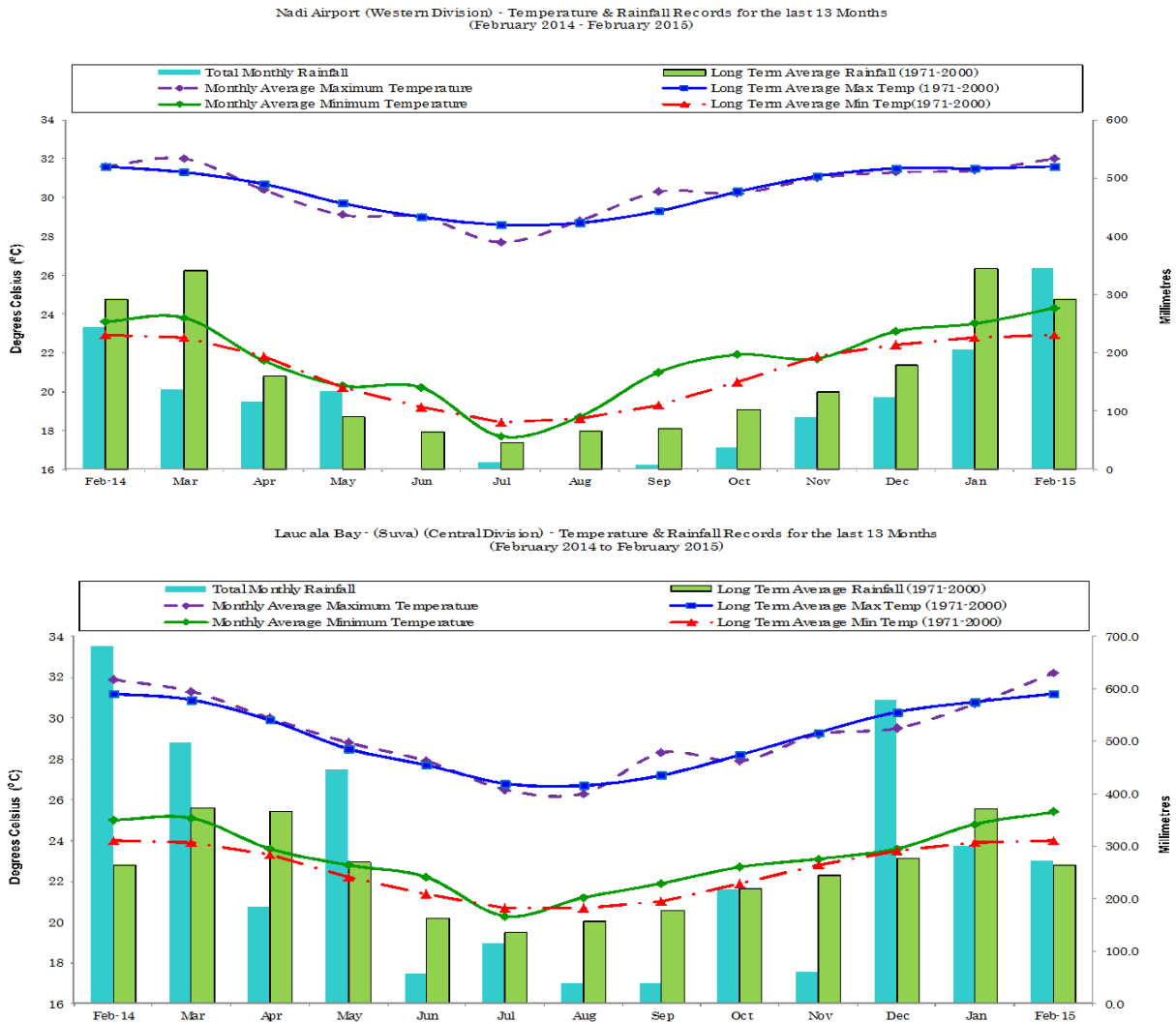
(1) Framework of Fiji's Weather

Viti Levu Island which is the largest island in the Republic of Fiji has different climate in the south-eastern part and the north-western part.

The mountains located in the central part of this island shield from south-eastern trade wind. Therefore, the annual rainfall in Suva located in the south-eastern part of Fiji is about 3,000mm and this town has a lot of rain through year keeping in a humid condition. The weather is more stable in Suva than in the western part of island. On the other hand, annual rainfall in Nadi town, located in the western part and 200km from Suva, is about 2000mm and this town has a lot of sunny days keeping in a dry condition. Besides, the annual temperature variation is small and it has comfortable climate and beautiful natural landscape, so

northwestern area along coast and near island is developed as resort area.

Monthly average temperature and monthly rainfall data during February, 2014-February, 2015 in Suva and Nadi town which the target area of this project are shown in the following figures;



Source : FMS "Fiji Climate Summary, February 2015"

Figure 2-9 Monthly average temperature and monthly rainfall data in recent years in Suva and Nadi town

Figure 2-10 compares the yearly rainfall data of Suva and Nadi and Figure 2-11 shows in pluvial map of Viti Levu Island. These figures show that the amount of rainfall in Nadi located in the western part of Viti Levu Island is less than that of Suva located in the eastern part but there is a tendency in the Nadi River Basin that rain occurs intensively and flooded by several days of consecutive rainfall.

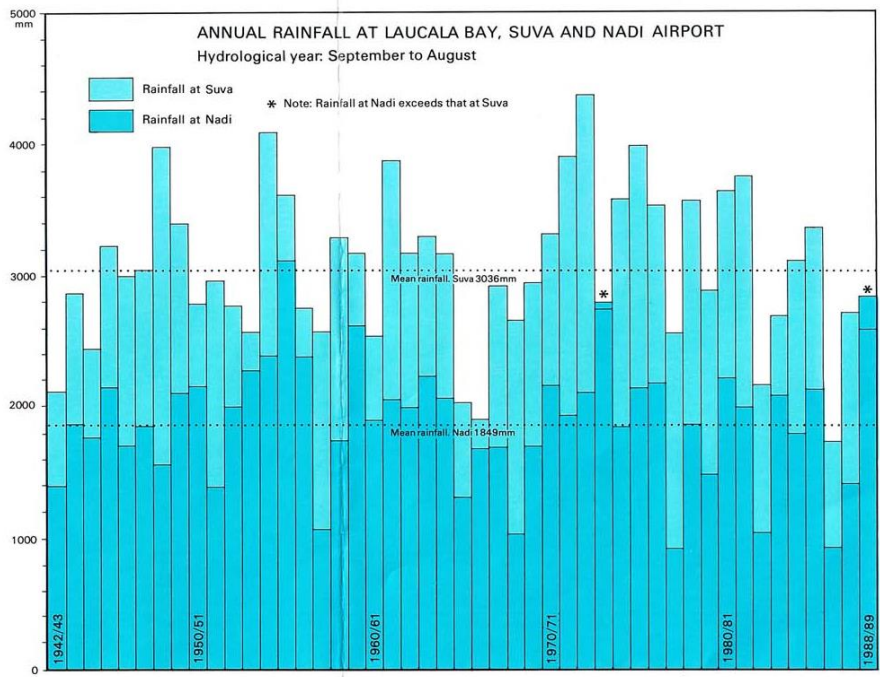


Figure 2-10 Comparison of Suva and Nadi yearly rainfall data (1942/43-1988/89)

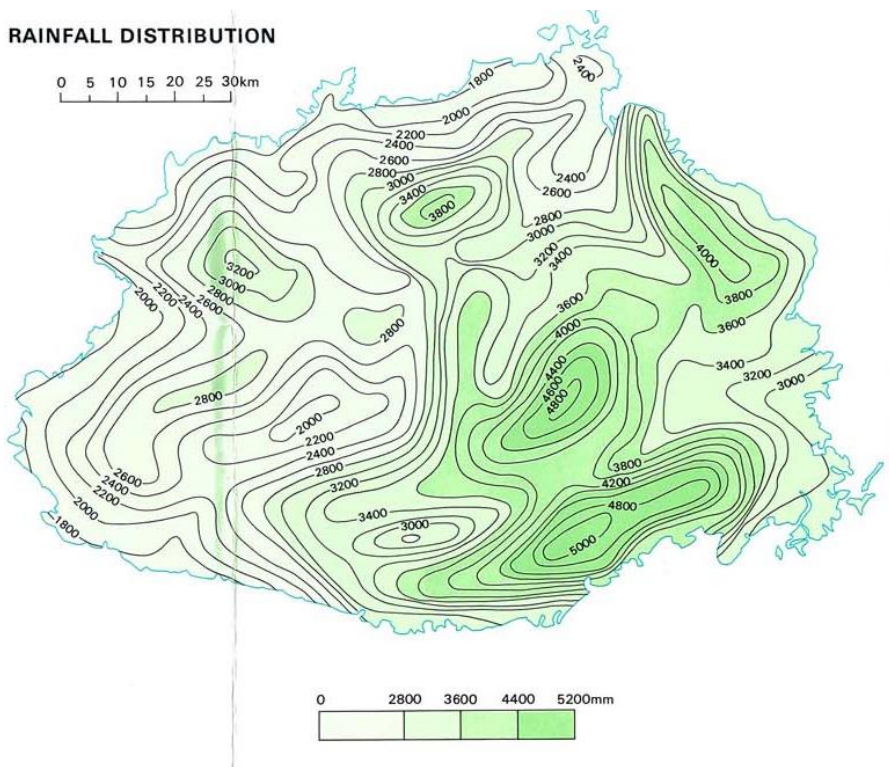


Figure 2-11 Precipitation distribution based on 1991 rainfall data

(2) Observed Data

i. Wether Observation

According to FMS, Fiji Meteorological Service, weather observation in Fiji is conducted in the observatory shown in the following table.

Table 2-1 Weather Observatory

| District Province | Station | Latitude | Longitude | Enclosure Elevation | Remarks | Station Established |
|-------------------|-----------------|---------------|----------------|---------------------|-------------|---------------------|
| Nadi | Vaturu Dam | 17°45' 03"S | 177°39' 56"E | 546m | Climate | *** |
| | Nausori Highlnd | 17°48' 40"S | 177°35' 58"E | 453m | Climate | Cls Nov 03 |
| | Nawaicoba Agri | 17°55' 26.5"S | 177°22' 59.6"E | 137m | Climate | *** |
| | Nadi Airport | 17°45' 35.8"S | 177°26' 41.7"E | 22m | Synoptic | *** |
| | Legalega | 17°45' 16"S | 177°28' 05"E | *** | Climate | *** |
| | Tuvatu-Korobebe | 17°43' 43"S | 177°33' 39"E | *** | Climate | *** |
| Lautoka | Vuda Mobil Oil | *** | *** | *** | *** | *** |
| | Lautoka Wharf | 17°36' 19"S | 177°26' 17"E | 00m | Tidal Gauge | *** |
| | FSC Lautoka | 17°37' 07"S | 177°26' 20"E | 26m | Climate | *** |
| | Lololo Pine | 17°34' 37"S | 177°34' 50"E | 90m | Climate | *** |

*** 2015年3月調査時点のデータ不足の標記

*** Not obtained as of March, 2015

Weather Observatory near the Nadi River Basin which is target of this project is “Nadi Airport” and “FSC Lautoka” and observed items are shown in the following table.

Table 2-2 Weather Observation Items

| Measurement Item | Definition of Daily data |
|-----------------------------|--|
| Maximum Temperature (MaxTT) | Maximum value between 9AM of the day and 9AM of the next day |
| Minimum Temperature (MinTT) | Minimum value between 9AM of the day and 9AM of the next day |
| Rain fall | Total of values between 9AM of the day and 9AM of the next day |
| Relative Humidity (RH) | The value of 9AM of the day |
| Air Pressure | The value of 9AM of the day |
| Sunshine Duration | Total of values between 6PM of the previous day and 6AM of the day |
| Wind Speed | The value of 9AM of the day |
| Wind Direction | The value of 9AM of the day (North: 0 and 360 degree) |
| Evapotranspiration | The value of 9AM of the day |

ii. Hydrological Observation

Hydrological Observatory near the Nadi River Basin is shown in the following table and locality map is shown in the following map. Observed data is recorded in FMS after 1962 but observed situation are different every year and data conservation condition is not integrated so data management is not good. Collected data in this project is shown in “Chapter 5”.

Table 2-3 Hydrological Observation

| SITE | Name | Coordinate | | | Status | Managed by | Type | Remark | |
|-------------|----------|-----------------------|------------------|------------------|-----------|---------------|-----------|------------------------------------|---|
| | | Latitude | Longitude | Source | | | | | |
| Rainfall | 1778510 | Navu/Solovi | 17°50' 52" S | 177°31' 06" E | Rep 1 | Not operating | FMS | PA | Installed by PWD Not working from 2008 |
| | V7793103 | Nawaicoba Res. Sin | 17°55' 26.5"S | 177°22' 59.6"E | FMS | Not operating | MOA | | |
| | 77744 | Nadi Airport | 17°45' 35.8"S | 177°26' 41.7"E | FMS | Operating | FMS | Telemetry | |
| | 177765 | Vaturu dam | 17°45' 03"S | 177°39' 56"E | FMS | Operating | WAF | Telemetry | |
| | 1777612 | Waidum | 17°44' 43" S | 177°35' 52" E | Rep1 | Operating | WAF | Telemetry | |
| | 1778611 | Subenasolo (old) | 17°51' 41.92" S | 177°35' 46.53" E | FMS | Not operating | FMS | Old | IWRM, Telemetry from 2010.12 |
| | | Subenasolo (new) | 17°49'47.29"S | 177°36'16.14"E | | Operating | | Telemetry | |
| | 777701 | Navunitawa | 17°45'16.36"S | 177°42'53.94"E | FMS | Operating | FMS | Telemetry | IWRM, Telemetry from 2010.12 |
| | 1777512 | Molveitāla | 17°45' 06.51" S | 177°33' 23" E | Rep1 | Not Operating | FMS | PA | Discontinue from 2009 |
| | 1777510 | Naboutini | 17°43' 15" S | 177°32' 10" E | Rep1 | Not Operating | FMS | PA | Discontinue from 2008 |
| | 1777513 | Nadurugu | 17°42' 34.36" S | 177°44' 44.52" E | Rep1 | Not Operating | FMS | PA | Not working from 1999.12 |
| | 1777710 | Bukuyu | 17°46' 31" S | 177°45' 41" E | Rep1 | Operating | FMS | Telemetry | Upgrade 2013 |
| | V7786103 | Nausori Highland | 17°48' 40"S | 177°35' 58"E | FMS | Not operating | DOF | | |
| | 1779510 | Vunamoli | 17°56' 43" S | 177°29' 36" E | Rep1 | Not operating | FMS | PA | |
| | 1776510 | Navilawa | 17°44' 57" S | 177°33' 45" E | Rep1 | Not operating | FMS | PA | |
| | 778602 | Natawa Village | 17°47' 35.90" S | 177°39' 30.07" E | FMS | Operating | FMS | Telemetry | IWRM |
| | 777502 | Toko Village | 17°47' 12.36" S | 177°35' 22.12" E | FMS | Operating | FMS | Telemetry | IWRM |
| 777501 | Nagado | 17°44' 25.72" S | 177°32' 43.59" E | FMS | Operating | FMS | Telemetry | IWRM | |
| 778501 | K2 | 17°51' 20.91" S | 177°30' 21.32" E | FMS | Operating | FMS | Telemetry | IWRM | |
| Water Level | 426351 | Toko Village | 17°47'14.82"S | 177°35'25.01"E | FMS | Operating | FMS | Telemetry | IWRM |
| | 425302 | Votualevu Old P/House | 17°46'24.94"S | 177°29'50.30"E | FMS | Operating | FMS | Telemetry | IWRM |
| | 424330 | Nadi Bridge | 17°47'55.05"S | 177°24'58.83"E | FMS | Operating | FMS | Telemetry Automatic before IWRM | IWRM |
| | 425200 | Yavuna | 17°49'36.67"S | 177°32'13.14"E | FMS | Operating | FMS | Telemetry | IWRM |
| | 425202 | Namulomulo | 17°47'41.26"S | 177°29'58.68"E | FMS | Operating | FMS | Telemetry | IWRM |
| | 425201 | Natuacere | 17°50'28.76"S | 177°28'13.17"E | FMS | Not operating | FMS | Telemetry Automatic before IWRM | IWRM |

V: Meteorological Station

PA: Rainfall Station with Automatic Recorder

P:Manual

Rep1: Detailed Planning Survey for The Project for The Planning of The Nadi River Flood Control Structures

FMS: Fiji Meteorological Service

MOA: Ministry of Agriculture

WAF: Water Authority of Fiji

DOF: Department of Forest

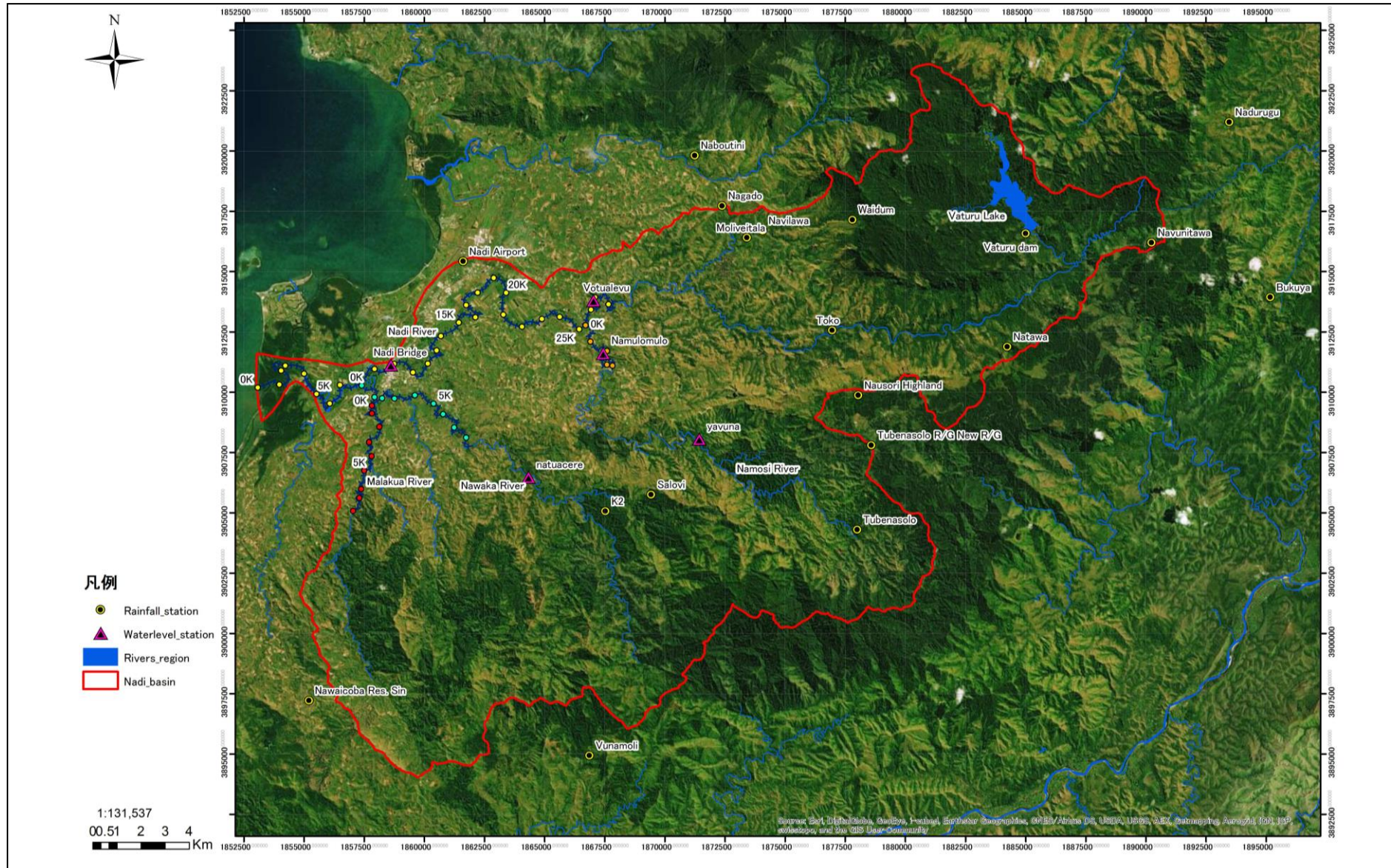


Figure 2-12 Locations of rainfall and water level observatories

2.1.5 Marine Phenomenon

Marine Phenomenon is discussed in “Chapter 9”.

2.1.6 Flood Damage

(1) Outline of Flood Damage

The outstanding flood, flood that caused deaths and damage in the northwestern part of Viti Levu Island and Nadi/Lautoka area during 1870-2014 in whole of Fiji is listed in the following table. Besides, framework of these floods is shown in Appendix 1.

The numbers of people killed by flood is high in the years 1985, 1993, 1997, 1999, 2003, 2004 and 2009. Flood disaster occurred in 2012 also killed a lot of people. Many people were killed by land slide in 2004.

Meteorological factors about flood damage in Fiji are divided into the following three factors;

- Type of South Pacific Convergence Zone (SPCZ)
- Type of Tropical Cyclone (TC)
- Type of Tropical Depression (TD)

The Flood disaster in 2012, which is said to be the worst flood disaster, was caused by TD activated by SPCZ.

Table 2-4 Main Disaster related to Flood in Fiji (1870-2012)

| Year | Month | Date | Disaster ¹⁾ | Number of | Human Affected | Estimated |
|------|---------|------------|------------------------|--------------------|------------------------|------------------|
| | | | | Deaths (Person) | Population (Person) | Damaged (USD) |
| 1871 | Mar | 20-21 | TC | | | |
| 1879 | Dec | 11 | TC | | | |
| 1886 | Jan | 4-5 | TC | | | |
| 1912 | Jan | 28-29 | TC | | | |
| 1918 | Feb | 7 | TC | | | |
| 1927 | Feb | 9 | N/A | | | |
| 1931 | Feb-Mar | Feb2-Mar2 | TC | 225 | | |
| 1932 | Feb | 5-6 | N/A | | | |
| 1933 | Mar | 27 | N/A | | | |
| 1938 | Feb | 27 | TC | | | |
| | Dec | 22 | TC | | | |
| 1939 | Jan | 21 | TC | | | |
| 1944 | Jan | 9 | TC | | | |
| | Mar | 20 | TC | | | |
| 1946 | Jan | 30 | TC | | | |
| 1948 | Jan-Feb | Jan31-Feb4 | TC | | | |
| 1954 | Jan | 15-19 | TC | | | |
| 1955 | Mar | 8 | N/A | | | |
| 1956 | Jan | 30-31 | N/A | 3 | | |
| | Mar | 6 | N/A | | | |
| 1964 | Mar | 22 | Storm | | | |
| | Dec | 18-22 | TC | | | |
| 1965 | Feb | 9-12 | TC | 11 | | |
| 1972 | Oct | 24-25 | TC Bebe | | | |
| 1973 | Mar | 2-6 | N/A | 5 | | |
| 1974 | Jan | 10-12 | N/A | | | |
| | Feb | 25-26 | N/A | | | |
| | Mar | 12-14 | N/A | | | |
| | Apr | 24-26 | N/A | | | |
| 1975 | Nov | 17-20 | N/A | | | |
| 1982 | Jan | 23-31 | Storm Hettie | 1 | | |

| Year | Month | Date | Disaster ¹⁾ | Number of | Human Affected | Estimated |
|------|---------|------------|------------------------|-----------|----------------|---|
| | | | | Deaths | Population | Damaged |
| | | | | (Person) | (Person) | (USD) |
| 1983 | Feb-Mar | Feb28-Mar2 | TC Oscar | | | approximately F\$148 million (World Bank, 2000) |
| 1984 | Mar | 16-18 | Gale Cyril | | | |
| 1985 | Jan | 17 | TC Eric | 23 | 150,000 | 39,712,636 |
| | Jan | 19 | TC Nigel | | | |
| | Mar | 5-7 | TC Gavin | 7 | | |
| 1986 | Mar | 16-17 | TC Hina | 3 | 6,000 | |
| | Apr | 10-11 | TC Martin | | 5,600 | |
| 1989 | Dec | N/A | TC Rajah | 1 | 3,000 | 14,000,000 |
| | Feb | 9-15 | TD | 9 | | |
| 1990 | May | 28-30 | TD | | | |
| | May | 21-22 | TC Rae | 3 | | 26,200,000 |
| 1992 | Nov | 27-28 | TC Sina | | | approximately F\$33million (World Bank, 2000) |
| | Dec | 10-11 | TC Joni | | | 1,600,000 |
| 1993 | Jan | 3 | TC Kina | 23 | 28,000 | approximately F\$188million (World Bank, 2000) |
| | Feb | 17 | Gale Oli | | | |
| 1995 | Mar | 13-19 | N/A | | | |
| 1997 | Jan-Feb | Jan19-Feb2 | TC Evan and Freda | | | |
| | Mar | 8 | TC Gavin | 25 | 3,500 | 18,300,000 |
| 1998 | Nov | 11-13 | TC | | | |
| 1999 | Jan | 18-19 | TC Dani, SPCZ | 12 | 2,000 | 2,000,000 |
| 2000 | Mar | 2 | LP | | | |
| | Mar | 17 | LP | 1 | | |
| | May | 2-4 | LP | | | |
| | Dec | 7-12 | TD | 4 | 5,600 | |
| 2001 | Feb | 19 | LP | 1 | | |
| | Feb-Mar | Feb28-Mar1 | TC Paula | 1 | | 800,000 |
| 2002 | Oct | 21-23 | LP | | | |
| | Feb | 23-24 | TD | | | |
| 2003 | Mar | 7-11 | SPCZ | | | |
| | Jan | 14 | TC Ami | 19 | | 22,089,200 |
| 2004 | Mar | 13-14 | TC Eseta | | | |
| | Feb | 6-14 | TD | | | |
| 2005 | April | 7-8 | TD | 12 | | 11,585,392 |
| | April | 18-20 | N/A | | | |
| 2006 | Oct | 26-30 | N/A | | | |
| | Jan | 28-29 | TC Jim, SPCZ | 4 | 1,049 | FJD 26,952.26 |
| 2007 | Feb | 4 | TC Jim, SPCZ | 1 | | |
| | Feb | 4-12 | TD | 0 | | FJD 2,985,989.00 |
| | Mar | 9-14 | LP | 3 | | FJD 695,327.00 |
| | Mar | 20-25 | LP | | | |
| 2008 | Apr | 4-5 | TC Cliff | 1 | | |
| | Jan | 3 | TD | 1 | | |
| | Jan | 28-30 | TD, TC Gene | | | FJD 43,532,149.70 (Estimation) |
| 2009 | Feb | 25 | SPCZ | | | |
| | Jan | 7-14 | SPCZ,TD | 11 | 146,725 | FJD 112,990,000 |
| | Jan | 28-29 | TC Hettie | | | |
| 2010 | Dec | 14-15 | TC Mick | 3 | 148,947 | 31,025,851.61 |
| | Mar | 1-12 | TC Tomas | 2 | | FJD 83,833,800.49 |
| 2012 | Jan | 23-25 | TD,SPCZ | 5 | 178,153 | FJD 85,020,000.00 (Initial Assessment) |
| | Mar-Apr | Mar29-Apr2 | TD,SPCZ | | | |
| | Dec | 17 | TC Evan | | | 108,467,187 |
| 2014 | Jan | 29-31 | SPCZ | | | |

Source: 「Summary of Major Disaster in Fiji 1985-March2010: NDMO」及び「Flooding in the Fiji islands between 1840 and 2009: Simon MCGREE, Stephen w. YEO and Swastika DEVI」を元に調査団にて作成

1) TC:Tropical Cyclone, TD:Tropical Dipression, LP:Low Pressure, SPCZ:South Pacific Convergence Zone

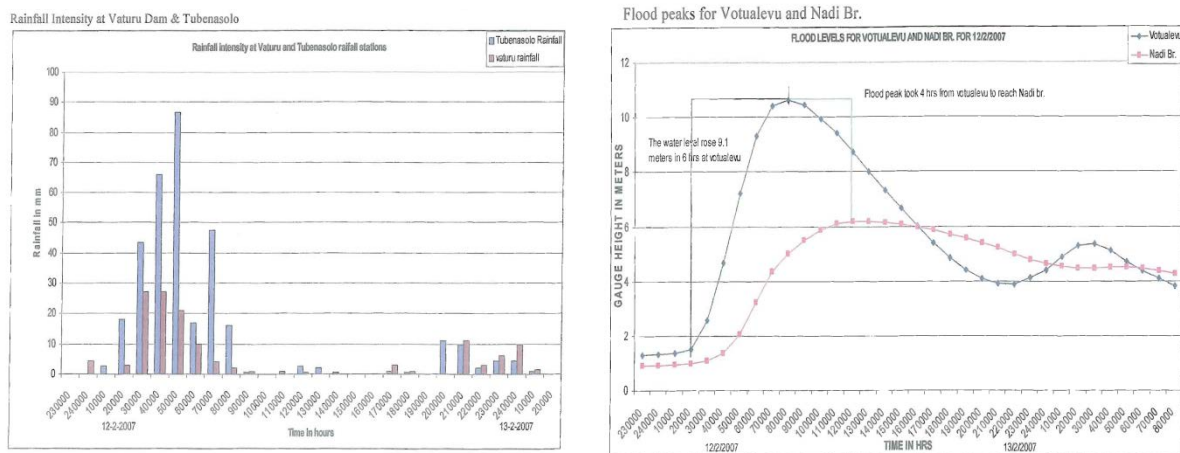
(2) Main Flood Disaster in Past

Outline of flood disaster including main flood disaster, water level record and economical damage by flood is described in the following sections.

i. Flood Disaster in February, 2007

A developed tropical depression on the north part of Rotuma Island was found on February 2007 and begun to transfer toward southwest. At the same time, depression trough including heavy rain hit the eastern part of the Fiji Islands and the depression went through Vanua Levu Island and Lau Island on February 4th. The depression had stayed in the north part of the Fiji Islands for several days and then had begun to move toward south on February 8 and heavy rain continued until February 13.

Rainfall data and peak water level during this flood disaster is shown in the following figure. The maximum hourly rainfall was 27mm/hr in Vaturu Dam Observatory and 86.5mm/hr in Tubenasolo Observatory and the maximum daily rainfall recorded by two observatories was 129mm /day and 337mm/day respectively on February 12. Vaturu Dam Observatory is located in upper stream of Nadi River and Tubenasolo Observatory is in upper stream in Namosi River, as shown in Figure 2-12, the location map is shown in figure 2-12. River water level was 10.5m at Votualevu Observatory and 62m at Nadi Town Bridge Observatory. The peak water level during flood was recorded at Nadi Town Bridge Observatory four hour later after it was recorded at Votualevu Observatory; the distance between these observatories is about 15km.



Source: "Hydrological Report Flash Flood on 12/2/2007 Western Division"

Figure 2-13 Rainfall Data and Water Level during the Flood in February, 2007

ii. Flood Disaster in January, 2009

The active depression trough and SPCZ had stayed above the Fiji Islands from February 7 to 14 and they brought especially heavy rain in the western and northern part. From February 11 to 12, the depression trough moved towards the north temporarily, but on February 13 and 14, moved back to the south and brought heavy rain again. The disaster damage reached the entire Fiji Islands and then 11 people were died and made 12 thousand people lost their homes and economic damage reportedly amounted to 113 million FJD (about 54.7 hundred million yen), which was the worst disaster damage in Fiji at that time.

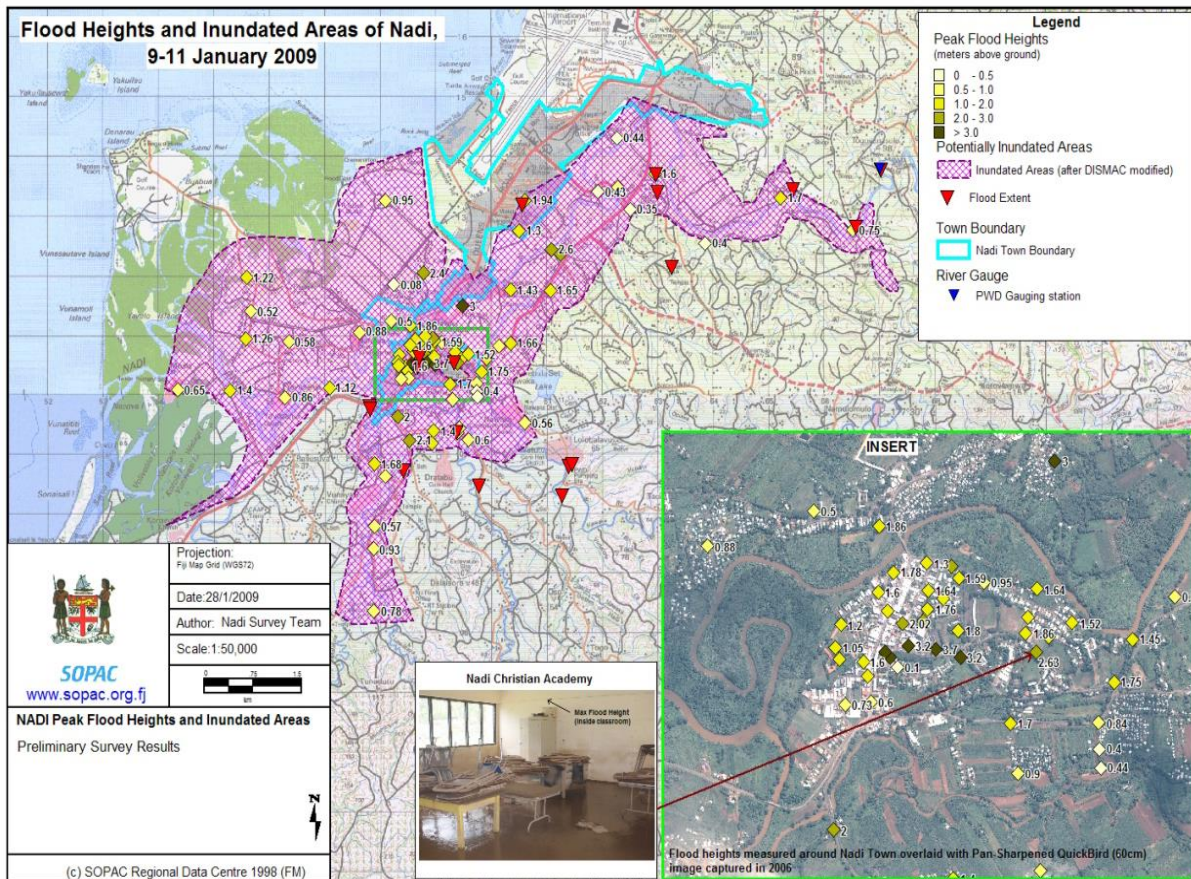
In Nadi Area, this flood disaster was the worst at that time and the inundation height was 1.2m above house floors at shopping street in Nadi Town according to the inhabitants. Before this disaster, flood had occurred in January, 1990 and had caused the worst damage in this town Nadi the inundation height of the 1990 flood had been 0.4m and the area covered with water had been not only the downtown of Nadi Town but also Nadi Back Road and other main major road.

A) Flood Data

The data of the flood occurred in January, 2009 including rainfall data and river water level are discussed in “Chapter 5”.

B) Inundation Record

The following figure shows the inundation record document by SPC/SOPAC. The inundation form of Nadi River is falling liquid type which means the flooding starts from confluence with Namosi River at upper stream and be covered with water at low-lying ground along river. Near Nadi downtown, flood occurred in the branches of the basin and wide range of the area near estuary was covered with water.



Source: SPC/SOPAC

Figure 2-14 Inundation Record (January, 2009)

C) Economic Damage

Total amount of economic damage was 113 million FJD in the entire Fiji Islands, and the damage of the western area including Nadi Town was 81.2 million FJD.

Table 2-5 Economic Damage Evaluation of 2009 flood

Table 1: National flood damage assessments

| Sector | Central/ eastern (F\$) | Western (F\$) | Northern (F\$) | Total (F\$) |
|--------------------|---------------------------|-------------------|-------------------|--------------------|
| Roads | 7 506 620 | 15 173 422 | 5 771 260 | 28 451 302 |
| Water and sewerage | 740 000 | 6 950 000 | 3 530 000 | 11 220 000 |
| Crops | 3 031 746 | 12 370 653 | 565 647 | 15 968 046 |
| Livestock | 1 680 201 | 2 280 316 | 35 282 | 3 995 799 |
| Drainage | 1 607 723 | 15 863 789 | 1 994 500 | 19 466 012 |
| Education | 138 000 | 915 960 | 420 000 | 1 473 960 |
| Health | 350 000 | 130 000 | 35 000 | 515 000 |
| Housing | | 3 000 000 | | 3 000 000 |
| Sugar | | 24 600 000 | | 24 600 000 |
| Telecommunications | | | | 1 300 000 |
| Electricity | | | | 3 000 000 |
| Total | 15 054 290 | 81 284 140 | 12 351 689 | 112 990 119 |

Source: Government of Fiji 2009.

According to “Nadi Floods Economic Costs Jan. 2009 (Sept. 2009)” by SPC/SOPAC, the economic damage in Nadi Area is estimated 2.44 hundred million FJD based on result of sample study. The damage consists household income loss of 14.5 million FJD, operating loss of 229.5 million FJD, which means about 5% of GDP at that time.

iii. Flood Disaster in January and March, 2012

A large-scaled flood disaster occurred in January and March in 2012

The January flood was caused by depression trough, which brought heavy rain in western part of Fiji, and it started on January 21 and continued until early February. 64 shelters worked and 4561 people escaped at flood peak. The flood affected infrastructure, agriculture and public facilities and was collected in Nadi Area and Lautoka Area, which was said the worst damage in that area. The total affected people by this flood were estimated 178,153.

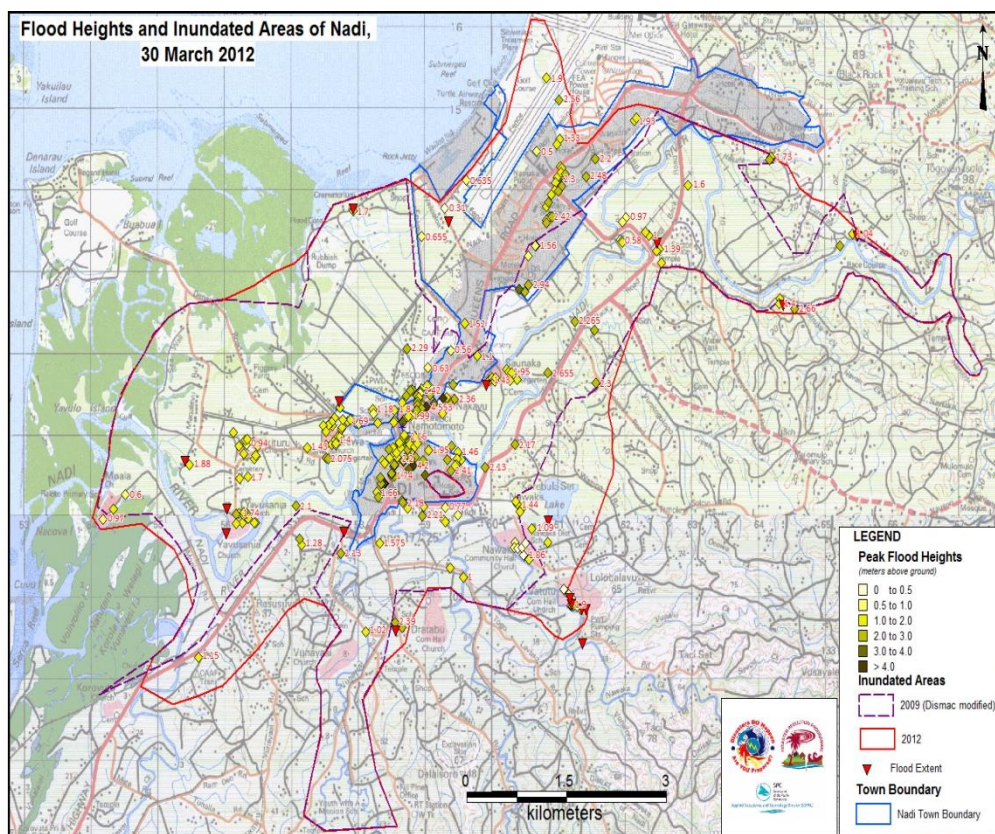
The March flood was caused by tropical depression which brought heavy rain from end of March to beginning of April and seriously affected and in a large scale the western part of Viti Levu Island. Heavy rain was observed in Nadi town and the most inundated area was also recorded in the town. The inundated depth was 2m in the main town in the western side including Nadi town and 150 thousand people were affected by the cut off electricity and water supplies. The detail of the damage which includes impact on house, school, and infrastructure and so on is not clear because not all areas were accessible.

A) Flood Data

The data of the flood occurred in January, 2009 including rainfall data and river water level are discussed in “Chapter 5”.

B) Inundation Record

The following figure shows the inundation record documented by SPC/SOPAC, which indicates that that inundation form is the same type as that of 2009 flood which means flooding started from confluence with Namosi River at upper stream and be covered with water at low-lying ground along river. The inundation depth was high in Nadi downtown and the deepest depth recorded was 2.4m and the runway of the Nadi International Airport was covered with flood water.



Source: SPC/SOPAC

Figure 2-15 Inundation Record (March, 2012)

C) Economic Damage

According to the summary prepared by NDMO in February 2012, the economic damage by this flood is estimated 50 million FJD in entire Fiji, however, this number does not contain economic damage by March, 2012 flood. According to Disaster Management Center (DISMAC), the economic damage of January Flood reports, the was estimated 41 million FJD and if of March Flood was 64 million FJD. But according to press reports, the economic damage of March Flood was estimated 89 million FJD.

Table 2-6 Economic Damage Evaluation of January- 2012 Flood

| NO | MINISTRY/SECTORS | DATE OF EST | ESTIMATES (\$) |
|----|---|-------------|--|
| 1 | Ministry of Transport, Works & Public Utilities | 31/1/2012 | 18,993,592.00 |
| 2 | Ministry of Sugar | 26/1/2012 | 16,342,000.00 |
| 3 | Ministry of Primary Industries | 31/1/2012 | 7,242,988.00 |
| 4 | Ministry of Education | 31/1/2012 | 1,789,038.00 |
| 5 | Ministry of Health | 26/1/2012 | 298,000.00 (Revision in the cost of damage to Lautoka Dental Clinic & Loma Nursing Station) |
| 6 | Ministry of Provincial Development & National Disaster Management | 23/2/2012 | \$1,125,000.00 (Cost estimate is as follows : 64 houses x \$15,000.00 and 33 houses x \$5,000.00) |
| | Subtotal | | \$45,790,618.00 |
| 6 | Fiji Electricity Authority | 26/1/2012 | 183,000.00 (CWD Report page 137) |
| 7 | Telecom Fiji Limited | | Damage estimate not received |
| 8 | Water Authority of Fiji | | 1,630,000.00 |
| 9 | Housing Authority | | 70,026.00 |
| 10 | Municipal Councils | | 2,373,700.00 |
| | Subtotal | | \$4,256,726.00 |
| | GRAND TOTAL | | \$50,047,344.00 |

Source: DISMAC

Table 2-7 Economic Damage Evaluation of January and March 2012 Flood

Table 2: Summary of Initial Damage Assessment

| Ministry | January Flood Estimated Cost(\$m) | March Flood Estimated Cost (\$m) | Consolidated Damage Assessment (\$m) | Remarks |
|---|-----------------------------------|----------------------------------|--------------------------------------|--|
| Ministry of Agriculture | 7.2 | 10.2 | 17.4 | Crops \$16.04 million; Livestock \$0.91 million and \$0.466 Drainage \$1.12 million. |
| Ministry of Sugar | 10.1 | 7.03 | 17.14 | Infrastructure Damage \$15.14 million and \$2 million for Crops. |
| Prime Minister's Office (FRA) | 19.0 | 22.0 | 22.0 | Central Eastern \$1.0 million; Northern \$ 1.0 million and Western \$ 20.0 million. |
| Ministry of Works | | 0.410 | 0.410 | Ba \$19,000; Lautoka \$40,000; Nadi \$75,000 and Sigatoka \$275,500. |
| Ministry of Health | 0.207 | 0.370 | 0.577 | Damage to infrastructure. |
| Ministry of Education | 0.755 | 3.2 | 3.2 | 26 Schools - \$754,000 and 126 schools - \$3,188,650. |
| Ministry of Local Government ⁷ | 2.4 | - | 2.4 | Nadi \$171,000; Lautoka \$120,000; Ba \$2,080,000 & Rakiraki \$2,700. |
| Ministry of Provincial Development | - | 5.63 | 5.63 | NPWD \$2.3 mill; NCAR \$1.57 mill; CAR \$1.376; & RWS \$0.384 mill. |
| Water Authority of Fiji | 1.6 | 11.91 | 11.91 | Rakiraki \$0.22million; Tavua \$1.05 million; Ba \$4.35million; Nadi \$1.7 million; Lautoka \$1.3 million & Sigatoka \$1.99 million. |
| Telecom Fiji Ltd | 0 | 0.152 | 0.152 | Damages to TFL Infrastructure mainly underground cables. |
| Fiji Electricity Authority | 0.2 | 4.0 | 4.2 | Damages to Laselevu Transmission \$300,000; Infrastructure \$1.0 million and Natadola Sub Station \$2.8 million. |
| Total | 41.46 | 64.90 | 85.02 | |

(Source: DISMAC 2012)

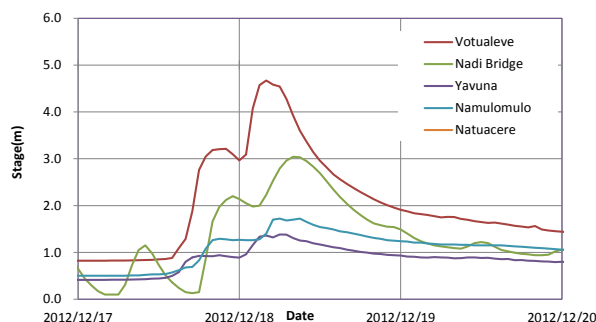
iv. Flood Disaster in December 2012

TC Evan brought December, 2012 Flood. TC Evan having Category4 energy (wind speed was 201km/h) hit the northwestern coast of Vanua Levu Island on December 17, 2012 and on the next day, the Regional Specialized Meteorological Centre in Nadi, RSMC, acquainted that TC Evan having Category3 energy was to approach the western coast of Viti Levu Island. TC Evan heavily affected house, infrastructures and farm produces but fortunately, the number of death and serious injures was not high. However, many people were affected by this TC and economic activities had to be stopped.

The December, 2012 flood is one of the very serious disasters occurred in 2012 which include January, 2012 flood and March, 2012 flood. The people living in Nadi and Lautoka areas were damaged by this flood, and had been also damaged by the earlier January and March Floods.

A) Flood Data

Although TC Evan had big wind energy, a large-scaled flood disaster did not occur. Water level at Nadi Town Bridge was 3m and elevation of riverside crown near Nadi Town Bridge was 6m so inundation did not occur.



Source: JICA Study Team based on the data from FMS

Figure 2-16 River Water Level (December, 2012 Flood, Nadi Town Bridge Observatory)

B) Economic Damage

Economic damage by the December, 2012 flood was estimated about 194.9 million FJD (108.4 million USD) and it corresponded to about 2.6% of GDP in Fiji. Direct economic damage was 121.5 million FJD and indirect damage was 73.4 million FJD.

Table 2-8 Economic Damage Evaluation of December 2012 Flood

| TOTAL EFFECT | | | | | |
|------------------------------|-------------------------|-----------------------|------------------------------|---|---------------------------------------|
| Sectors | Production Damage Value | Production Loss Value | Total Damage and Loss Effect | Total Damage And loss Effect (USD) 0.5564 | Contribution to Total Damage and Loss |
| Productive Sectors | | | | | |
| Agriculture | 6,660,435.50 | 31,007,228 | 37,667,664 | 20,958,288 | 19.6 |
| Forestry | 6,254,000 | | 6,254,000 | 3,479,726 | 3.3 |
| Hotels & Restaurants | 40,000,000 | 28,157,764 | 68,157,764 | 37,922,980 | 35.5 |
| Commerce | 834,371 | 4,634,856 | 5,469,227 | 3,043,078 | 2.8 |
| Infrastructure Sector | | | | | |
| Transport | 5,701,641 | 4,215,812 | 9,917,453 | 5,518,071 | 5.2 |
| Communication | 1,141,000 | 294,150 | 1,435,150 | 798,517 | 0.7 |
| Electricity | 4,300,000 | 1,455,673 | 5,755,673 | 3,202,456 | 3.0 |
| Water | 2,945,000 | 104,152 | 3,049,152 | 1,696,548 | 1.6 |
| Government Building | 421,493 | 20,000 | 441,493 | 245,647 | 0.2 |
| Housing | 46,879,095 | 3,138,364 | 50,017,459 | 27,829,714 | 26.1 |
| Social Sector | | | | | |
| Health | 504,537 | 359,463 | 863,999 | 480,729 | 0.5 |
| Education | 5,887,572 | 44,190 | 5,931,762 | 3,300,432 | 3.1 |
| Total | 121,529,145 | 73,431,652 | 194,960,798 | 108,476,187 | |

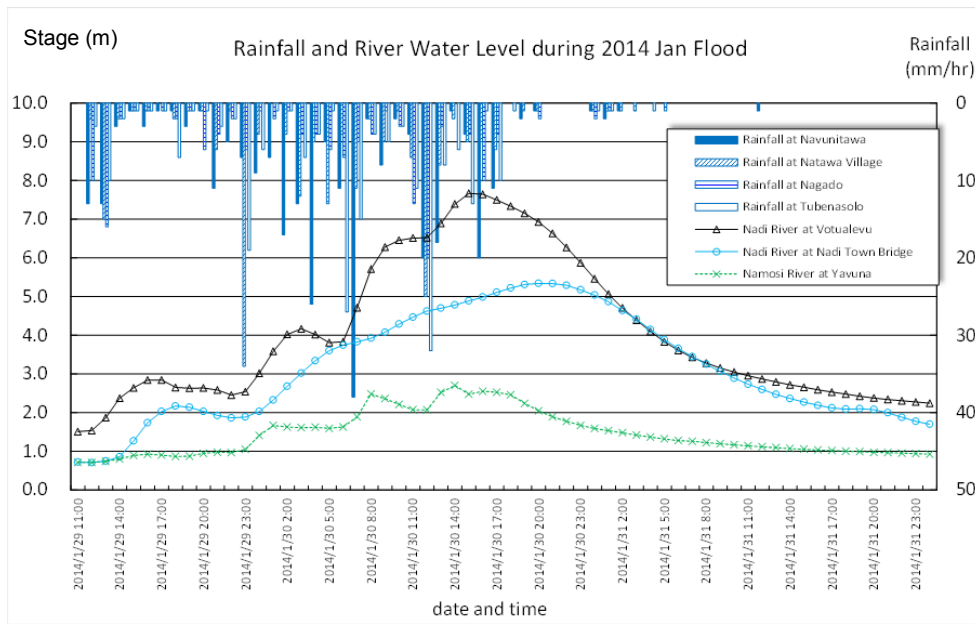
Source: Estimates based on official Government of Fiji data.

v. Flood Disaster in January, 2014 (Source: Development Study of Detailed Plan for Flood Control Development Project in Nadi River Basin in Fiji, 2014 by JICA)

Flood disaster in January, 2014 was caused by floating SPCZ and it rained from January 29 until midnight of 31. Rainy time accorded with spring tide, the time of which was 6:41 PM, on January 31st, and the time of high water was 5:47 PM, 30th so damage escalation was concerned. However, inundation of river water did not occur because the SPCZ moved toward the south earlier than it was thought.

A) Flood Data

The following figure shows rainfall hyetograph and river water hydrograph of the January, 2014 Flood. The site for observing the Nadi River are located at that of Votualevu (27km from estuary) and Nadi Town Bridge (10km from estuary) and that of Namosi River is located, Yavuna (20km from confluence with Nadi River). The data of all observatories shows that rain which fell on and off heavily and upside down of river level worked together. The Peak hour of Votualevu observatory located upstream of nadi was 5 hours earlier than that of Nadi Town Bridge observatory located downstream of Nadi so it was assumed that time of flood concentration, the time it took the upstream flood peak to reach the downstream was about 5 hours (distance between these two observatories is about 15km). Additionally, spring tide defined by astronomical tide level was 2.1m at 6:41PM on January 31, 2014.







Source: Development Study of Detailed Plan for Flood Control Development Project in Nadi River Basin in Fiji, 2014 by JICA

Figure 2-17 Rainfall Hyetograph and River Water Hydrograph of January 2014 Flood

B) Situation of Flood Disaster

The following photos show the January 14 flood disaster situation.

Picture 2-1 Photos of January 2014 Flood

| | |
|--|--|
|  |  |
| <p>Nadi Town Bridge before the flood taken on August 28, 2013</p> | <p>Nadi Town Bridge picture taken during the flood on January 30, 2014 River channel was filled with flood water</p> |
|  |  |
| <p>The Bridge across Nadi River located at 17km site, before the flood- taken on August 28, 2013</p> | <p>The Bridge across Nadi River located at 17km site, during the flood on January 30, 2014 River channel was filled with flood water</p> |

Source: Development Study of Detailed Plan for Flood Control Development Project in Nadi River Basin in Fiji, 2014 by JICA

2.1.7 Climate Change

Intergovernmental panel related to climate change, IPCC, comprehensively evaluates climate change based on chemical and social economic standpoint and publishes Assessment Report every 5-7 years. In 2014, Fifth Assessment Report, AR5, summary for policy decision maker was confirmed and published and then the report itself was also adopted.

In AR5, the main risks, subject of adaptation and view in small islands of developing states including Fiji were indicated as follows.

- ✓ Interaction between average sea level rise in the world and high water level phenomenon in 21st century will threaten the lower coastal area (Certainty Factor is high)
- ✓ If the ratio of coastal area compared to the whole area of land, adaptation will be big problem as economic situation and natural resource for islands.
- ✓ The options for adaptation are maintenance and restoration of coastal topography and ecosystem and suitable Building Standards Act and residence pattern.

Relevant organizations and bodies have not yet published their view point on materials on AR5 but climate change prospect based on AR4 is estimated as shown in the following table and figures. According to these data, it was estimated that probability of maximum daily rain (200mm) would rise and probability of sea level rise would decrease. Besides, 21% increase of average yearly rainfall by 2055 was estimated depending on the scenario.

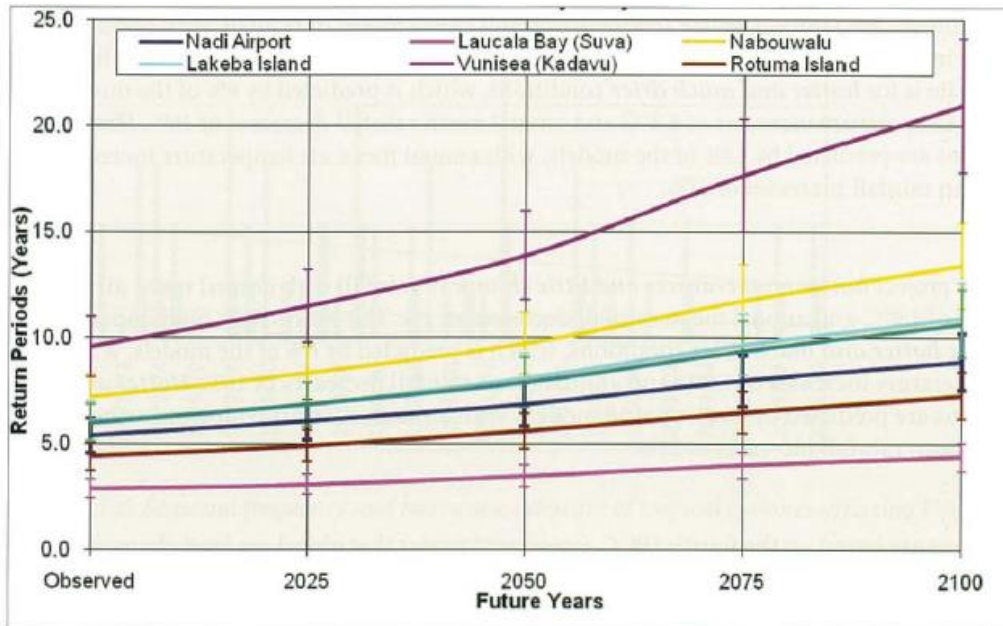
Table 2-9 Climate Projections (Global Climate Models)

| | |
|---------|---|
| By 2030 | The most likely projected change for Fiji is for warmer temperatures and little change in rainfall with annual mean temperature increases of 0.7°C and negligible (-1%) change in mean annual rainfall, which is predicted by 69% of the models. Warmer and drier change in projected climate is predicted by 6% of the models with annual mean air temperature increases of 0.6°C and annual mean rainfall decreases of 6%. Warmer and wetter conditions are represented by 13% of the models with annual mean air temperature increases of 0.8°C and annual mean rainfall increases of 7%. |
| By 2055 | The majority of the models (569.) project hotter temperatures and little change in rain fall, with annual mean air temperature increases of 1.9°C and annual mean rainfall decreases of 1%. The other likely high impact projected climate is for hotter and much drier conditions, which is predicted by 6% of the models, with annual mean air temperature increases of 1.8°C and annual mean rainfall decreases of 16%. Hotter and much wetter conditions are predicted by 13% of the models, with annual mean air temperature increases of 2.3°C and annual mean rainfall increases of 21%. |
| By 2090 | Nine out of 16 models project hotter temperatures and little change in rainfall with annual mean air temperature increases of 1.9°C and annual mean rainfall decreases of 1%. The other likely high impact projected climate is for hotter and much drier conditions, which is predicted by 6% of the models, with annual mean air temperature increases of 1.8°C and annual mean rainfall decreases of 16%. Hotter and much wetter conditions are predicted by two out of 18 models, with annual mean air temperature increases of 2.3°C and annual mean rainfall increases of 21%. |
| By 2100 | The sea level projections are based on the fourth IPCC assessment report that global sea level changes are expected to be ranging from 0.21 to 0.48 meters by end of the century (IPCC 2007a). However, there is significant uncertainty surrounding ice-sheet contributions to sea level rise and a larger rise than that projected cannot be excluded. |

Source: Republic of Fiji, National Climate Change Policy 2012

Maximum rainfall

The maximum daily rainfall of 200 mm is projected to become less frequent by 2100 at various locations in Fiji (Figure A1-7).

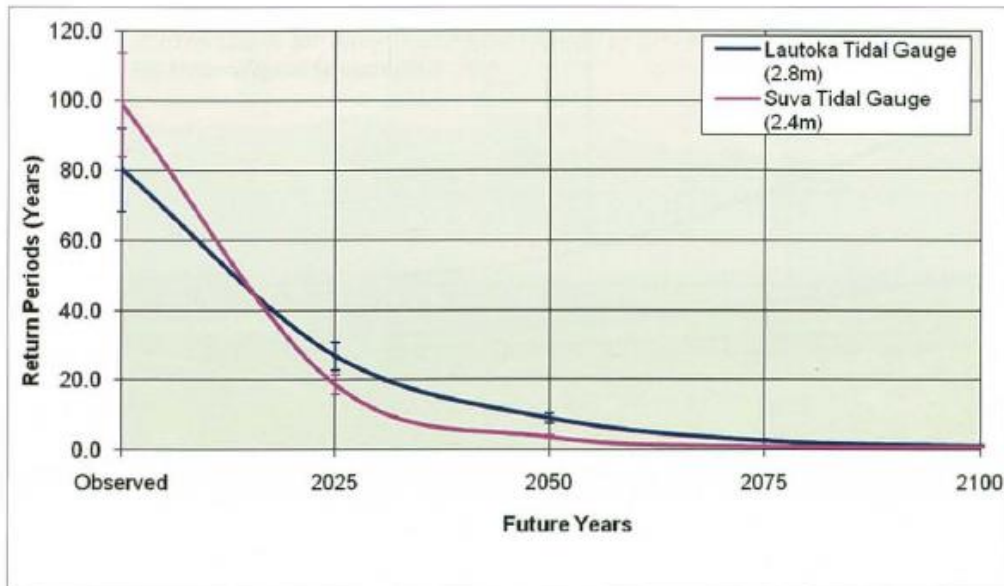


Source: Fiji Meteorological Services 2011, Republic of Fiji, National Climate Change Policy 2012

Figure 2-18 Projections for daily maximum rainfall of 200 mm in Fiji.

Maximum sea levels

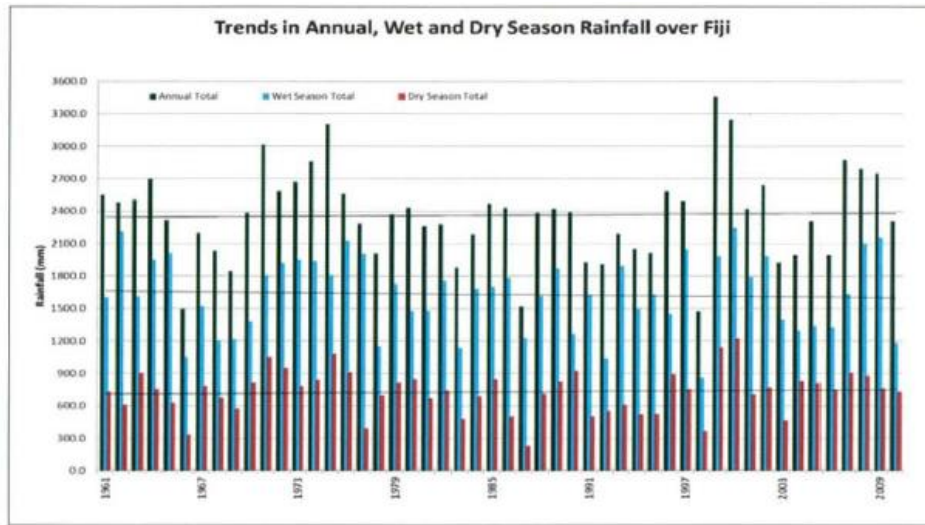
Maximum sea level currently observed at Lautoka and Suva tide gauges are expected to become more frequent by at least by 2050 and become a normal occurrence by 2100 (Figure A1-11).



Source: Fiji Meteorological Services 2011, Republic of Fiji, National Climate Change Policy 2012

Figure 2-19 Projection of climate risk of maximum sea levels at various locations in Fiji

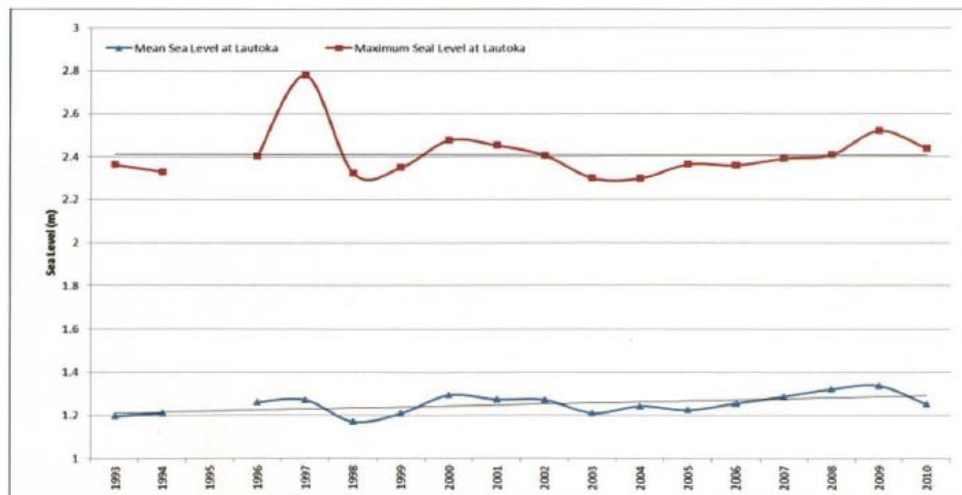
According to the data observed from 1961 to 2010, the amount of rainfall shows a slightly increasing tendency, sea level indicates **the same tendency** and number of incidents shows a decreasing tendency.



- a very weak positive linear trend in annual rainfall; an annual increase of about 0.65mm/year (approximately 0.03%/year);
- a weak decreasing linear trend in wet season rainfall, with a seasonal decrease of 1.30mm/season (approximately 0.08%/year);
- A weak increasing linear trend in dry season rainfall, with a seasonal increase of about 0.76mm/season (approximately 0.11%/year).

Data source: Fiji Meteorological Services 2011, Republic of Fiji, National Climate Change Policy 2012

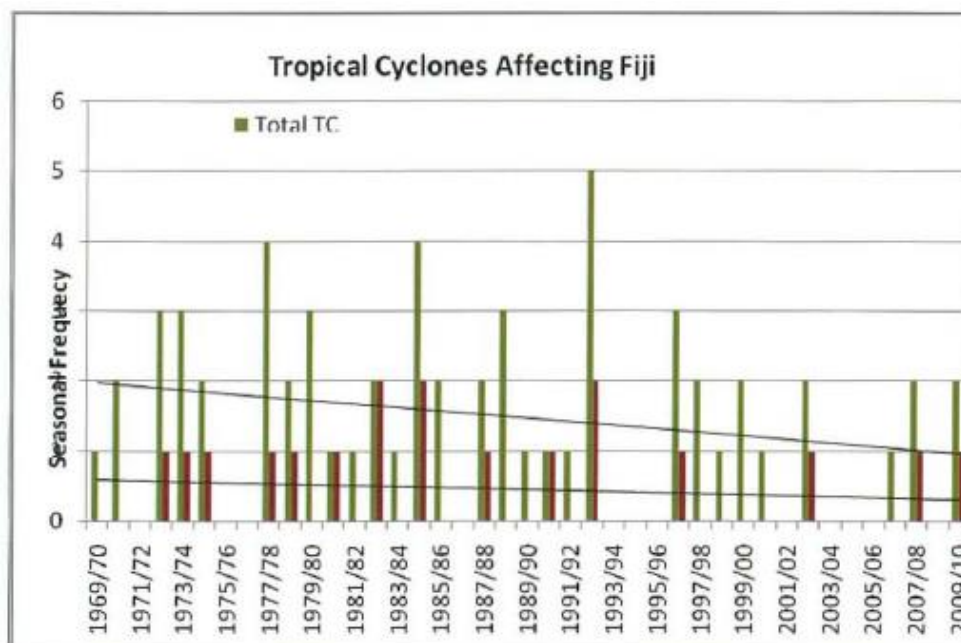
Figure 2-20 High inter-annual variation in annual and seasonal rainfall over Fiji, 1961 to 20/0



The mean monthly sea levels at the Lautoka tide gauge have been increasing (after accounting for the precise leveling and inverted barometric pressure effect) at a rate of 4.6 mm/decade. Satellite observations, however, indicate that the sea level is changing at the faster rate of 6 mm/year over the same period. Given that the sea level record is relatively short, it is still too early to deduce realistic long-term sea level rise. Variations in the mean sea level include the influence of EN SO.

Source: South Pacific Sea Level and Climate Monitoring Project, Republic of Fiji, National Climate Change Policy 2012

Figure 2-21 Trends in mean and maximum sea levels at Lautoka tide gauge, 1993-2010



Tropical cyclones are one of the most severe extreme events that have affected Fiji on numerous occasions in the past four decades. They usually affect Fiji from November to April but they have occurred in October and May. On average, one or two cyclones affect some part of Fiji every season, with the greatest risk during the EI Nino season. There have been seasons when Fiji has had no cyclones and seasons with four cyclones (1984/85) and five cyclones (1992/93). A decreasing trend in both the number of tropical cyclones and cyclones with hurricane intensity affecting Fiji has been observed in the last four decades.

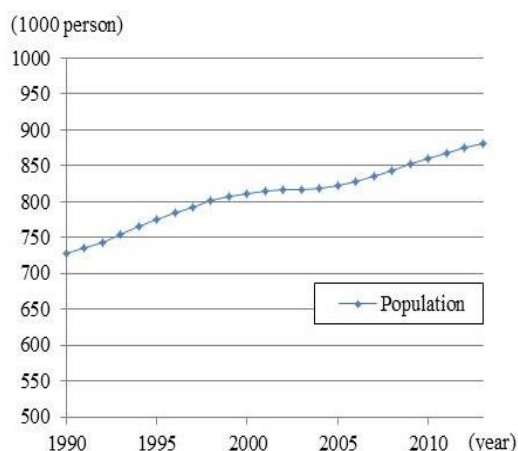
Source: Fiji Meteorological Services 2011, Republic of Fiji, National Climate Change Policy 2012

Figure 2-22 Seasonal frequency and hurricane intensity of tropical cyclones affecting Fiji from 1969/70 to 2009/10

2.2 Social and Economic Conditions

2.2.1 Population and the number of households

Population of Fiji is 868 thousand (2007 census). Half of the population lives in urban area. Racial According to the 2007 racial composition in Fiji is as follows. 57% Fijian (consist of Melanesian and Polynesian), 38 of Indian and 5% of others. As Figure 2-23 shows the population of Fiji is increasing. In 2013, the population had reached 120% of 1990.



Source: United Nations Statistics Division

Figure 2-23 Population Trends of Fiji

The population and the numbers of households in the Nadi River Basin are shown in Table 2-10 based on the Fiji census 2007. The population of the Nadi River Basin is 70 thousand. As shown in Table 2-12, residents are not concentrating in Nadi Town and widely dispersed in the vicinities and peri-Urban Areas.

Table 2-10 Population and number of households in Nadi River Basin

| | Populations (person) | Number of Households (Nos) |
|------------------|----------------------|----------------------------|
| Nadi River Basin | 70,444 | 15,143 |

Source: GIS data form Fiji Statistic Bureau (Nadi Basin_Pop_HH.DAT)

Table 2-11 Population of Urban Area (Nadi , Lautoka and Ba)

| Name of the Area | Nadi | | Lautoka | | Ba | |
|------------------|--------|------------|---------|------------|--------|------------|
| | Town | Peri-Urban | City | Peri-Urban | Town | Peri-Urban |
| Population | 11,685 | 30,599 | 43,473 | 8,747 | 6,826 | 11,700 |
| | 42,284 | | 52,220 | | 18,526 | |

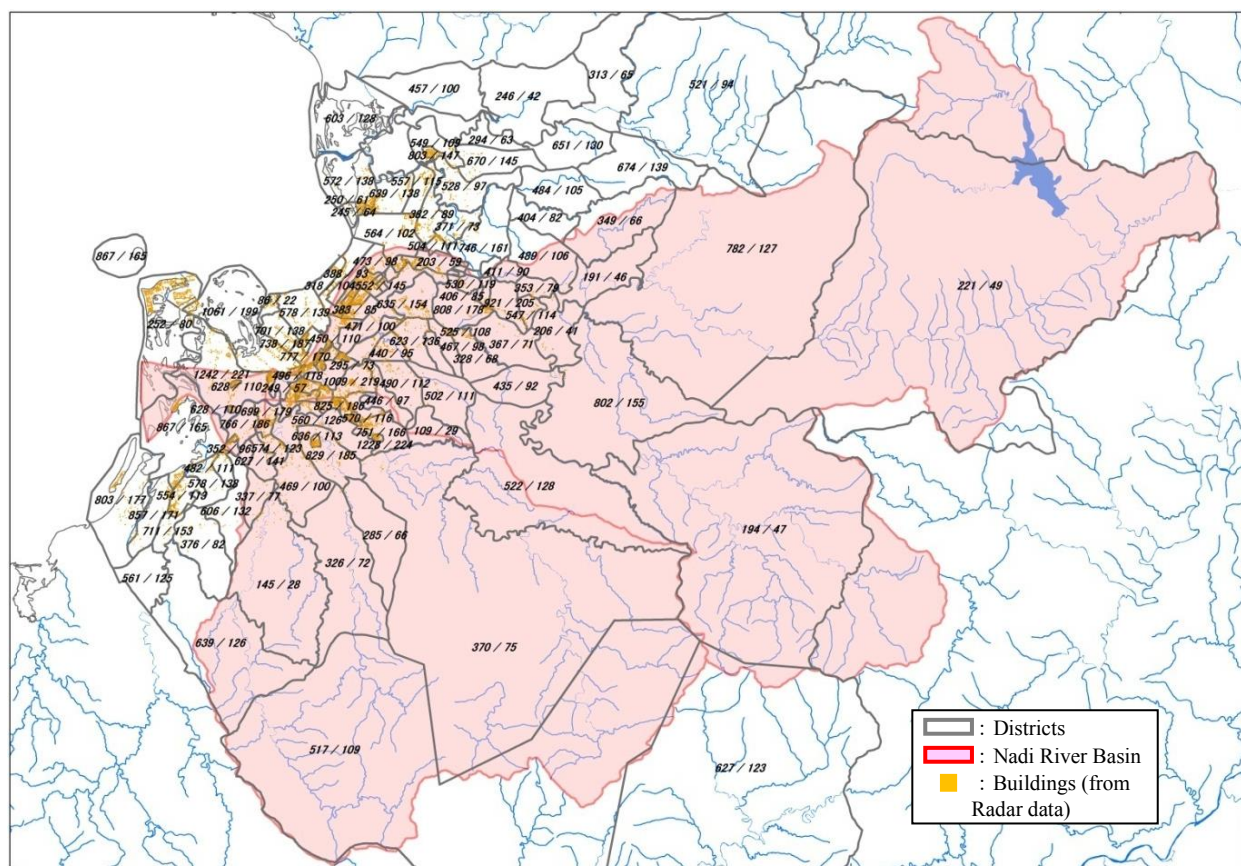
Source: Fiji Statistic Bureau, 1.4 Populations of Towns and Urban Areas by Ethnic Origin and Sex on 16 September 2007[p]

Trends of population in Nadi River Basin and vicinities are shown in Table 2-12 similar to the national trend, the population of the area is increasing.

Table 2-12 Trends of Population in Nadi River Basin and Vicinities

| | | 1986 | 1996 | 2007 |
|---------|--------------------|--------------|--------------|--------------|
| Nadi | Population (Ratio) | 15,520(1.00) | 30,884(1.99) | 42,284(2.72) |
| Lautoka | Population (Ratio) | 39,057(1.00) | 43,274(1.11) | 52,220(1.34) |
| Ba | Population (Ratio) | 10,260(1.00) | 14,716(1.43) | 18,526(1.81) |

Source: Fiji Statistic Bureau

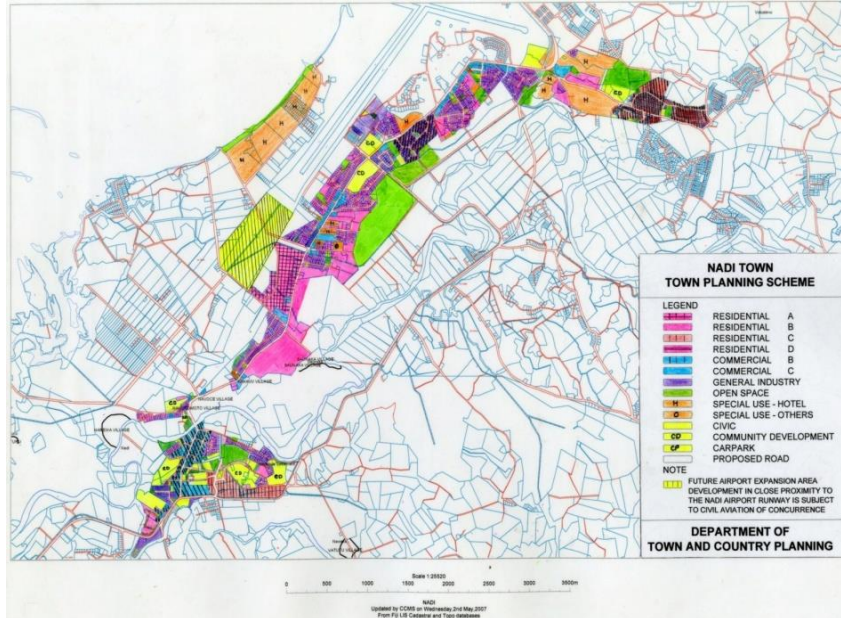


Source: Fiji Statistic Bureau GIS data (Nadi Basin_Pop_HH.DAT)

Figure 2-24 Population and Number of Households in Nadi River Basin (Numbers on the map shows “Population / number of households”)

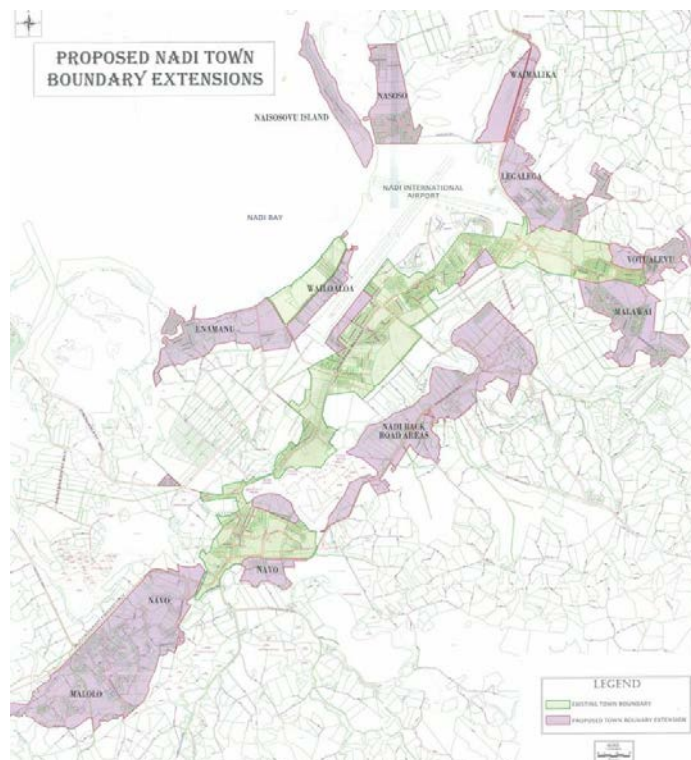
2.2.2 Urban Area

Nadi Town is the third biggest Town in Fiji. Nadi Town is the commercial and sightseeing center of Fiji, not only because of its traditional sugar industry but also because of its prospering tourist business. According to the Nadi Town Council (here in after “NTC”), the area boundaries are designated by “Nadi Town Planning Scheme” shown in Figure 2-25. In addition, NTC has the plan to expand the boundaries. The proposed area of expansion is shown in Figure 2-26.



Source: Nadi Town Council

Figure 2-25 Nadi Town Area by Nadi Town Planning Scheme



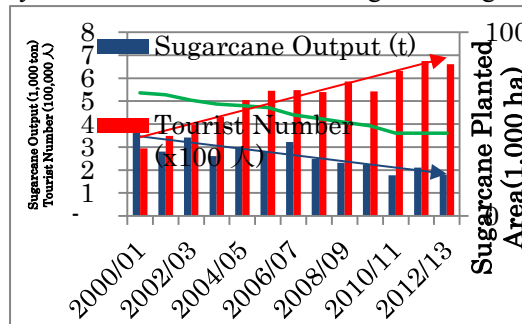
Source: Nadi Town Council

Figure 2-26 Proposed Nadi Town Boundary Expansions

2.2.3 Industries

Major industries in Fiji are sugar, tourism and garment industries. These industries are major sources to earn foreign currency earner in Fiji. However, these industries are easily affected by many external factors such as international economy and market trends making Fiji's economy. Figure 2-27 shows the trends of number of tourists and production volume of sugar industry.

Tourism industry, the biggest foreign exchange earner, is increasing year by year, but slightly decreased in 2009 and 2012, the two years the regent had been severely damaged by flood. This facts shows flood mitigation effort is needed for tourism industry. On the other hand, the production volume of sugar cane industry which led Fiji economy for long years, decreased to two million tons recently although it was four million tons in 2000. In addition, suspension of exports to Japan and US form 2008, deterioration of transportations and facilities, the postponement of leasing, abolishment of special import price, decreasing the international capacity of competition and other issues affected the sugar industry. It was under the situation, that the floods in January and March 2012 floods damaged the sugar cane industry.



Source: Department of Immigration 2012 (Number of Tourist)

Sugar cane production volume: Fiji Bureau of Statistics Dec.2013

Figure 2-27 Trends of Number of Tourist and Production of Sugar

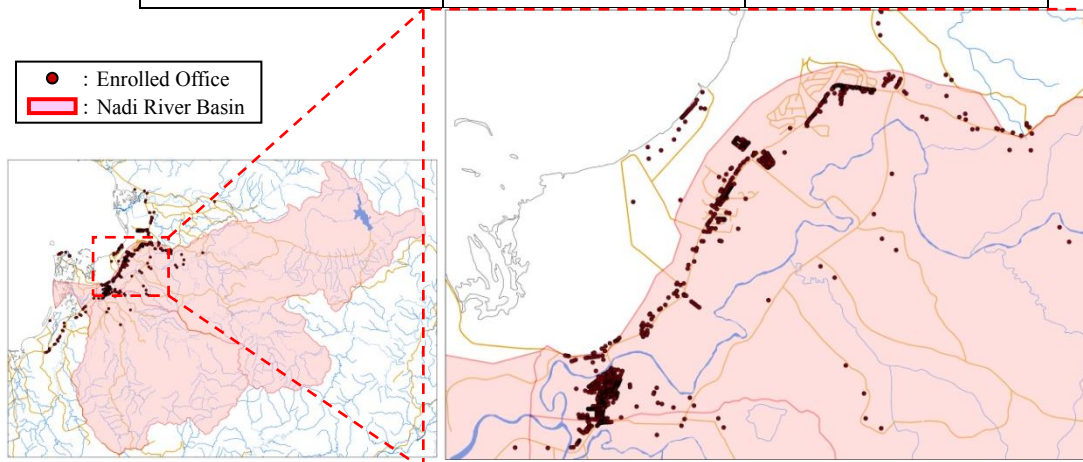
The industries in the Nadi River Basin accept the primary industry, summarized in employment statistics in 2012. The number of business is shown in Table 2-13.

Businesses such as construction, manufacture, electricity, gas and heat provider, drinking water, hotels and restaurants in the Nadi River Basin are located along the Queen's Road of the central area of Nadi Town.

Tourism industries and hotels are located near the airport and Denarau. In Nadi Town, mainly wholesale trader, retail trade, services related daily life and entertainment are located.

Table 2-13 Number of Businesses and payrolls

| | Business | Total payrolls |
|------------------|----------|----------------|
| Nadi River Basin | 1,263 | 16,829 |



Source: Fiji Statistic Bureau GIS data (Nadi Business Register 2011.DAT)

Figure 2-28 Number of Businesses in the Nadi River Basin

2.2.4 Economy

(1) Fiji's Economic Situation

Fiji's GDP declined by 0.9% in 2007, immediately after December, 2006 coup and the GDP decreased by 1.4% again in 2009, affected by recession in major advanced countries however GDP has been continuously increasing in five since 2010. Similarly, Per Capital GNI in Fiji has continued to increase and reached to US\$4,370 (World Bank, Atlas method) in 2013, which was more than standard of lower-middle-income economies (\$1,046 to \$4,125). The current balance in 2013 is in deficit of 14.5%, but World Bank forecast to improve about 8.7% in 2014, due to the increase of the tourist income and remittance from overseas. The following table shows Fiji's major economic index.

Table 2-14 Major Economic Indexes of Fiji

| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|--------|-------|-------|-------|-------|--------|
| GDP (current US\$, million) | 3,523 | 2,870 | 3,140 | 3,646 | 3,849 | 3,855 |
| GDP growth (annual %) | 1.0% | -1.4% | 3.0% | 2.7% | 1.8% | 3.5% |
| GNI per capita, Atlas method (current US\$) | 4,010 | 3,870 | 3,650 | 3,710 | 4,020 | 4,370 |
| Current account balance (% of GDP) | -15.0% | -4.3% | -4.5% | -5.4% | -1.5% | -14.5% |
| Consumer price index (2010 = 100) | 7.7% | 3.7% | 5.5% | 8.7% | 3.4% | 2.9% |

Source: World Bank Data <http://data.worldbank.org/>

The Ministry of Finance, Fiji's GDP would develop by 4.2% in 2014, 4.0% in 2015 and 3.0% in 2016. On the other hand, CPI reached peak at 8.7% in 2011 but continued to decline to lower level, thanks to recent trend of declining commodity prices over the world. As a result, CPI was 1.5% in 2014. Generally speaking, Fiji's economy is forecasted to have a stable growth under low-inflation situation.

Table 2-15 Forecast of GDP and CPI in Fiji

| | 2014f | 2015f | 2016f | 2017f |
|-----------------------|-------|-------|-------|-------|
| GDP growth (annual %) | 4.2% | 4.0% | 3.0% | 3.0% |
| CPI (annual %) | 1.5% | 3.5% | 3.0% | n.a. |

Source: Ministry of Finance in Fiji "Economic and Fiscal Update. November 2014"

International trade occupies big balance in Fiji's economy, an export account of product and service occupied about 60% of GDP. Especially, the income from tourism occupied 40-50% of the total export, showing the importance of tourism industry to earn foreign currency.

Sugar industry lost its competitive power in international market and it was also damaged by 2009 and 2012 due to severe flood so both production volume and export volume have been declining. However, the Ministry of Sugar Industry was established from 2011 and there were an effort to rehabilitate the sugar industry was aimed as a first priority by the government. Sugar industry recovered both production and export volume in recent years reflecting such enhanced policy.

Table 2-16 Overseas Transactions and Overseas Tourism Income in Fiji

| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|-------|-------|-------|-------|-------|-------|
| Exports of goods and services (current US\$, million) | 2,008 | 1,435 | 1,821 | 2,224 | 2,425 | 2,274 |
| Exports of goods and services (% of GDP) | 57% | 50% | 58% | 61% | 63% | 59% |
| International Tourism current US\$, receipt(million) | 938 | 724 | 809 | 933 | 989 | 971 |
| International tourism, receipts (% of total exports) | 47% | 51% | 45% | 42% | 41% | 43% |

Source: World Bank Data <http://data.worldbank.org/>

Table 2-17 Sugar Industry in Fiji

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|-------------------------------------|-------|-------|-------|-------|-------|-------|-------|
| Sugar Cane Production (000, tonnes) | 2,478 | 2,321 | 2,247 | 1,778 | 2,096 | 1,546 | 1,610 |
| Sugar Production (000, tonnes) | 237 | 208 | 168 | 132 | 167 | 155 | 180 |
| Sugar export (F\$, million) | 185 | 248 | 147 | 78 | 122 | 156 | 237 |

Source: Statistics Bureau in Fiji "Key Statistics March 2014"

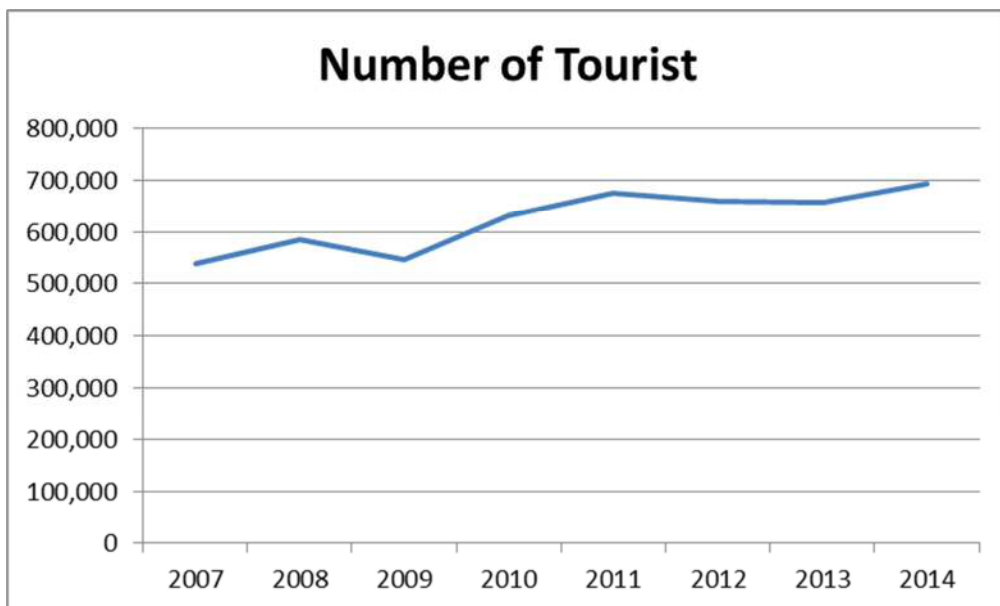
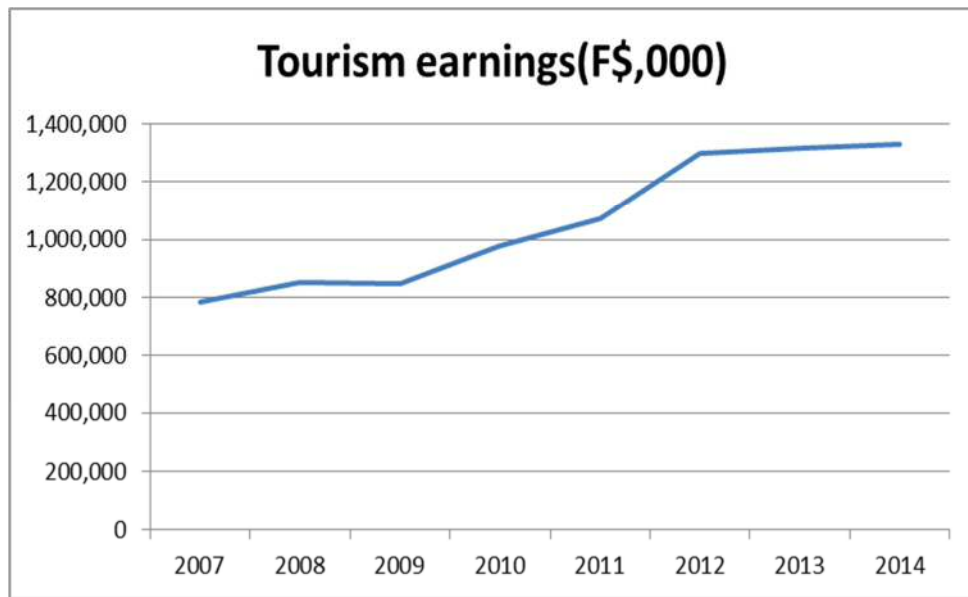
(2) Economic Situation in Nadi Area

Nadi town has an international airport and luxury resort hotels and sightseeing sites in Denarau and Naisoso, so many foreign tourists mainly from Australian and New Zealander visit this area for tourist vacation. Also, new tourist resort, Fantasia Islands, is currently under development. The new resort is located at stopping point toward Resort Island such as Mamanuca & Yasawa Islands Group, which are very popular for foreign tourists. As the following table and the graph show increasing economic effects in tourism industry, Nadi area is important for tourism industry in Fiji.

Table 2-18 Tourism Income in Fiji

| Data from Fiji Bureau of Statistics | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|-------------------------------------|---------|---------|---------|---------|-----------|-----------|-----------|-----------|
| Tourism earnings(F\$,000) | 784,100 | 853,800 | 848,900 | 976,700 | 1,276,800 | 1,300,000 | 1,318,200 | 1,331,000 |
| Number of Tourist | 539,881 | 585,031 | 545,750 | 631,868 | 675,050 | 660,590 | 657,706 | 692,630 |

Source: Statistics Bureau in Fiji “Key Statistics March 2014” and <http://www.statsfiji.gov.fj/>



Source: Based on Statistics Bureau in Fiji, Project Team makes

Figure 2-29 Transition of Tourism Earnings and Number of Tourist in Fiji

2.2.5 Land Ownership

The ministry having jurisdiction over land ownership in Fiji is the Ministry of Lands and Mineral Resource. Land ownership is divided into the 3 following kinds; 1) Native land, 2) State land, 3) Freehold land. The proportion of each type of land ownership in Fiji and in the Nadi River Basin is shown in the following table.

Table 2-19 Land Ownership Type with Proportion

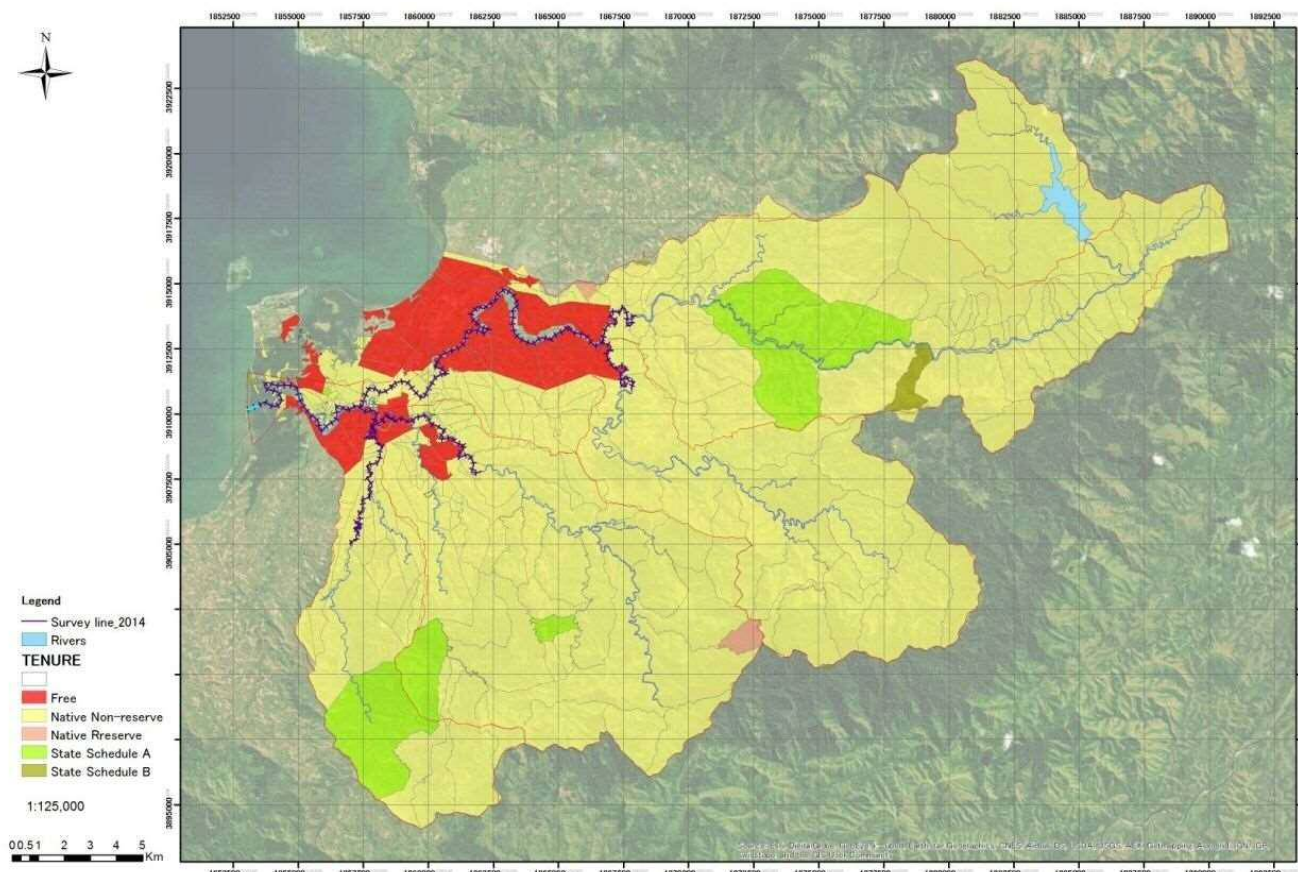
| Kind of Land | Ratio in Fiji | Ratio in Nadi River Basin |
|---------------|---------------|---------------------------|
| Native Land | 87.9% | 88.4% |
| State Land | 3.9% | 3.6% |
| Freehold Land | 7.9% | 8.0% |
| Rotuma Land | 0.3% | |

Source: Ratio in Fiji: Fiji Facts and Figures, Fiji Bureau of Statistics, 2012,

Ration in Nadi River Basin: GIS data about land ownership division supplied by TLTB

*Rotuma Land is land owned by Lotuma, having roots from southern Pacific Ocean

*Kind of Land is explained chapter “Land Ownership”



Source: Based on Ministry of Lands and Mineral Resource in Fiji, Project Team makes

Figure 2-30 Land Ownership Map

i. Native Land

Native Land is land owned by Fijian, which is owned by Land Owing Unit, LOU, composed of Tokatoka (family), Mataqali (aggregation of Tokatoka) and Yavusa (aggregation of Mataqali). It is not allowed to sell, give and exchange Native Land. Taukei Land Trust Board (TLTB) is established to manage all Native Land based on Native Lands Trust Act (cap 134). The owner of Native Land is allowed to lease their land but management is conducted through TLTB.

Besides, Native Land is divided in two types, Native Non-reserve (NN) and Native Reserve (NR). NN is land which owner lease to any person and has nothing to do with the TLTB. On the other hand, NR is land under TLTB management, for example in case of no LOU to inherit NN. Reserve Commission established in TLTB and involved NR is advertised by the Reserve Commission and land owner is selected.

ii. State Land

Fiji government has the ownership of State Land and Lands Department in the Ministry of Lands and Mineral Resource manages the State Land. State Land is divided in two types; State Schedule owned by LOU and State Schedule B owned by government since 1950s when contemporary legislative system was enacted.

iii. Free Hold Land

Free Hold Land is a kind of land which all can own and trade freely.

2.3 Legal Framework and Policy

2.3.1 Legal Framework and Policy related to Disaster Management

(1) 1998 Natural Disaster Management Act

Natural Disaster Management Act stipulates institutional arrangements for control and coordination of all disaster related activities in Fiji. The Act endorses the establishment of the following councils and committees:

- National Disaster Management Council
- Emergency Committee
- Preparedness Committee
- Mitigation and Prevention Committee

The Act focuses on coping with emergency situations and relief and rehabilitation but less on mitigation and disaster prevention. In view of climate change in recent years the need for review has been raised in the Government and the review of the Act is under consideration.

In view of recurrent changes of weather patterns and disaster occurrences, the needs have been raised for revision of both the Act and the Plan. The National Disaster Management Council (NDMC) has endorsed the revision of the 1998 Natural Disaster Management Act. The Act is planned for a review in 2015.

2.3.2 Legal Framework and Policy related to River

(1) Rivers & Streams Act, 1985

Rivers & Streams Act is singular law having title of “River” at the moment. “River” is defined as waterway where people can move by using canoe or Takias which have been used from way back by Fijian. “Stream” is defined as upper reach river and branch stream where people cannot move by using canoe or Takias. The following is established by Rivers & Streams Act.

“20 feet (about 6.1m) width from normal water level or maximum water level in rainy season is regarded as a part of river in case of need for public purpose and land easement must be given to all of public purpose”

On the other hand, if Bank in certain section is established as Town Planning Area under Town Planning Act, land easement expires about objecting bank. If road construction is planned under appropriate law at land neighboring bank, Public Right may be limited as Reservation.

Land owner, town, village and inhabitants neighboring river have right for using river use and are indemnified water rights with river water by the Chief of Land Bureau and Director of Lands and Surveyor-General being excluded rights to use of irrigation water, industry water, agricultural water and domestic water. The Chief of Land Bureau and Director of Lands and Surveyor-General don't give water rights over 25 years without special permission from Jurisdiction Minister and Rivers & Streams Act regulates water rights and limited items.

(2) Drainage Act, 1985

Drainage Act mandates the Controlling Authority to establish Drainage Area being approved by Jurisdiction Minister. Drainage areas designated by the Drainage Act in 1985 when this law came into force are the following 7 areas: Ba/Tavua, Dreketi/Bua, Labasa, Lautoka, Nadi, Ra and Sigatoka.

The Jurisdiction Minister assigns Drainage Board, which maintains, improves, inspects the existing drainage channels and constructs new ones in corresponded areas. Land owner living in drainage area must pay Drainage Fund and Drainage Board collects and manages it.

There is Drainage Board and Irrigation & Drainage Division belonging to the Land and Water Resource Department, Agricultural Ministry as organ for maintenance of drainage channels and they currently play the following roles; Drainage Board maintains drainage channel and Irrigation & Drainage Division prepares new drainage plan.

(3) Irrigation Act, 1985

Irrigation Act mandates the Jurisdiction Minister to assign a Commissioner for Irrigation, who designates Irrigation Area and has responsibility for maintenance of construction, improvement, maintenance of irrigated institution and irrigated agriculture. New irrigation plan is produced by Director of Town & Country Planning through the Commissioner for Irrigation. Commissioner for Irrigation should impose Irrigation Rates and collect it. Besides, Commissioner has the authority to draw irrigation water. Irrigation areas written in Irrigation Act of the 1985 were only the following 2 areas; Nausori Irrigation Area and Navua Central Irrigation Area. Navua area was provisioned as irrigation area for rice cultivation by JICA's support.

(4) Attention Items related to River & Streams Act when making Flood Control Plan

i. Items related to Rivers & Streams Act

In case a project plans to construct new waterways such as a change of the river flow or a diversion channel, the same standard procedures as construction of any other public works structure is applied for land acquisition process in accordance with the respective laws and procedures.

In terms of water rights, the land of river bed belongs to the state but use of rivers (*profits à prendre*) is granted to the public for all purposes.

The above-stated concerns have to be clarified in the legal provision, in case the river is altered in any manner in the project. To summarize these are:

- A definition of new waterways such as a change of the river flow or a diversion channel
- The water right of such waters

ii. Legal Fixed Position about Institution for Flood Control and Retarding Basins

Retarding basin, one of alternatives for flood control measures, is a new concept in Fiji and there is currently no legal provision for such use of land.

On the other hand, at the time of the last flood occurrence in 2012, although limited to the State Land, the MOL took measures on an ad-hoc basis, to lift the payment of lease for the inundated areas by the flood for a period of one year.

State Land Act is currently under review, coinciding with the study period. The review process will approximately continue between 2015 and 2017. Therefore, in case the project needs a specific regulatory framework for the retarding basin, it is timely to revise the Act to include the retarding basin.

2.3.3 Land Management Laws and Acts

(1) Laws and Acts related to Land Management

The laws and acts listed below are enforced for land management. State Land Act is under review. The review process continues from 2015 to 2017 (tentatively) to adjust the Act with necessary amendments. In case the project needs a specific regulatory framework for the implementation of the project particularly retarding pond and/or retention areas in terms of definitions and regulations, such an arrangement can be considered during the review process to institutionalize them. The project team is advised to make recommendations to the Fijian Government in order to facilitate the discussion for the review process, providing practical examples which the Fijian Government can take into account, for instance the experience from Japan.

Table 2-20 Laws and Ordinances related to Land Own

| Laws and Acts | Remarks |
|--|--|
| • State Land Act (132) | Law on use and maintenance of State Land |
| • Native Land Act (133) | Law regulating Native Land owned by Fijian |
| • Native Land Trust Act (134) | Law on land lease through TLTB and authority of TLTB |
| • State Acquisition of Lands Act (135) | Law on use of land owned by government for public purpose |
| • Town Planning Act (139) | Law regulating all lands and building developments, land subdivision, on-site operations and activities defined as development |

| | |
|---------------------------------|--|
| • Subdivision of Land Act (140) | Law regulating all lands and building developments, land subdivision, on-site operations and activities defined as development |
| • Rotuma Lands Act | Law on use and maintenance of Rotoma |
| • Land Transfer Act | Law on use, maintenance and trade of Free Hold Land |

Source: Study Team, 2015

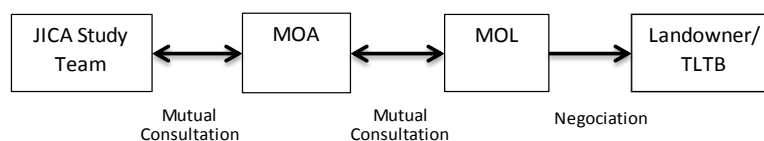
(2) Regulation of Land Use

Town Planning laws, both the Town Planning Act (Cap.139) and Subdivision of Land Act (Cap.140) regulates all lands and building developments, land subdivision, on-site operations and activities defined as development under the Act. It is administered by the Department of Town and Country Planning. Both laws extends to all town planning areas, both urban and rural as well as islands where developments have taken plan, excluding proclaimed villages, village reserves and native reserves.

Under the Town Planning Act (Cap.139) Town Planning General Provisions (1998), requirements for building developments in flood areas are outlined. According to the Act, no building shall have the floor level of any habitable room lower than 6.0meters in Nadi, relative to Mean Sea Level. Under Subdivision of Land Act (Cap.140), drainage provision is a requirement in any land subdivision

(3) Attention Items of Land Relevant Law Institutional Aspect At Formulation of Flood Control Plan

For land acquisition, an application route implementation is as follows in the case of JICA project. With reference to other similar projects implemented in Fiji in recent years, the negotiation process for the land acquisition may require 3-6 months or longer. While acquisition of land is principally conducted through negotiations, the State Land Act also stipulates possibility of compulsory acquisition where necessary.



Source: Produced by the Study Team based on an interview with MOL

Note: (⇔: mutual consultation, =>: negotiations)

Figure 2-31 Land Acquisition Process

2.3.4 Laws and Acts in related to Environmental Social Consideration

(1) Laws related to Environmental Management

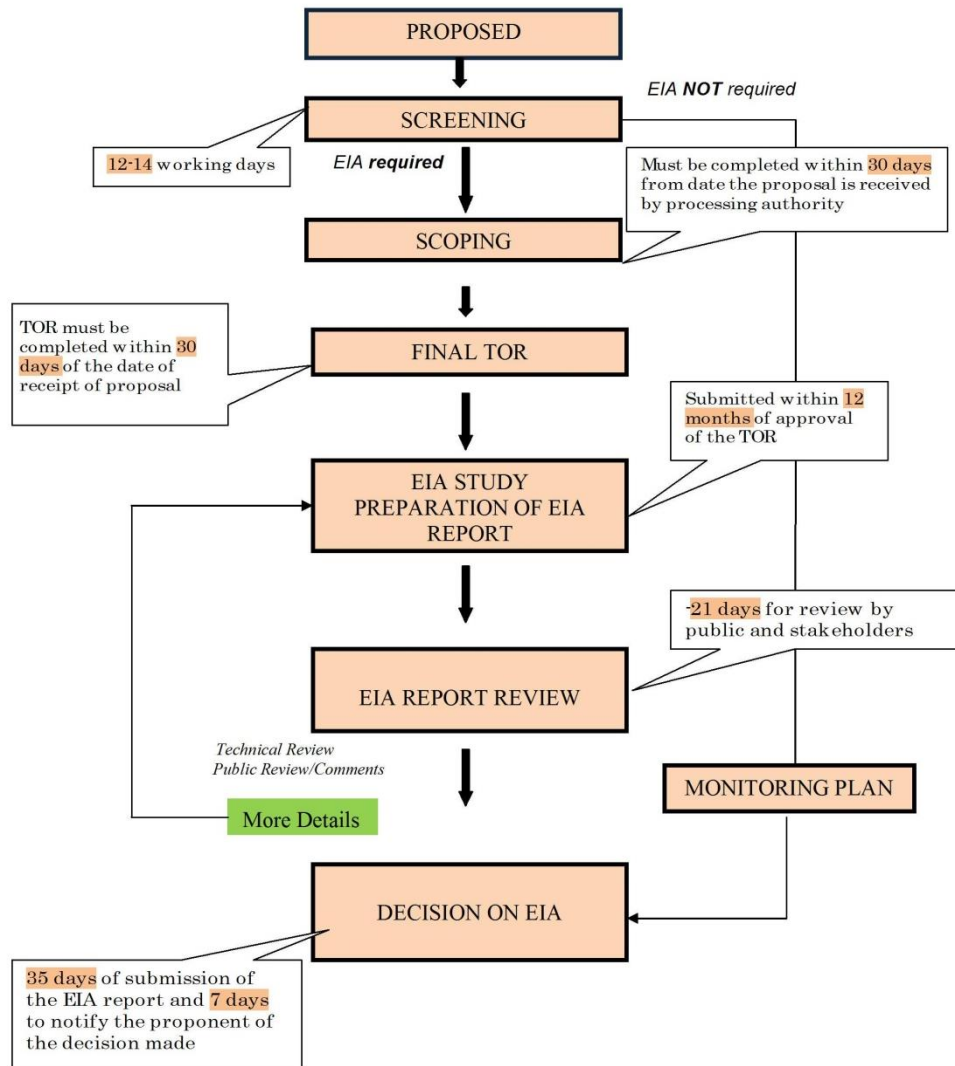
The Environmental Management Act 2005 was established in 2005 and the act provides legal framework for Environmental Impact Assessment, EIA, and comprehensive management practice for natural resources, waste management and anti-pollution measures. Competent authority of this law is the Department of Environment, DOE.

For regulation of this law, Environment Management (EIA Process) Regulations 2007 and Environment Management (Waste Disposal & Recycling) Regulations 2007 were established in January, 2008 and many sorts of procedures about environmental management were prescribed.

DOE had prepared Environmental Impact Assessment Guidelines in 2008 and revised second edition in 2012.

(2) Process related to Environmental Influence Assessment

The process related to Environmental Influence Assessment (from submission to approval) and the required days for each step of the process are shown in Figure 2-32.



Source: Environmental Impact Assessment Guidelines (Ed 2), Department of Environment, 2012

Figure 2-32 EIA Process in Fiji

2.4 National Development Plan and Disaster Management Related to Upper Level Plan

2.4.1 Development Plans

The following three planning policy documents are relevant in relation to development plans in Fiji which also cover the disaster management issues.

(1) The Peoples Charter for Change, Peace and Progress

This document is a result of nation-wide participatory consultations initiated by the Government between 2007 and 2008 in aim of rebuilding parliamentary democratic governance, stability, and peace in Fiji. It is a guiding policy document for the Government of Fiji to orientate the overall long-term direction. The vision for rebuilding Fiji that underpins this overarching objective is guided by the following key principles:

- A just and fair society;
- Achieving unity and national identity;
- Merit based
- Quality of opportunity for all Fiji citizens;
- Transparent and accountable government;

- Uplifting of the disadvantaged in all communities;
- Mainstreaming of the indigenous Fijian in a modern, progressive Fiji; and
- Sharing spiritualities and interfaith dialogue.

The document covers 11 key pillars of undertakings, each pillar having concrete objectives for improvements and undertakings to implement.

Table 2-21 Peoples Charter 11 Key Pillars

| Key Pillars |
|---|
| 1. Ensuring Sustainable Democracy and Good and Just Governance |
| 2. Developing a Common National Identity and Building Social Cohesion |
| 3. Ensuring Effective, Enlightened and Accountable Leadership |
| 4. Enhancing Public Sector Efficiency, Performance Effectiveness and Service Delivery |
| 5. Achieving Higher Economic Growth While Ensuring Sustainability |
| 6. Making More Land Available for Productive and Social Purposes |
| 7. Developing an Integrated Development Structure at the Divisional Level |
| 8. Reducing Poverty to a Negligible Level by 2015 |
| 9. Making Fiji a Knowledge based Society |
| 10. Improving Health Service Delivery |
| 11. Enhancing Global Integration and International Relations. |

Source: Peoples Charter for Change, Peace & Progress, 2008 National Council for Building a Better Fiji

(2) Roadmap for democracy and sustainable socio-economic development 2009-2014

The Ministry of National Planning established a five-year plan. A new five-year plan for 2015-2020 has been submitted to the Cabinet and its approval is scheduled for June 2015. Due to ministerial reform in 2014, the Ministry of National Development, Statistics was reorganized as part of the sections under the Ministry of Finance.

With regard to flood, the floods caused by cyclone in recent years is considered as a lesson and Roadmap for democracy and sustainable socio-economic development 2009-2014 sets policy goals for a strong nation-building in disaster and climate change, and policy objectives strategy moreover policies are made to lead the strategies with key performance indicators. In addition, the introduction of the early warning system (Early Warning Systems) has been commended as a possible effective tool for prevention of disasters such as floods.

Table 2-22 Policy on Reduction of Disaster and Disaster Management

| Goal: Building national resilience to disasters and adapting to climate change | | |
|---|--|--|
| Policy Objectives | Strategies | Key Performance Indicators |
| Communities are better protected from the risks of disasters and are better able to cope with their consequences. | <ul style="list-style-type: none"> ● Identify and implement effective risk reduction projects. ● Improve community response capacity in dealing with disasters and risks with effective, integrated and people-focused early warning systems on all hazards. ● Enhance analysis and evaluation of hazards, vulnerabilities and risks. ● Promote and strengthen food security program to enhance community based disaster reduction initiatives. ● Strengthen organizational, institutional, | <ul style="list-style-type: none"> ● Government responds to disaster situation within the first 24 hours. ● Casualties reduced from 30 per year to none. ● Everybody to receive timely warning ● One third of all villages and settlements in Fiji have disaster plans and committees in 2010 ● Models of best practice developed and adopted to support disaster risk reduction ● Cost for disaster emergency relief food |

| | | |
|--|--|--------------------------------------|
| | <p>policy and decision making frameworks.</p> <ul style="list-style-type: none"> • Enhance knowledge, information, public awareness and education. • Strengthen effective planning, response and recovery. • Ensure availability of adequate necessary plan and response to support recovery. | <p>ration reduced by 20% by 2012</p> |
|--|--|--------------------------------------|

Source: Roadmap for democracy and sustainable socio-economic development 2009-2014, MoP

(3) A Green Growth Framework for Fiji: Restoring the Balance in Development that is Sustainable for Our Future, 2014

The document is intended to support and complement the Peoples Charter for Change, Peace and Progress and the 2010-2014 Roadmap for Democracy and Sustainable Socio-Economic Development and its successor national development documents. As such, this Green Growth Framework has the same vision as the Roadmap. In the Green Growth Framework, the disaster management is placed as one pillar of challenges. The document set short-term (about 2 years), medium-term (3-5 years) and long-term (more than 5 years) goals to strengthen the resilience to climate changes and disasters and sets an action plan to promote the implementation of the initiatives as a policy framework. Challenges and Action Plan proposals related to the flood measures are as shown in Table 2-23.

Table 2-23 Key Challenges and Proposed Way Forward

| Key Challenges | Proposed Way Forward, Actions and Time-bound Indicators |
|---|---|
| (i) There is a need to develop an integrated approach and policy and at operational level to effectively address climate change and disaster management. | <p>Short Term (up to 2 years)</p> <ul style="list-style-type: none"> • Establish a National Platform for Climate Change and Disaster Risk Management by 2015. • Develop a National Strategic Plan for Climate Change and Disaster Resilience by 2015. • Review the Fiji National Disaster Management Arrangements to include Climate Change by 2016. |
| (ii) There is a need to ensure that buildings constructed in urban and rural areas are cyclone resistant. | <p>Short Term (up to 2 years)</p> <ul style="list-style-type: none"> • Review the National Building Code by the end of 2016. <p>Medium Term (3 to 5 years)</p> <ul style="list-style-type: none"> • Provide incentives to support compliance with new building standards by 2017. |
| (iv) There is a need for greater Understanding of the impacts of climate change and disasters for better planning recovery and long - term development. | <p>Short Term (up to 2 years)</p> <ul style="list-style-type: none"> • Develop a comprehensive assessment framework, including adoption of the damage and loss assessment methodology by 2015. <p>Medium Term (3 to 5 years)</p> <ul style="list-style-type: none"> • Institutionalize a mechanism to collect and analyze hazard, vulnerability and exposure data by 2017. • Mainstream cost-benefit analysis into decision making process in mitigation and preparedness measures by 2017. • Encourage collaboration with development partners and tertiary institutions in conducting research on priority areas with climate change and disaster risk reduction by 2017. <p>Long Term (over 5 years)</p> <ul style="list-style-type: none"> • Develop hazard maps and models for all potential hazards (including sea level raise, storm surge, flood and tsunami) by 2020. |
| (v) There is a need to ensure climate change mitigation and adaptation, and disaster risk management become a part of the national and sub national development planning and budgetary process. | <p>Short Term (up to 2 years)</p> <ul style="list-style-type: none"> • Integrate the climate change and disaster risk reduction into the National Development Plan by 2015. • Revise capital budget appraisal guidelines to incorporate comprehensive hazard and risk management (CHARM) and vulnerability and adaptation (VA) assessments by 2015. |

| Key Challenges | Proposed Way Forward, Actions and Time-bound Indicators |
|---|---|
| (vi) There is a need to increase the Resources of adaptation and mitigation measures given the growing impact of climate change and disasters on public infrastructure and livelihoods. | <p>Short Term (up to 2 years)</p> <ul style="list-style-type: none"> • Explore post-disaster financing modalities by 2015. <p>Medium Term (3 to 5 years)</p> <ul style="list-style-type: none"> • Improve access to global financing facilities such as the Global Green Fund. |
| (vii) There is a need to strengthen partnerships at all levels for building Resilience towards climate change and disaster. | <p>Short Term (up to 2 years)</p> <ul style="list-style-type: none"> • Partner with civil society in undertaking capacity building at divisional and community level on building resilience, also by providing incentives for performers/performance. <p>Medium Term (3 to 5 years)</p> <ul style="list-style-type: none"> • Undertake vulnerability assessment for all communities by 2019. • Develop climate and disaster resilience plans for urban and rural communities (prioritizing squatter settlements and other vulnerable communities) by 2019. <p>Long Term (over 5 years)</p> <ul style="list-style-type: none"> • Provide Capacity building to communities for which vulnerability assessments have indicated that relocation is the long-term strategy to minimize risks due to anticipated impacts of climate change. |

Source: A Green Growth Framework for Fiji, 2014, MoP

2.4.2 Disaster Management Plans

After the independence in 1970 until 1990s, the response to natural disaster in Fiji has been based on rather ad hoc arrangements with emphasis on emergency responses. In 1990, the United Nations has designated the 1990s as the International Decade for Natural Disaster Reduction (IDNDR) to reduce loss of life, property damage, and social and economic disruption caused by natural disasters, especially in developing countries. Following this international initiative, the Government of Fiji started to focus on the management of all aspects of disaster management and mandated the task to the Ministry of Regional Development.

Subsequently, National Disaster Management Plan was developed in 1995 and Natural Disaster Management Act was enacted in 1998. National Disaster Management Office (NDMO) started its operation with 12 staff in 2001. In view of climate change, the paradigm has further shifted in recent years to focus on two aspects of social development and disaster management: reducing the vulnerability of communities and contributing to sustainable development. This paradigm was included in Strategic Development Plan (SDP) 2007-2011.

In view of recent climate change and exacerbating natural disaster events, the needs for revision of policy documents were raised to include the mitigation and preventive measures, reduction of social vulnerability and disaster management.

Further, at the occasion of National Platform for Disaster Risk Management in 2014, the government was mandated to develop a National Strategic Plan for disaster risk management and climate change.

(1) 1995 National Disaster Management Plan

The National Disaster Management Plan aims to outline arrangements for control and coordination of all disaster related activities in Fiji. The document outlines the roles and responsibilities of specific bodies in disaster management, indicates the roles of agencies and Ministries in relation to natural disasters and gives guidelines for operations and activities at all stages of disaster management.

This will serve to:

- Reduce (or avoid, if possible) the potential losses and other adverse effects of known hazards;
- Assure prompt and appropriate delivery of disaster assistance to disaster survivors, when necessary;

- Achieve rapid and durable recovery after disasters.

In this document the range of natural disasters in Fiji are noted as cyclones, flood, earthquake, tidal wave (Tsunami), whirlwind/freak wind, landslide, forest fire, and drought. Most of these natural hazards are related to river management in one way or another.

Main pre-disaster activities include the types of activities listed below. The emphasis of these activities is institutional and capacity building towards disaster receptive measures. There is a gap between the Plan and Implementation as the implementation of these planning concepts focuses on preparedness and capacity building rather than mitigation measures and development of comprehensive river management. In 2014 the Plan is expected a revision to reflect the recent trends of climate change and challenges.

Table 2-24 Operational Activities outlined in the National Disaster Management Plan

| Types of Activities | Activities |
|-------------------------------------|---|
| Policy framework, infrastructure | Disaster mitigation plans and projects, including hazard assessment, vulnerability analysis and disaster reduction programs |
| Preparedness of the Government | Disaster preparedness activities of government agencies |
| Community education and involvement | Activities to improve the capabilities of communities to cope with natural disasters by improving their awareness |
| Capacity building | Training of government officials, NGO-staff and communities in disaster preparedness, emergency operations and post-disaster recovery |

Source: National Disaster Management Plan 1995, GoF

2.4.3 Regional Disaster Management Plan

National Disaster Management Plan 1995 (here in after “NDMP”) define an authority to prepare the local DRR plan in each Divisions and Districts. Table 2-25 shows the responsible organizations for preparation of local DRR plan and current status of provision.

As shown in Table 2-25, NDMP1995 and Natural Disaster Management Act are under revision process. Division level DRR plan will be prepared based on revised Plan and Act. In a district, they implement unique countermeasures for DRR. The District Officer hold DRR meeting with attendance of district level DRR related organizations to share the information of role and capacity (including human resources and equipment) of the organizations during disasters. Based on the information which shared in the DRR meeting, Do-Nadi will prepare the Standard Operation Procedure (SOP).

Town and Village level Local DRR Plans are developed. In a village level plans were developed at the training which conducted by the NDMO and international donors. According to the Village leaders or member of CDMC, the plans are not effectively utilized because of part of the development plans are missing, or displayed on a wall of community center but utilization manner is not clear.

Table 2-25 Current status of regional disaster management plan in the Nadi River Basin

| Government Level | Responsible Organization *1 | Current Status*2 | Remarks*2 |
|------------------|-------------------------------------|------------------|---|
| Division | Commissioner Western Division (CWD) | Not developed | The plan will be developed as soon as the revision process of the National Disaster Management Plan :(NDMP) 1995 and Natural Disaster Management Act :(NDMA) 1998 is complete. |
| District | District office of Nadi (Do-Nadi) | Not developed | Do-Nadi has called a meeting to discuss the holistic approach of disaster response preparedness and emergency responses by gathering agencies/organizations |

| | | | |
|---------|--|-----------|---|
| | | | relevant to disaster prevention in Nadi District. |
| Town | Nadi Town Council | Developed | - |
| Village | Community Disaster Management Committee (CDMC) | Developed | Town's Disaster Management Plan has been developed (as part of a project organized by NDMO and international donors). |

Source: *1 National Disaster Management Plan (1995), *2 Based on interview survey by the Team

2.5 Government Organization and Structure

2.5.1 The Ministries and Departments of the Fiji Government

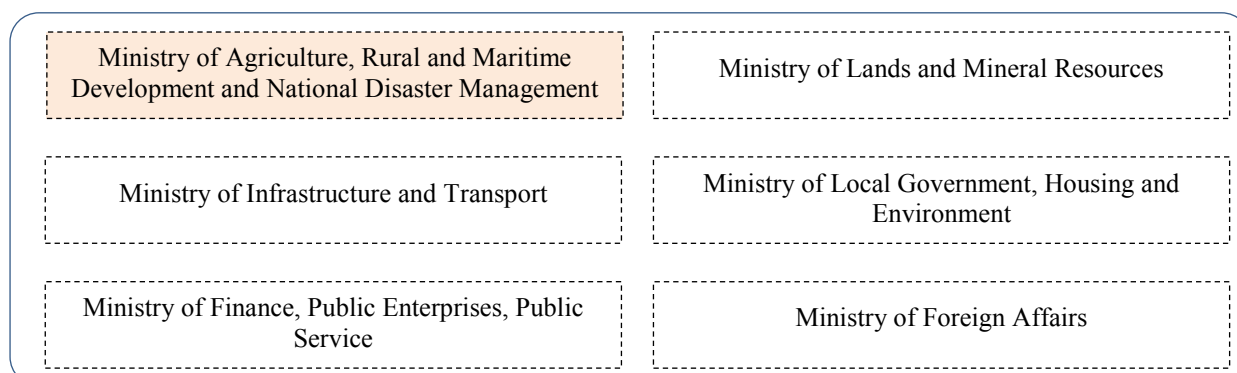
The Government of Fiji consists of 17 ministries and department, including the Prime Minister's Office. The list of the ministries as of 2014 is shown in Figure 2-26.

Table 2-26 The Fiji Government Ministries and Departments

| Section | Ministries |
|-------------------------|--|
| Prime Minister's Office | Ministry of Agriculture, Rural and Maritime Development and National Disaster Management |
| | Ministry of Education, Heritage & Arts & National Archives of Fiji |
| | Ministry of Employment, Productivity and Industrial Relations |
| | Ministry of Industry & Trade and Tourism |
| | Ministry of Fisheries and Forests |
| | Ministry of Finance, Public Enterprises, Public Service |
| | Ministry of Foreign Affairs |
| | Ministry of Health and Medical Services |
| | Ministry of Immigration, National Security and Defense |
| | Ministry of Infrastructure and Transport |
| | Ministry of Justice /Attorney-General |
| | Ministry of Lands and Mineral Resources |
| | Ministry of Local Government, Housing and Environment |
| | Ministry of Women, Children and Poverty Alleviation |
| | Ministry of Youth and Sports |
| | Department of Information |

Source: Government of Fiji Gazette Supplement, 2014

As to flood control project implementation, the following ministries are concerned in one way or another.



Source: Study Team, 2015

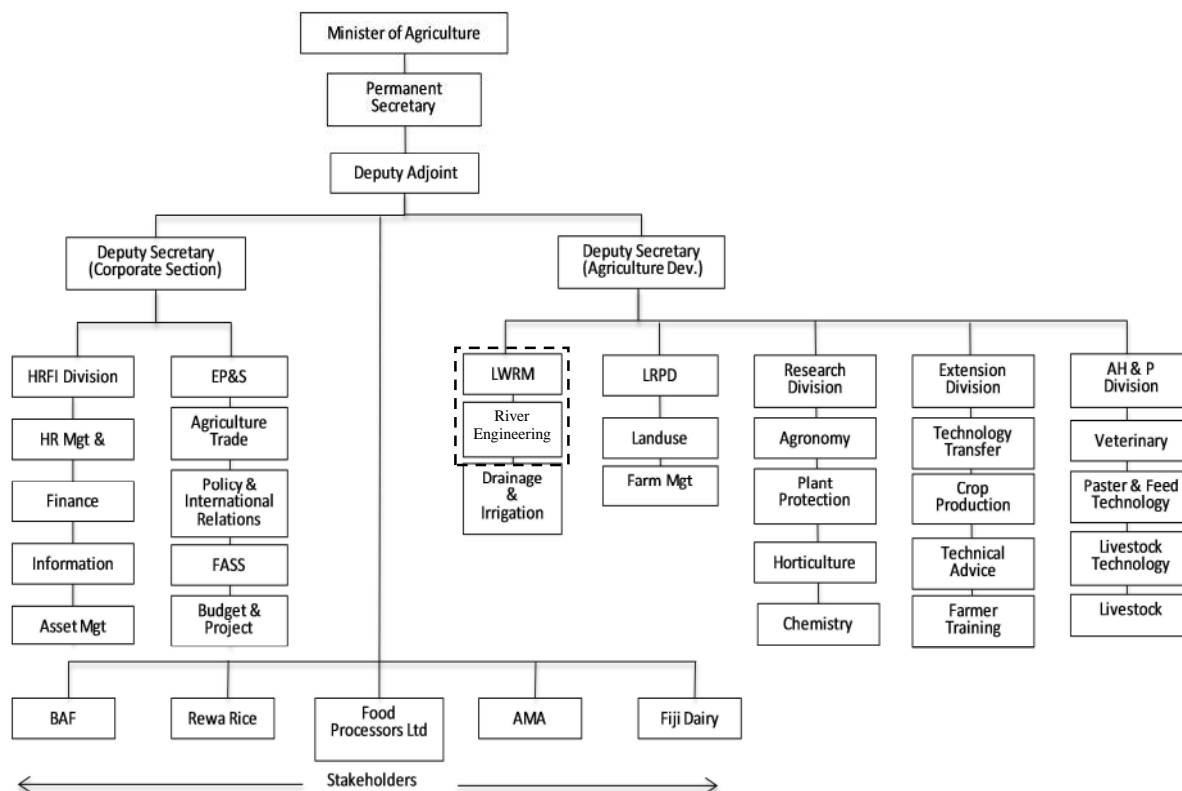
Note: Counterpart Ministry for the Study Team

Figure 2-33 Ministries related to Flood Control in Fiji

2.5.2 Ministry of Agriculture, Rural and Maritime Development and National Disaster Management (Agriculture Section)

(1) Organizational Structure of Agriculture Section

The structure of Agriculture section has the following organogram.



Source: Annual Corporate Plan 2014, MOA

AH&P: Animal Health & Production, BAF: Biosecurity Authority of Fiji, AMA: Agro-Marketing Authority, LRPD: Land Resettlement Planning Dept.

Figure 2-34 Organizational Structure of Agriculture Section

(2) Government Businesses

The MOA has the following 6 areas of performance targets to monitor the governmental intervention in the agricultural sector:

- Outcome 1: Non-sugar Agriculture and Livestock
- Outcome 2: Poverty Alleviation
- Outcome 3: Land Resource Development and Management
- Outcome 4: Gender and Women Development
- Outcome 5: Agriculture Support in Rural area Island areas
- Outcome 5: Public Sector Reform

The conduct of the following businesses related to disaster management falls under the responsibility of the MOA:

- ◆ Land Development, Conservation and Utilization
- ◆ Disaster Control and Management

- ◆ Disaster Risk Reduction
- ◆ Divisional Administration
- ◆ Integrated Rural Development
- ◆ Rural & Outer Island Development
- ◆ Rural Housing

(3) Divisions in charge of Flood Control

The Land & Water Resources Management (LWRM) is the division that deals with the river management, watershed management as well as activities related to flood protection. Apart from LWRM, the Economic Planning and Statistics and the Land Resource Planning Dept. have respective functions for implementation of interventions with international bilateral cooperation. Key functions of relevant divisions in relation to flood control and watershed management as well as bilateral cooperation are as outlined below.

Table 2-27 Key Functions of Divisions in the Ministry

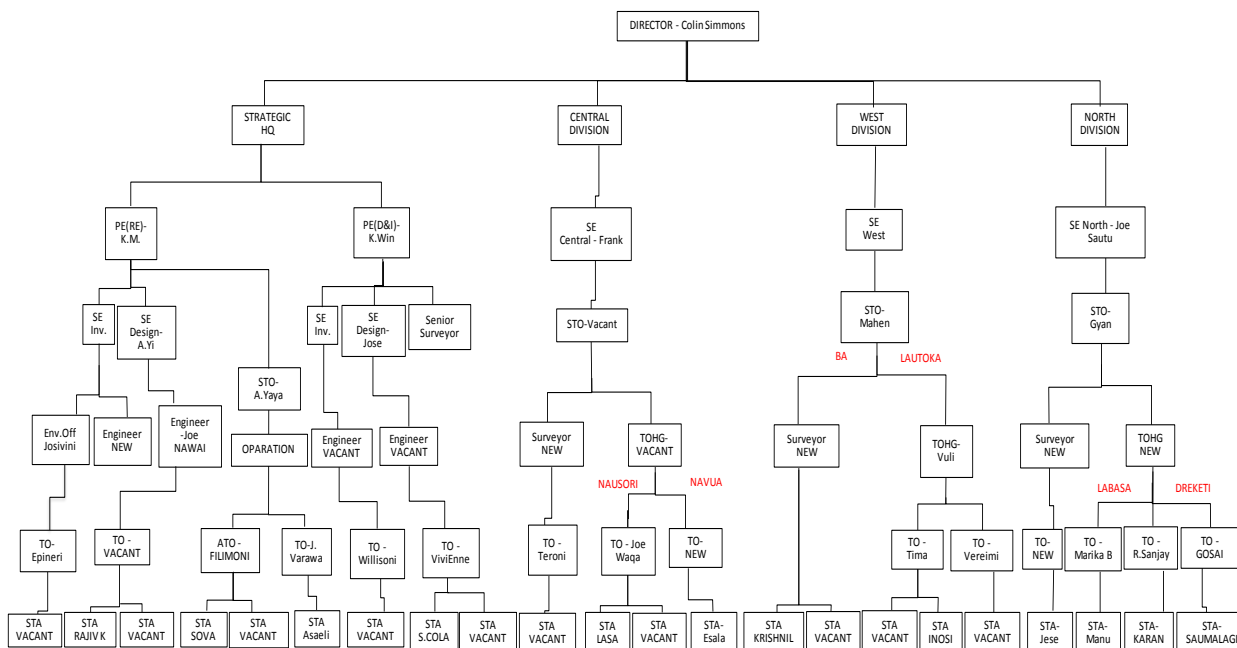
| Division | Functions |
|-----------------------------------|--|
| Economic Planning & Statistics | <ul style="list-style-type: none"> ● Formulate the agricultural sectors development policies with appropriate strategies and subsequent program activities in accordance with the government strategic plan ● Conduct marketing research on market opportunities and facilitate the private sector marketing of agriculture produce, both locally and abroad ● Establish and enhance effective and sustainable linkages with external organizations, including global donor agencies at bilateral, plurilateral and multilateral levels ● Collate, compile and analyze agricultural statistics to assist in the formulation of policies ● Analyze policy options and assess its impact on the agriculture sector ● Assist in the identification, preparation, monitoring and evaluation of all agricultural projects in Fiji, ● Coordinate the ministry's annual budget emphasis on the capital expenditure on quarterly basis ● Coordinate and facilitate the training of staff in marketing, project planning, implementation, monitoring, evaluation and report writing |
| Land & Water Resources Management | <ul style="list-style-type: none"> ● Mitigate flood risks which may result in damage to agricultural crops, livestock, property and human lives ● Provision of efficient and effective drainage to maximize agricultural land utilization ● Increase of crop yield and enhancement of food security with timely and efficient irrigation services ● Formulation of framework for water resource development and management to mitigate drought impacts and support alternative livelihood and national adaptation strategy ● Enforcement of regulatory services in compliance with relevant legislations for delivery of efficient services ● Provision of efficient and sound engineering advise to increase agricultural productivity ● Effective coastal engineering services to protect the erosion of country's foreshore and provide security to population located along the coastline ● Reliable construction and maintenance services to the relevant divisions of the Ministry ● Proficient secretariat services to support engineering programs |

| Division | Functions |
|------------------------------|--|
| Land Resource Planning Dept. | <ul style="list-style-type: none"> ● Capacity building for farmers and agriculture officials in the areas of farm business planning and farm business advisory services ● Farm management training for crop & livestock ● Upgrading farm management manual ● Preparation of farm business plan ● Creation of a new generation of young farmers who could be motivated and assisted through this grant ● Promote sustainable land use practices with major emphasis on land conservation and land degradation issues ● Provide quality and timely advice to the management and our partners on optimum land utilization techniques ● Strengthen and accelerate participation and adoption of sustainable agricultural systems for all and ensure sustainable land management ● Accelerate the generation and use of appropriate and innovative technology ● Promote farming as a business and as a rewarding form of employment ● Provide agricultural property valuation service and undertake sales analysis to determine the volatility of the market |

Source: Annual Corporate Plan 2014, MoA

i. The Land and Water Resources Management Division

The structure of the Land and Water Resources Management Division has the organizational structure shown below. However, the structure is in a transitional period and this structure is not yet fully implemented.



Source: Land and Water Resources Management Division internal document, 2014, MoA

Note: PAO Principal Admin. Officer, SE Senior Engineer, SS Senior Surveyor), E Engineer, Env.O Environment Officer, TOHG Technical Officer Higher Grade, TO Technical Officer, CO Clerical Officer, STA Senior Technical Officer

Figure 2-35 Organization Structure of LWRM

The current incumbents of the division are only 15 and a high vacancy rate is a challenge to the division to

deliver effective services.

Table 2-28 The Current staff of Division of LWRM

| Section | Position | Nr of staff | |
|---------------------------|------------------------------------|-------------|---------|
| | | Actual | Planned |
| Administration | Director | 1 | 1 |
| | Secretary | 1 | 1 |
| | Typist-telephone operator | 1 | 1 |
| | Driver | 2 | 2 |
| River Engineering Section | Principal Engineer: River engineer | 1 | |
| | Senior Engineer: River engineer | 1 | |
| | Senior Technical Engineer: O&M | 1 | |
| | Engineer | 1 | |
| | Senior Technical Assistant | 1 | |
| | Recorder/Typist | 1 | |
| Environment/ Hydrology | Environment Officer | 1 | |
| | Technical Officer | 2 | |
| | Attachee | 1 | |
| | | | |
| | Total | 15 | |

Source: Land and Water Resources Management Division internal document, 2014, MoA

(4) Division Office of LWRM

The role of the Land and Water Resource Management Division in Nadi Office is to facilitate sustainable land and water resource management for agricultural development in support of the Department of Agriculture's strategic and corporate goals.

The Division is a multi-disciplined engineering organization that provides a wide range of services from land surveying to environmental planning, drainage and irrigation, river improvement, watershed management, coastal and building designs. Our technical expertise includes flood risk assessment, integrated water resource management and building adaptive capacity and resilience to the challenges of climate change and variability. We provide our services to our key partners, stakeholders, municipalities, state agencies, provincial councils, landowners, and farmers.

The Land and Water Resource Management Division's core functions are:

- ◆ Drainage infrastructure maintenance works for the improvement and effective utilization of agricultural land in the Central, Northern and Western Divisions,
- ◆ Dredging activities to reduce vulnerability and risk of flooding in Ba, Rewa and Labasa rivers
- ◆ Watershed management structural measures to regulate peak flood flows in Nadi catchments,
- ◆ Irrigation infrastructure and maintenance works in the Central, and Northern Divisions in support of rice revitalization
- ◆ Agricultural infrastructure development support for commodity priority areas
- ◆ Water resource mapping to address drought mitigation

(5) Flood Control Project

The projects regarding flood control conducted by MOA in recent years are Watershed Management Project and River Dredging Project. The following section explains the framework of these projects.

A) Watershed Management Project

This project has been conducted by MOA from 2008 to 2017. The major components and control area of

this project are shown as following:

The major components of the project

- Construction of small retention dams & reservoirs
- Providing drainage & irrigation facilities
- Flood /drought mitigation and Riverbed Dredging
- River bank protection
- Land conservation works

Control Area

The control areas of Watershed Management Project are as listed below and Nadi river basin is chosen as a pilot project area. In Nadi river basin, typical problems such as inundation of flood water, soil erosion and sediment deposit have occurred and that is why this basin is chosen as pilot project area to implement the project for watershed management and development.

The control areas of Watershed Management Project:

- Nadi Watershed Areas – a pilot scheme
- Ba Watershed Areas
- Sigatoka Watershed Areas
- Labasa Watershed Areas
- Nakauvadra Watershed Areas
- Rewa Watershed Areas

The content of the pilot project is construction of retention dam as flood control. Three retention dams, Namulomulo Dam (Namosi River), Vaturu Dam (Nawaka River) and Taci Dam (Nawaka River), were constructed in 2006, 2009 and 2010 respectively by the pilot project. Besides, Namosi II Dam (Namosi River) is under construction. In addition, new site for dam construction is proposed and chosen in Nawaka River and Masi River but summary report for arrangement plan of retention dam is not left and details of the project is not clear.

Table 2-29 Dams Constructed in Nadi River by Pilot Project

| Basin | Retention Dam | Site | Catchment Area | Notes |
|---|----------------|---|-----------------------|--------------------------------------|
| Namosi River | Namulomulo Dam | 11 km Upstream from confluence with Nadi River | 70 km ² | Constructed in 2006 |
| | Namosi II Dam | — | — | Under construction in February, 2015 |
| Nawaka River | Vaturu Dam | 6 km Upstream from confluence with Nadi River | 94.51km ² | Constructed in 2009 |
| | Taci Dam | 11 km Upstream from confluence with Nadi River | 69.77 km ² | Constructed in 2010 |
| | Nawaka III Dam | 16 km Upstream from confluence with Nadi River | 30.9 km ² | Under planning |
| Masi River (Branch of Namosi River) | Masi I Dam | 7.55 km Upstream from confluence with Nawaka River and 20.75km from Nadi River estuary. | 20.14 m ² | Under planning |

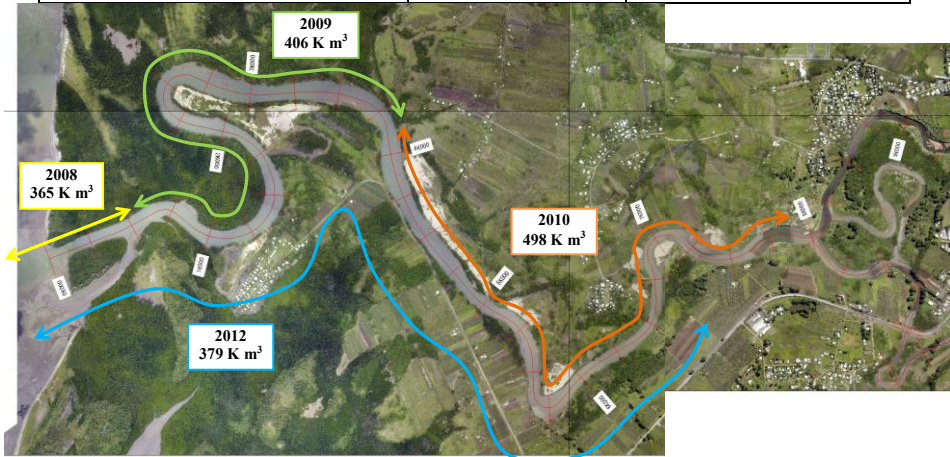
Source: Medium Term Capital Expenditure Programme, 2015

ii. River Dredging Project

River dredging had been conducted from 2008 to 2012 in Nadi River estuary and 1,651 thousand m³ of sediment had been dredged. The dredged sediment volumes are shown in the following table and figure but details on the period and section of the work are not clear.

Table 2-30 Sediment Volume of Excavation in Nadi river (Performance-based)

| Year | Area | Sediment Volume (thousand m ³) | Notes |
|------|--------------|--|-------------------------------|
| 2008 | -1.2k-0.5k | 365 | |
| 2009 | 0.5k-3.7k | 409 | |
| 2010 | 3.7k-7.775k | 498 | |
| 2012 | -1.2k-6.975k | 379 | Conducted after flood in 2013 |
| SUM | | 1,651 | |



Source: Based on Hearing Survey to LWRM, Investigation Committee made

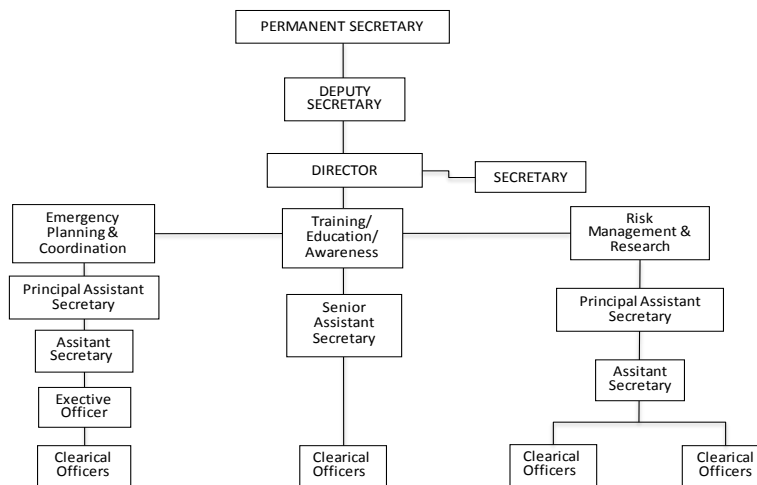
Figure 2-36 Area of River Dredging

2.5.3 Ministry of Agriculture, Rural and Maritime Development and National Disaster Management (National Disaster Management Section)

The Department for Regional Development (in the Ministry of Rural and Maritime Development and National Disaster Management) was mandated to take the overall responsibility for an effective national disaster management strategy, covering prevention, mitigation, preparedness, emergency operations, relief and rehabilitation in 1990.

i. National Disaster Management Office

The National Disaster Management Office is a permanent institutional entity set up within the Ministry of Rural and Maritime Development and National Disaster Management. The organizational structure is as shown below.

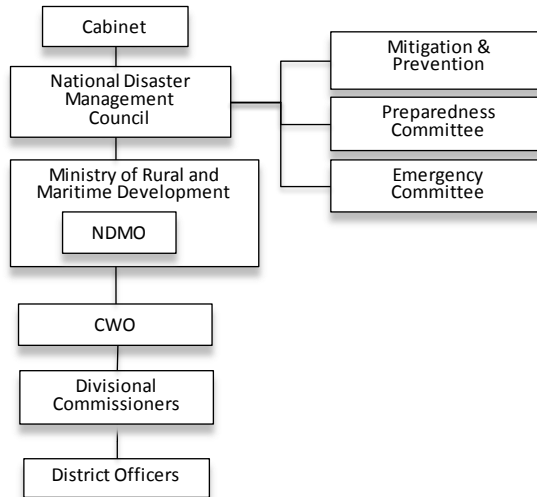


Source: National Disaster Management Plan, National Disaster Management Council and Government Agencies, 1995

Figure 2-37 Organizational Structure of NDMO

ii. Organizational Structure of National Disaster Management

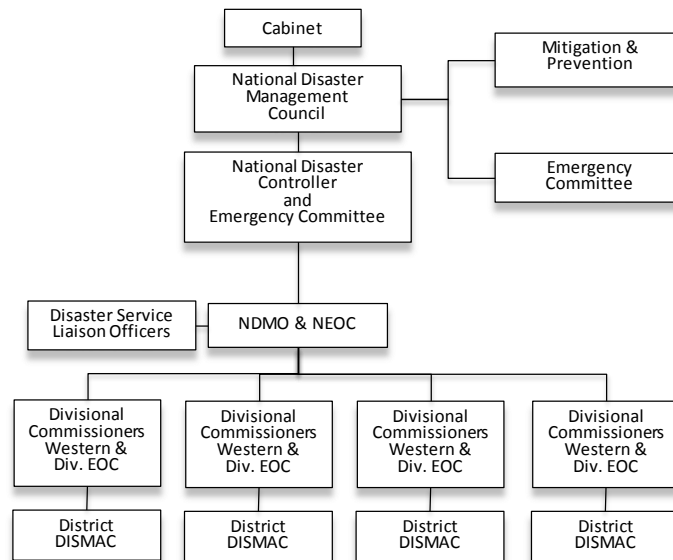
The Fijian Government has established an institutional structure to respond to disasters in accordance with National Disaster Management Plan 1995. There is a permanent structure as well as a structure which is activated during emergency operations. These two structures are illustrated in the following figures.



Source: National Disaster Management Plan, National Disaster Management Council and Government Agencies, 1995

Figure 2-38 Permanent Bodies of the Disaster Management Structure

The structure below is activated during emergency operations to handle the situation.

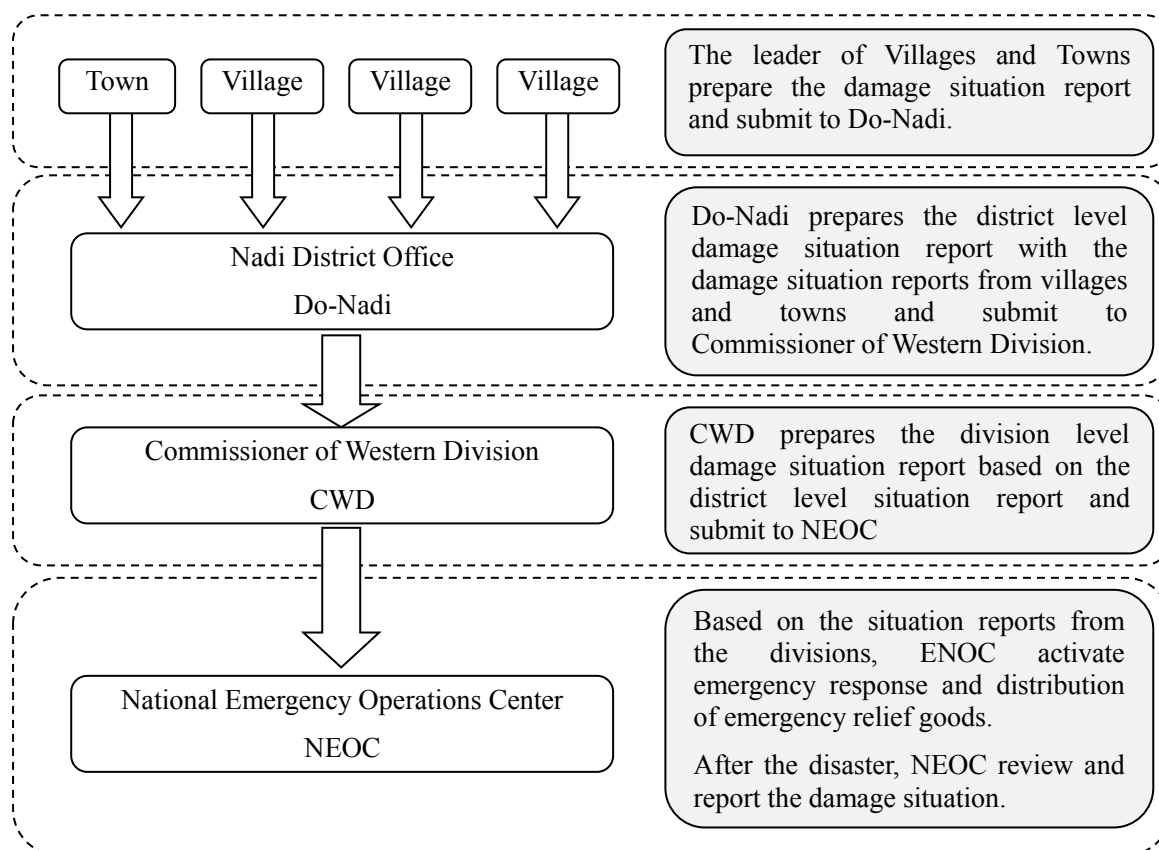


Source: National Disaster Management Plan, National Disaster Management Council and Government Agencies, 1995

Figure 2-39 Disaster Management Structure for Emergency Operation

(2) The System of Damage Assessment after the Disasters

Damage assessment and data collection are conducted by the organizations shown in below. In case of emergency (Floods and Cyclones), the situation of damages are reported to National Emergency Operations Center with the flow shown in below.



Source: Prepared by the Study Team based on the interviews from NDMA, CWD, Do-Nadi, Nadi Town and Villages

Figure 2-40 The damage reporting flow in Fiji

Even though, a situation report is prepared by each level of local community, district and division, only hard copy is available and it is not digitalized. Moreover, developed situation report is not compiled properly and it is not utilized for disaster damage assessment and disaster risk assessment especially for local community level.

The Situation Report form Town, Villages, Districts and Divisions are not digitized. Especially in Town and Village level, developed situation reports are not stored adequately and not utilized for damage and risk assessment

National Disaster Management Act 1998 and National Disaster Management Plan 1995 regulate that NDMA shall be conduct Post-Disaster Review within six (6) months after a disaster happen. The Post-Disaster Review Reports are prepared with the assistance from international donors.

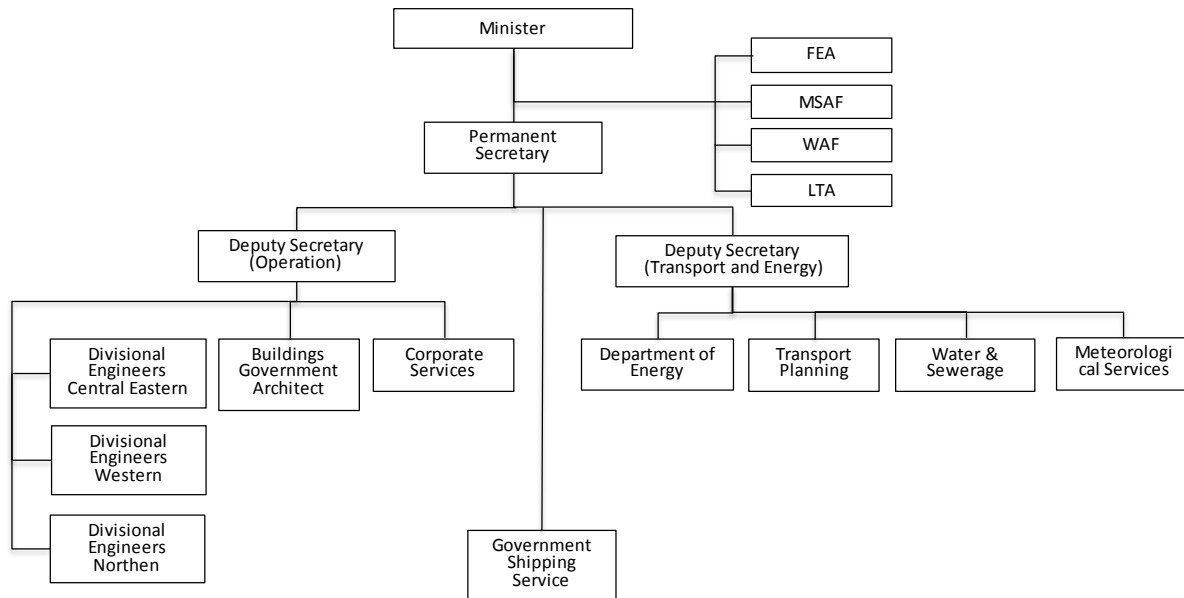
i. Institutional Challenges and Needs of National Disaster Management

The National Disaster Management Plan 1995 is under review. One of the key observations made herewith is that the Plan inclines to emphasize largely on activities related to responses to disasters such as emergency and recovery operations. Mitigation and preventive measures are not sufficiently attended to mitigate losses and damages in view of recent exacerbation of climate related disasters.

2.5.4 Ministry of Infrastructure and Transport

The Ministry of Infrastructure and Transport (MOIT) is directly responsible for policy formulation, planning, and design, regulation, coordination and implementation of programs, projects and services relating to public works, meteorology, transportation and utilities in Fiji. The infrastructure related to flood control measures is not included in the mandates of MOIT, except for meteorological data collection and analysis.

(1) Organizational Structure of MOIT



Source: Annual Corporate Plan, 2014

Note: FEA Fiji Electricity Authority, MSAF Maritime Safety Authority of Fiji, WAF Water Authority of Fiji, LTA Land Transport Authority

Figure 2-41 Organizational Structure of Ministry of Infrastructure and Transport

(2) Government Businesses

The implementation of the following government businesses falls under the responsibility of MOIT.

- ◆ Meteorology
- ◆ Infrastructure, Buildings
- ◆ Transport Planning, Land Transport, Road Safety, Roads, Railway Services
- ◆ Registration of Architects and Engineers
- ◆ Shipbuilding, Shipping Services, Marine Services
- ◆ Biofuel Policy Development, Conservation of Fuel
- ◆ Development of Energy Resources, Electricity Supply (other than rural electrification), Energy Development Policy, Fuel and Power Energy Measures, Rural Electrification
- ◆ Water and Sewage, Water Rates

The Meteorological services fall under the MOIT. The Ministry's corporate plan includes interventions related to the disaster risk reduction and disaster management. Project plan by MOIT in 2014, which contains items related to flood control, such as reinforcement of atmospheric data and hydrological data is shown as follows.

Table 2-31 Target Outcome: Disaster Risk Reduction and Disaster Management

| Output | Strategies | Output Indicators | Responsible Division | |
|---|---|--|--|--|
| Output8: Provision of Meteorological Data | Acquisition of real time meteorological data | Daily Synoptic Weather Reports | FMS | |
| | | Meteorological Aviation Report (Metar) | | |
| | | Special Weather Reports for Aviation (Speci) | | |
| | | Quick Climate Data | | |
| | | Daily Climate & Rainfall Records | | |
| | | Sub-Daily Hourly Records (Metar, Synops, Tideda) | | |
| | | QMS Verification Statistics | | |
| Output9: Provision of Hydrological Data | Acquisition of real time hydrological data | River/water Level | | |
| | | Rainfall | | |
| | | Stream flow measurement (Gauging) | | |
| | | River discharge (Rating) | | |
| Output10: Provision of meteorological product and services | Continuous & efficient manning of the National Weather Forecasting Centre | Public and Routine Weather Forecasts issued. | | |
| | | Routine Marine Weather Forecasts issued | | |
| | | Routine Aviation Weather Forecasts issued | | |
| | | Forecast Warnings & Advisories | | |
| | | 3 Day Tropical Cyclone Outlook | | |
| | | Tropical Cyclone Reports | | |
| | | Weather Forecast for SMS to mobile networks | | |
| | | Plain language weather updates to the media | | |
| | | Continuous & efficient manning of Climate Services | Monthly Climate Summary | |
| | Seasonal Climate Outlook | | | |
| | Monasavu Climate Outlook | | | |
| | Fiji Sugarcane Rainfall Outlook | | | |
| | Annual Climate Summary | | | |
| | Tropical Cyclone Guidance | | | |
| | Information Sheets | | | |
| | ENSO Update | | | |
| | Provision of Climate Science and Projections | | | |
| | Continuous Media Publications & online delivery of meteorological products & services | IT Desktop Audit | | |
| | | Installation of Disaster Recovery Centre at Laucala Bay office. | | |
| | Establishment of backup plan | Implement backup plan | | |
| | | Renewal of Software Licenses | Purchase of Software Licenses | |
| | | | FIMS Server & Workstation replacement (3yrs) | |
| | | | | |
| | Output 11: Provision of Hydrological product and services | Routine/non Routine Hydrological Forecasts Issued | Provision of Hydrological data | |
| | | | Flood Forecasts | |
| | | | Hydrological Drought Forecasts | |
| | | | Flood Report | |
| Hydrological Drought Reports | | | | |
| Output 12: Upgrading & Installation of Meteorological Systems & Equipment | Maintain reporting networks to WMO and ICAO standards | Upgrading of Outer Island Stations (Solar Power Installations) | | |
| | Maintain quality data availability | Replacement of Automatic Weather and Climate Stations | | |
| | 6 monthly & quarterly for preventing maintenance on radar | Inspection & Maintenance Program of all Meteorological Equipment | | |
| | Timely severe weather warning | Upgrade of Labasa Conventional Radar | | |
| | | Upgrading of National Climate Monitoring Telemetry System | | |
| | | Data Rescue and Digitization (Request for carry over into 2014) | | |
| | | IT Systems Support and Maintenance | | |
| Output 13: Upgrading & | Maintain reporting networks to WMO standards | Installation of New Telemetry Stations and Upgrading of Communication Network. | | |

| Output | Strategies | Output Indicators | Responsible Division |
|--|---|--|----------------------|
| Installation of Hydrological Systems & Equipment | | Inspection & Maintenance of Hydrological network. | |
| Output 19: Construction Services | Construction of government facilities and infrastructure | Number of lighthouse, Health Centers and Nursing Stations, sea walls, Government House, Fisheries and Forestry projects constructed | DBGA/DE PWSO |
| Output 20: Design and Costing Services | Survey, scoping, documentation and estimating. Construction by private contractors to be facilitated by - Project management - Tendering and management - Subcontracting - Monitoring of consulting & contract services | Number of projects completed by private contractors, DOW, number of designs, documentation and supervision of projects by private consultants, technical and tender evaluations completed, technical documents vetted for other Ministries, feasibility study. | DBGA/DE |

Source: Annual Corporate Plan 2014, MoIT

i. **Fiji Meteorological Service: FMS**

The Fiji Meteorological Services (FMS) is an agency under the Ministry of Infrastructure and Transport and responsible for providing weather forecast and warning services for Fiji as well as the islands nations in the Pacific region with the following objectives:

- To satisfy Fiji's need for weather, climate and hydrological data, associated forecasts, warnings, projections and other related information, as required.
- To monitor the climate of Fiji and advice on issues relating to the science of climate, climate change and variability, including extremes.
- To provide weather forecast, warning and advisory services for other Pacific Island Countries.
- To function as a Regional Specialized Meteorological Centre (RSMC) for tropical cyclones, under the World Weather Watch Program of the World Meteorological Organization (WMO).
- To serve as the Meteorological Watch Authority (MWA) and the Meteorological Watch Office (MWO) for the Nadi Flight Information Region (FIR) and other specified areas as per International Civil Aviation Organization (ICAO) designation, for the purpose of international air navigation. To provide meteorological forecast and warning services for international shipping in the tropical South-west Pacific waters, as per WMO and International Oceanic Commission requirements.
- To maintain, sustain and develop Fiji's meteorological and hydrological observation networks, to WMO, ICAO and ISO standards.
- To maintain, sustain and develop the Departments Information, Computing & Telecommunication systems to internationally agreed standards to ensure timely exchange and dissemination of meteorological, hydrological, and related information.
- To provide and facilitate meteorological and hydrological training to Fiji and the Pacific Island Countries as well as awareness and education to all communities in Fiji

The agency operates the following centers.

Table 2-32 Technical Service Centers in FMS

| Centers | Service |
|---|--|
| National Weather Forecasting Centre (NWFC) | Weather information in Fiji |
| Regional Specialized Meteorological Centre | Weather forecasts, cyclone and other severe weather warnings |
| Tropical Cyclone Centre (RSMC Nadi-TCC): in conjunction with the World Weather Watch Program of the World Meteorological Organization (WMO) | Advisory information for the tropical South Pacific region |

Source: Fiji Meteorological Services, 2015, FMS

(3) Water Authority of Fiji: WAF

Water Authority of Fiji (WAF) belonging to MOLT, is responsible for business related to water supply, sewerage system and water bill. WAF was established as a public corporation in 2007 by Fiji's government and in 2010 it undertook business of Water and Sewerage Department (WSD), reorganized in 2009 into its current system which is composed of five departments: management department, production department, project management department, accounting department and customer service department. The main purpose of WAF is to offer good quality water and sewer services.

M/P for Nadi and Lautoka area was being formulated by WAF in February, 2015 and it will be conducted to decrease NRW and pressure control by solving the high leakage rate (more than 50 %) which is regarded as current problem, to satisfy water supply required in future. The source of water supply in Nadi which WAF have jurisdiction over is completely dependent on Vaturu dam and increasing the height of Vaturu dam embankment is reviewed as part of water source development. On the other hand, there is some possibility of utilizing ground water as additional water source but WAF is not using ground water as water source but surface flow.

WAF reserves water resources during and after disaster as part of flood control but it is not responsible for concrete disaster prevention project. However, multipurpose dam that can be utilized in flood management is considered in this project.

2.5.5 Local Government

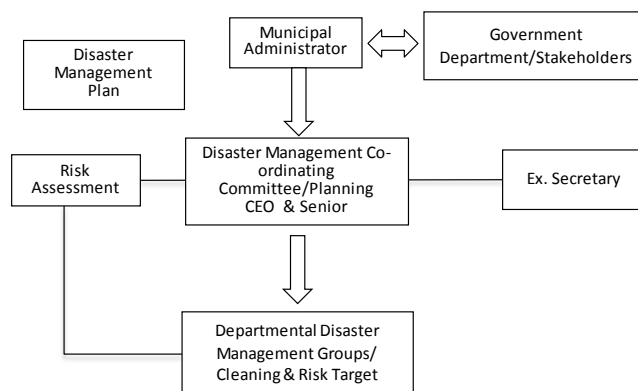
(1) Organization System

The activities of Town Council falls under the jurisdiction of Local Government work of the Ministry of Local Government, Housing & Environment. The ministry focuses on legislative reviews, urban planning and managing the impacts of rapid urbanization, municipal reforms, fire protection and disaster management, and control and regulation of land use. The Department of Town and Country Planning controls and regulates the appropriate use of land in Fiji through the Town Planning Act (Cap.139) and Subdivision of Land Act (Cap.140).

Nadi Town Council is directly responsible to implement a process of administrative decisions, organization, operation in conjunction with policies and strategies to lessen the impacts of natural hazards and related environmental and technological disasters. Nadi Town Council has already produced a disaster management plan.

A) Structure of the Disaster Management in Nadi Town

The disaster management plan describes the institutional structure of the disaster management as follows.



Source: Disaster Management Plan, Nadi Town Council

Figure 2-42 Organizational Structure of Nadi Town Disaster Management

Risk reduction plan includes the following aspects shown in the following table.

Table 2-33 Nadi Town Council Disaster Risk Reduction Plan

| Event | Risk Reduction |
|-------|---|
| Flood | Know the flood risk and the elevation of the area |
| | Clean and clear all existing drains within the town boundary |
| | General clean-up and trimming beside and alongside drains |
| | Check all rock lining on drains are well intact |
| | Follow evacuation or escape plan i.e. vehicles & people |
| | Monitor river level during heavy rains |
| | Keep important documents and electrical items on safe and flood free area |
| | Have a portable radio, flashlight, and emergency supplies |
| | Watch Phase (2-3 days for flood; 2-12 hours for flash flood) |
| | Move furniture and other items to higher levels |
| | Fuel all council vehicles |

Source: Disaster Management Plan, Nadi Town Council

2.6 Financial Condition in Fiji’s Government

Fiji’s fiscal budget was in surplus by 2011 but it has been in deficit since 2012, affected by aggressive investment in infrastructure. Debt balance has been declining recent years, but has been over 50% of the GDP figures. Financial deficit would continue as Fiji’s government would continue to invest in infrastructure as a policy priority beyond 2014 to expand productivity.

In the meantime, Fiji’s government has set a mid-term target to achieve a good balance between by investment-led development and financial discipline in macro economy and national fiscal budget. Therefore, the government plans budget to reduce deficit and gross debt beyond 2014.

Table 2-34 Financial Standards in Fiji

| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Revenue(F\$,000) | 1,454,935 | 1,415,856 | 1,537,841 | 1,804,144 | 1,937,144 | 2,098,410 |
| Expenditure(F\$,000) | 1,162,568 | 1,258,147 | 1,280,302 | 1,668,690 | 2,013,673 | 2,327,385 |
| Surplus(debt),(F\$,000) | 292,367 | 157,709 | 257,539 | 135,454 | (76,529) | (228,975) |
| Surplus/Debt ratio of GDP | 6.2% | 3.3% | 5.1% | 2.5% | -1.4% | -3.8% |
| Government Total Debt(F\$, 000) | 2,887,000 | 3,132,200 | 3,383,200 | 3,566,500 | 3,679,500 | 3,825,300 |
| Government Debt/GDP | 50.00% | 55.80% | 56.20% | 54.50% | 53.30% | 51.40% |

Source: Fiji’s Statistics Bureau “Key Statistics March 2014” and “Fiji Budget Estimates 2015”

Table 2-35 Mid-Range Target related to Macro Economy and National Finance

| | |
|------|--|
| i. | To raise economic growth rate to 5% |
| ii. | To keep spending on investment more than 25% in Budget Expenditure |
| iii. | To manage inflation rate around 3.0% |
| iv. | To keep sufficient foreign currency reserve |
| v. | To reduce government debt to GDP to 40% gradually |
| vi. | To keep budget deficit under 3.0% |

Source: Ministry of Finance “Economic and Fiscal Update. November 2014”

Table 2-36 Finance Forecasting and Target in Fiji

| | 2014 estimate | 2015 budget | 2016 target | 2017 target |
|--------------------------------|---------------|-------------|-------------|-------------|
| Revenue(F\$,000) | 2,387,549 | 3,122,438 | 3,032,900 | 3,166,600 |
| Expenditure(F\$,000) | 2,883,261 | 3,336,292 | 3,216,700 | 3,312,800 |
| Surplus(debt),(F\$,000) | (495,712) | (213,854) | (183,800) | (146,200) |
| Surplus/Debt ratio of GDP | -6.0% | -2.50% | -2.00% | -1.5% |
| Government Total Debt(F\$,000) | 4,100,297 | 4,114,100 | 4,406,200 | 4,552,300 |
| Government Debt/GDP | 49.50% | 48.30% | 47.90% | 46.70% |
| GDP at Market Prices | 8,283,429 | 8,668,800 | 9,190,500 | 9,743,400 |

Source: Ministry of Finance “Government Debt Report, January 2014”, “Fiji Budget Estimates 2014, 2015”, “Economic and Fiscal Update. November 2014”

The brief summary of national finance, budget allocated to major ministries and payment on overseas loans is extracted from 2015 Budget, shown in following Table: 2-37.

The budget allocated to the Ministry of Agriculture in 2015 is about FJD 60 million (about JPY 3,500 million, FJD=JPY59.109, calculated by JICA 2015.3 rate) including about FJD 13 million (about JPY 770 million) for water conservation and irrigation department and about FJD 9 million (about JPY 530 million) for construction investment.

Principal payment on overseas loans is about USD 30 million (about JPY 3,600 million, calculated by JICA 2015. 3 rate).

Table 2-37 2015 Budget Funding Program of Fiji’s Government, Budget for Major Ministries and Payment on Overseas Loans (2015 Budget Estimate)

| 2015 Budget Items | FJD (000) |
|---|------------|
| Fiji’s National Budget | |
| Revenue | 3,122,438 |
| Expenditure | 3,336,292 |
| Estimated Budget Deficit | 213,853 |
| Debt Repayment | 149,668 |
| Gross Deficit 2015 | 363,522 |
| Gross Deficit to be financed from Overseas Loans | 105,800 |
| Gross Deficit to be financed from Domestic Loans | 257,722 |
| Estimated Nominal GDP 2015 | 8,668,818 |
| Budget for major Ministries in Fiji | |
| Ministry of Primary Industries- Department of Agriculture | 60,638 |
| Of which, Land, Drainage and Flood Protection | 13,567 |
| Of which, Capital Construction | 9,000 |
| Ministry of Education | 397,818 |
| Ministry of Health | 251,338 |
| Ministry of Land and Mineral Resources | 30,386 |
| Ministry of Industry and Trade | 48,047 |
| Ministry of Public Enterprises | 10,399 |
| Ministry of Sugar | 11,138 |
| Ministry of Infrastructure and Transport | 107,531 |
| Fiji Roads Authority | 653,788 |
| Payment on Overseas Loans | US\$(000) |
| Overseas Interest Payments | US\$61,479 |
| Overseas Principal Payments | US\$30,483 |

Source: Budget document by Ministry of Finance (2015 Budget Estimate)

2.7 Existing Plan for River Management and Flood Control

2.7.1 River Management Plan

(1) Framework of River Management Plan

Cutoff channel and waste channel were proposed by a 1998 development study of the Nadi River Basin but after that, a systematic river management plan covering the entire basin and putting river management institution in order and was not formulated and only topical protection and small-scale retention dam to protect village and farming land was conducted by MOA.

Large-scale floods occurred in 2009 and 2012 and it is urgent project to consider not only structural measures but also formulating comprehensive river management plan including non-structural measures.

There is no guideline or standard documents to formulate water management plan in Fiji and then technical measures for water management have not been established. When planning and designing water management institution, it is popular to use the opinion of in Australian, New Zealand and European technical standards as reference and to plan institutions relying on the knowledge and experience of the engineer. In River Engineering Section of LWRM which is C/P, a plan is established by knowledge and experience of the principal engineer.

(2) Design and Construction of Water Management Institutions

i. Design

There is no original guideline or standard documents about design in Fiji like water management, so it is ordinary style for each agency to use the Australian, New Zealand and European technical standards as reference and to design relying on knowledge and experience engineer.

In River Engineering Section of LWRM, engineers belonging to LWRM design by themselves retention dam and culvert referring to the Australian technical standard and concrete technical standard. However, as there are only technical standards and not designed documents in this agency, it seems that design is conducted by referring to the Internet as required.

ii. Construction

There is no original guideline or standard documents about design in Fiji so it is popular to construct institutions relying on knowledge and experience engineer has. River Engineering Section of LWRM contract out construction of water structures to private operators (Construction Company) and conduct construction and management by itself. When water management project like construction of retention dam is ordered by LWRM, private operators submit work description and cost estimate documents to the Government Tender Board. After that, proposals are evaluated based on the construction cost and technological strength comprehensively after which the winner is decided. Finally, this result is approved by the LWRM manager. According to the principal engineer of LWRM, the construction companies in Fiji have gradually developed their capability.

The following photos taken at the construction site show the construction situation of retention dam. Items related to construction such as construction plan, construction measures, quality control and safety administration are required the measures based on field conditions in Fiji but have many improvement method.

Picture 2-2 Construction Situation of Retention Dam (taken in August, 2014)

| | |
|---|--|
|  |  |
| Construction Situation (1) | Construction Situation (2) |
|  |  |
| Concrete Placement(1) | Concrete Placement (2) |
|  |  |
| Diversion Work by Embankment | After Concrete Placement |
|  |  |
| Concrete Form and Reinforcement Bar Arrangement | Setting out by Field Survey (inner part of photo) |
|  |  |
| Cutting Slope | Construction Materials (Boulders) |









(3) Application and Operation & Maintenance

Water management institutions like the river structures in the Nadi River Basin would be arranged into “Structural Measures”, “River Structures” and “Appendix-2”. River Engineering Section in LWRM conducts regular inspection and Operation & Maintenance of water management institutions and it conducts damage investigation of facilities only after large-scale flood disaster to assess the damage situation and estimate the restoration cost. The restoration seldom advances because there is not

extraordinary budget reserved for restoration and ordinary budget is used. Besides, documents of damage investigation result have not been kept.

The following photos show damage situation of water management facilities after the March, 2012 flood. Restoration situation of Namulomulo Dam in Namosi River included in “Appendix-2”.

Picture2-3 Damage Situation of Water Management Facilities after Flood Disaster (provided by LWRM)

| | |
|--|--|
|  |  |
| Vaturu Dam in Nawaka River (after flood in March, 2012) | Vaturu Dam in Nawaka River (after restoration) |
|  |  |
| Taci Dam in Nawaka River (after flood) | Taci Dam in Nawaka River (after restoration) |
|  |  |
| Namulomuro Dam in Namosi River (after flood in March, 2012) | Namulomulo Dam in Namosi River (after restoration) |
|  |  |
| Wreckage of damaged bridge in Nadi River, taken during field study in Natawa Village, 2014 (the date of the disaster is not clear) | Wreckage of damaged bridge in Nawaka River, taken during field study of Geleloa Bridge, 2014 (the date of the disaster is not clear) |

2.7.2 Measures against Flood Disaster

(1) Structural Measures

Measures against flood disaster, especially structural measures, in the Nadi River Basin are shown in the following table.

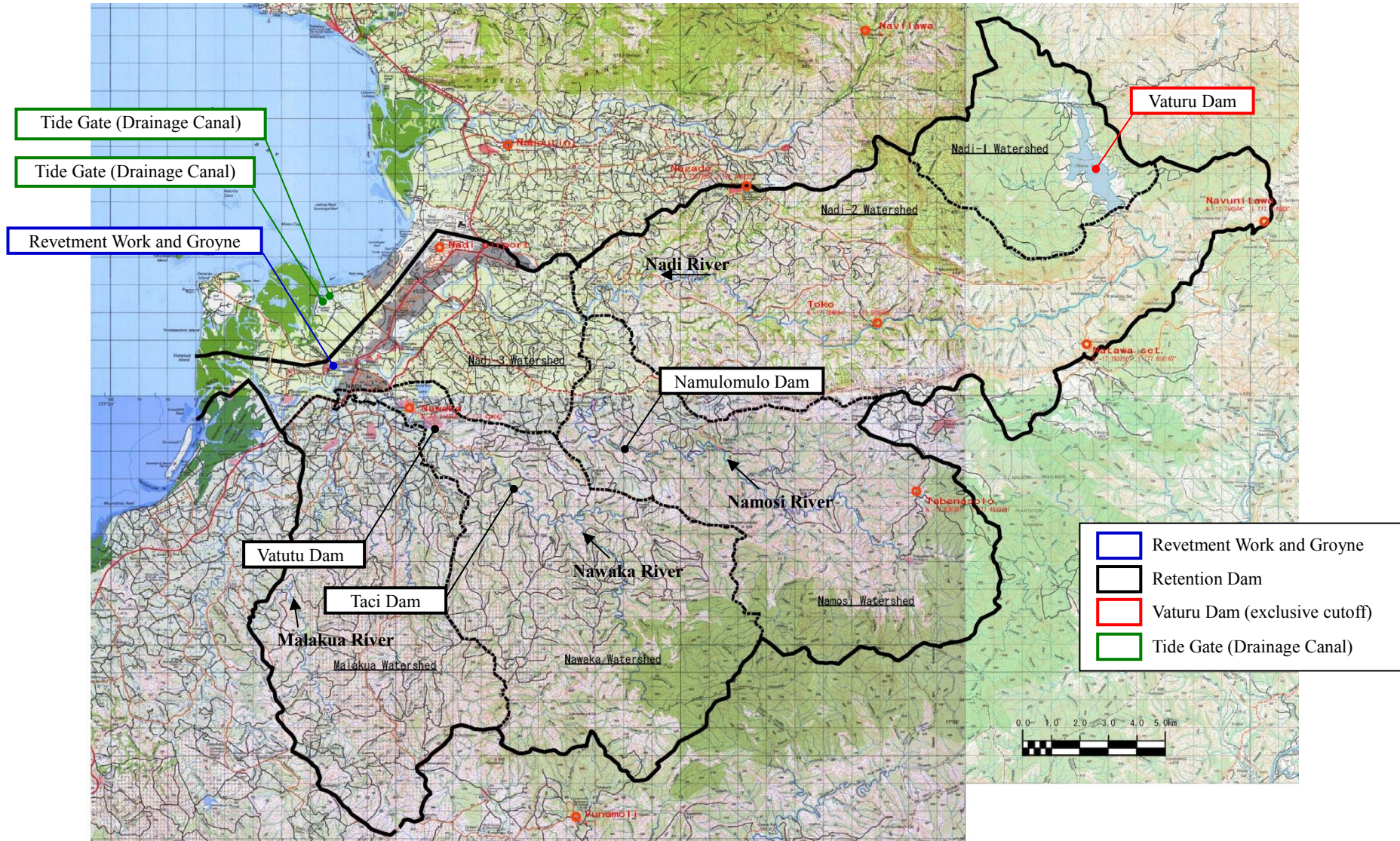


Figure 2-43 Location Map of Structural Measures

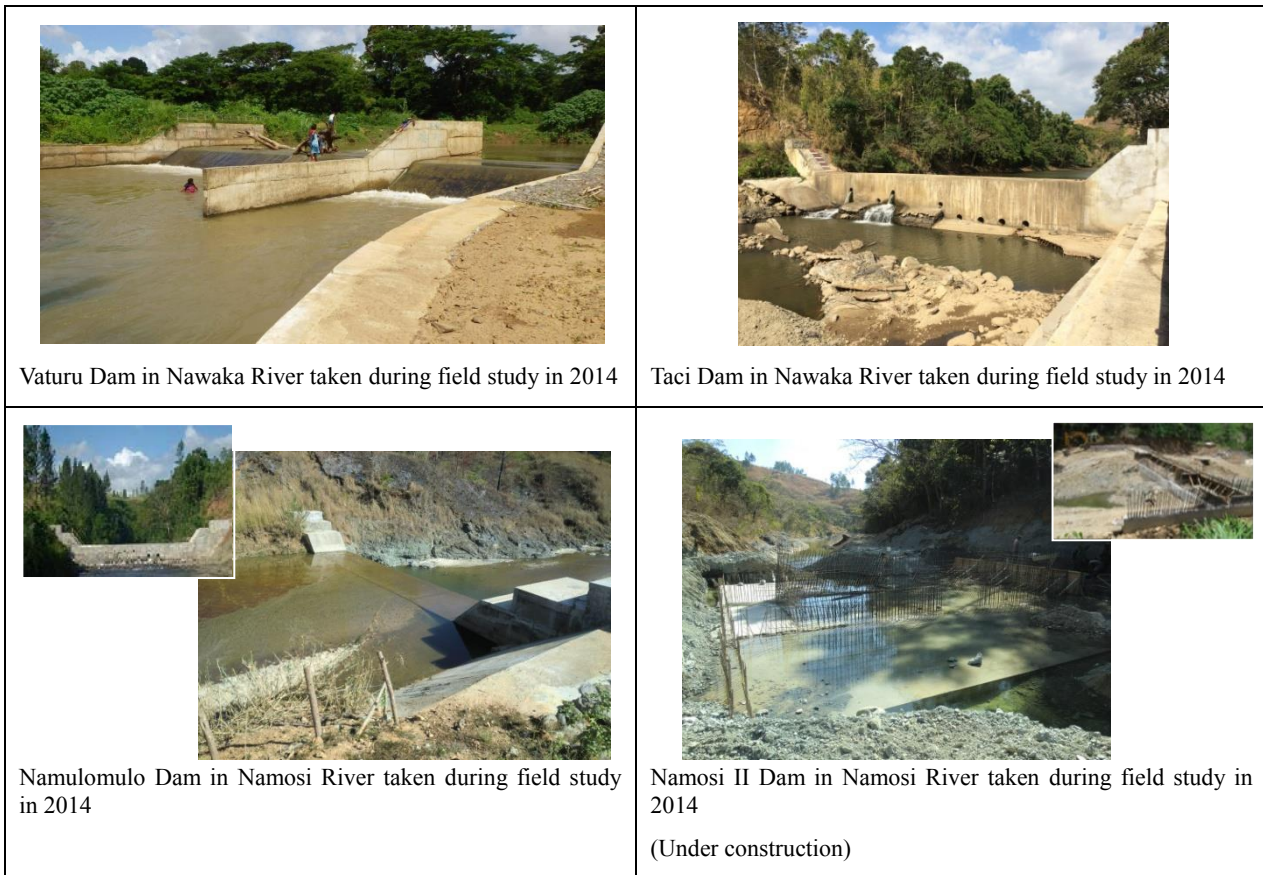
ii. Retention Dam

According to the Ministry of Agriculture, arrangement plan of 15 retention dams was formulated, but there were no plan documents. 3 dams had been already built and 1 dam was under construction in December, 2014. The Ministry of Agriculture said that the purpose of these dams are reduction of peak flow during flood and small-scale retention but facility scale is small and it is assumed to be effective to prevent only small-scale flood and sediment outflow.

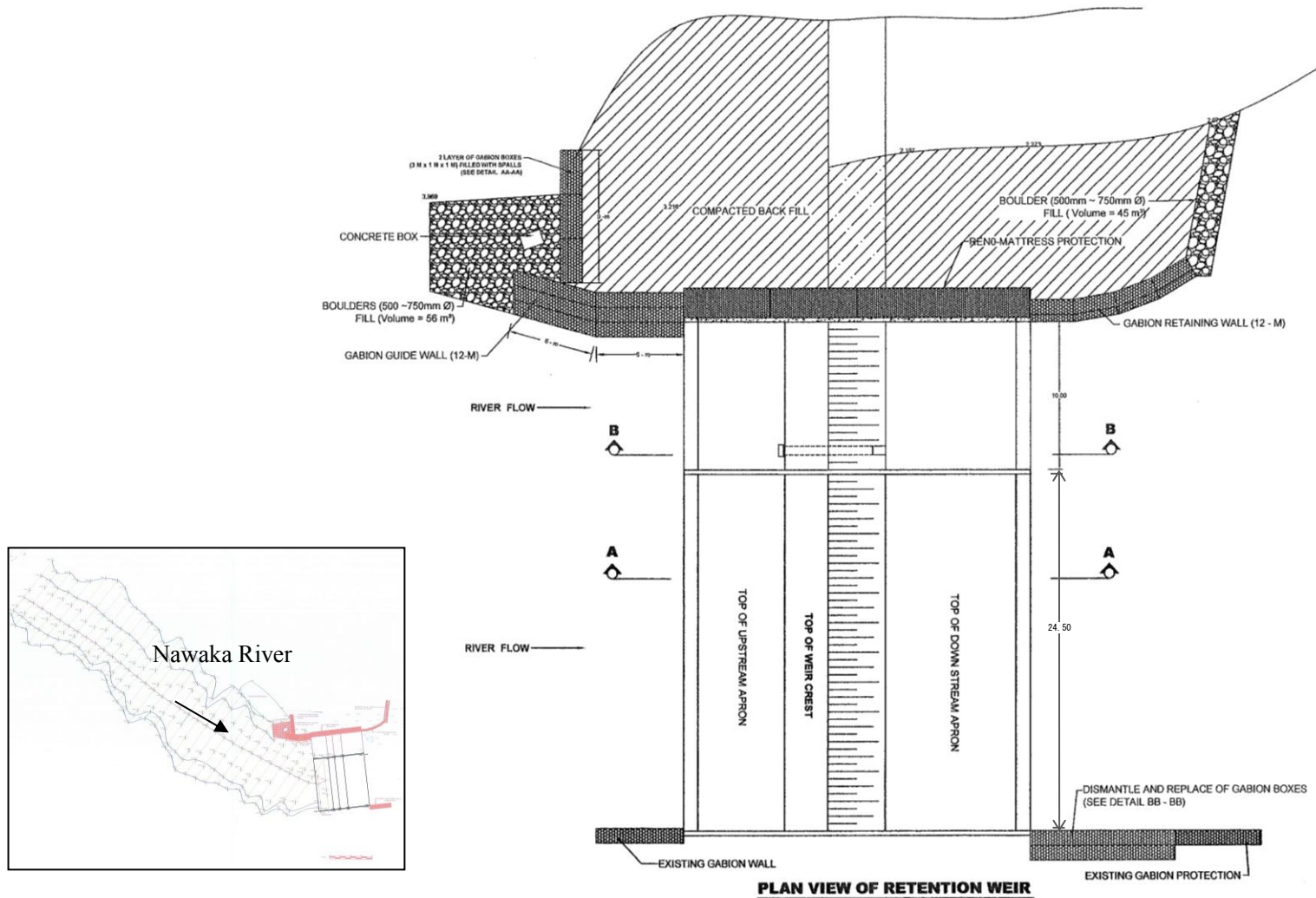
All the retention dams that had been already built (Vaturu Dam and Taci Dam in Nawaka River and Namulomulo Dam in Namosi River) are not in Nadi River itself but in its branches, which were. All the dams were damaged by flood in 2012 and rehabilitated after the disaster. Documents on damage situation are not kept.

Namulomulo Dam in Namosi River was filled by sediment deposits. The dam which was under construction is Namosi II dam in Namosi River.

Picture 2-5 Retention Dam

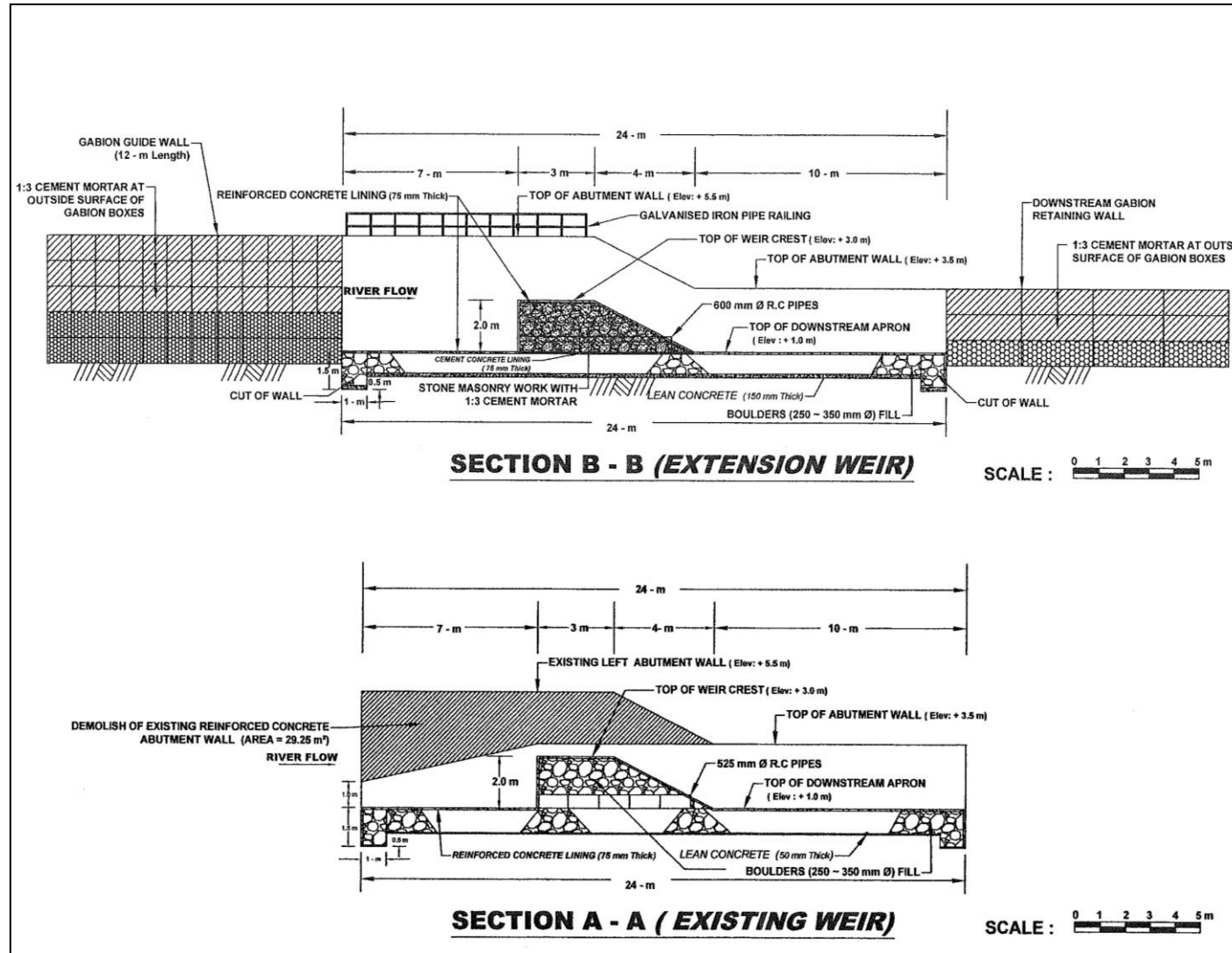


Design drawings of Vaturu Dam and Taci Dam in Nawaka River are shown in the following figures. 3 dams had been already built and they have Gabion and Masonry structures covered by concrete and the Namosi II dam structure is concrete. The details documents related to the plan and construction process such as height of crown and width of dam body was not kept so the detail is not clear.



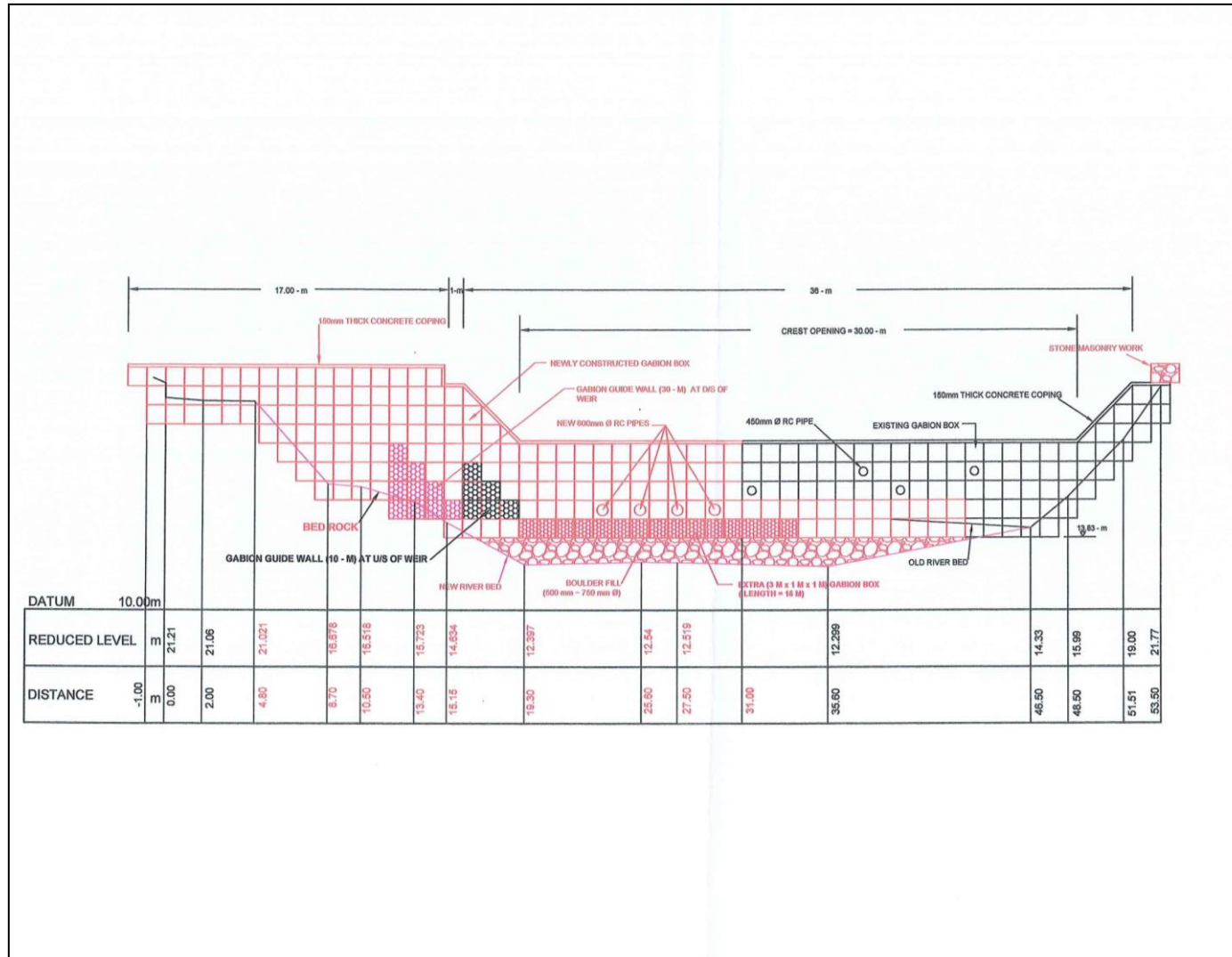
Source: Documents provided by LWRM

Figure 2-44 Retention Dam Drawing of Vaturu Dam in Nawaka River (1/2)



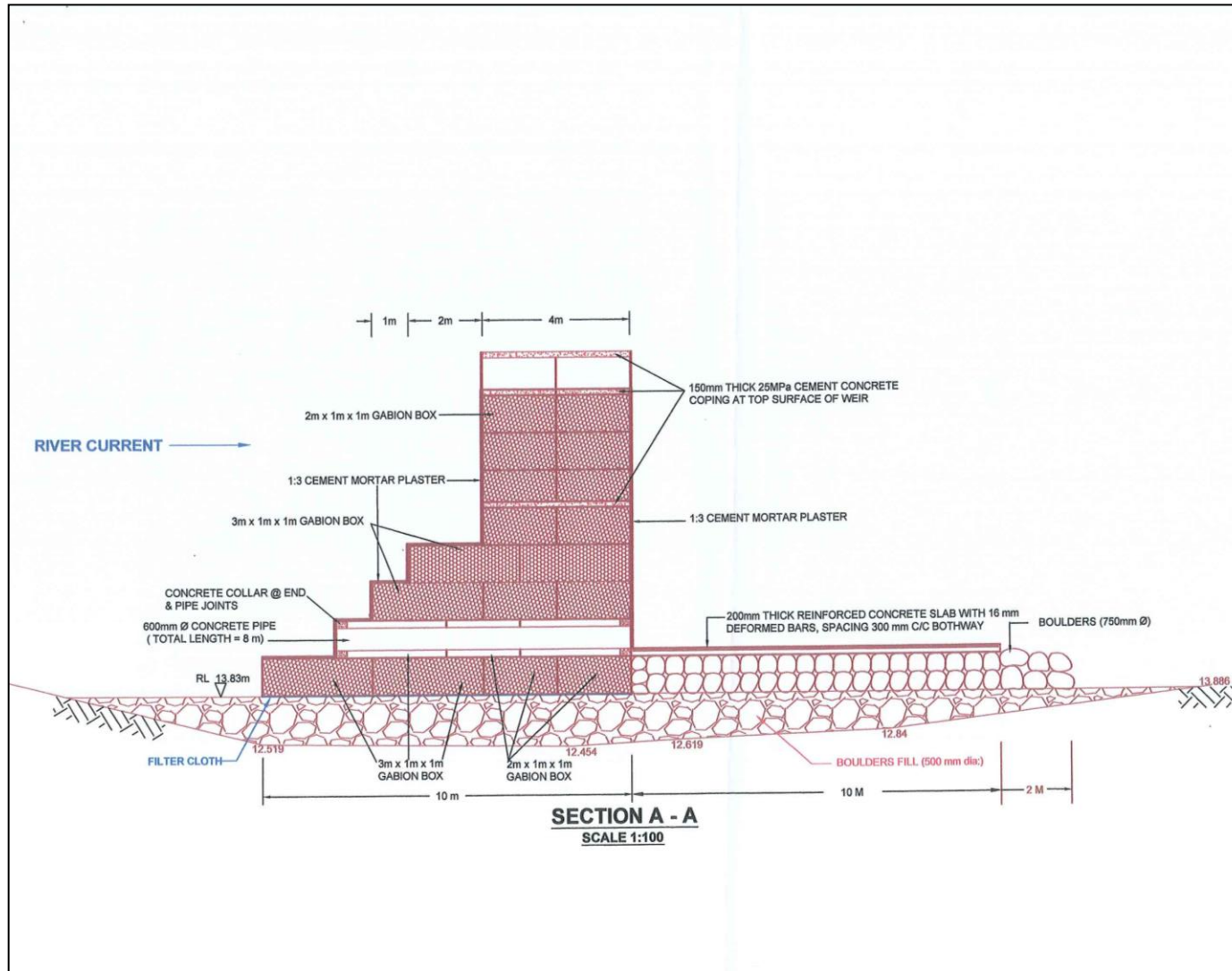
Source: Documents provided by LWRM

Figure 2-45 Retention Dam Drawing of Vaturu Dam in Nawaka River (2/2)



Source: Documents provided by LWRM

Figure 2-47 Retention Dam Drawing of Taci Dam in Nawaka River (2/3)



Source: Documents provided by LWRM

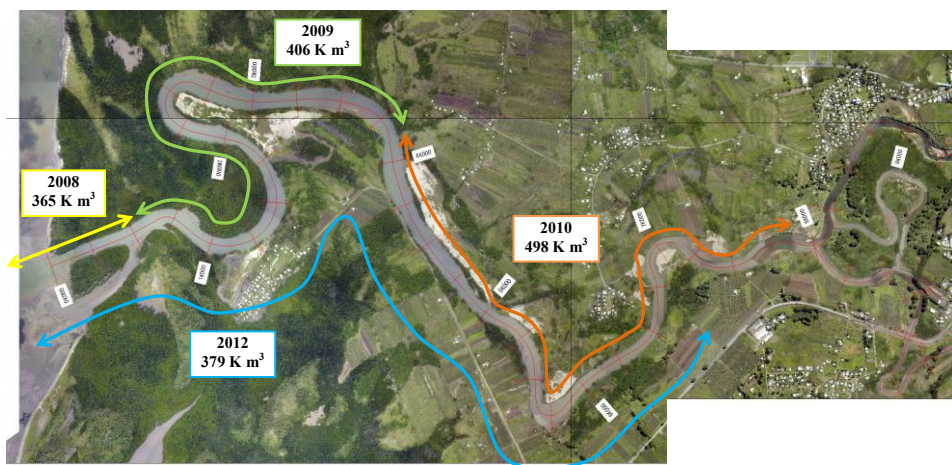
Figure 2-48 Retention Dam Drawing of Taci Dam in Nawaka River (3/3)

iii. River Dredging

As mentioned above, river dredging was conducted at Nadi River Estuary from 2008 to 2012 by the Ministry of Agriculture. As a result, 1651 thousand m³ of sediment was removed in total. The table and figure below show the dredging work area, removed sediment volume and location, however documents giving more details on the dredged section including the dates of the work could not be found.

Table 2-39 Sediment Removed by Dredging Nadi River (based on results)

| Year | Area | Sediment Volume (thousand m ³) | Notes |
|-------|--------------|--|-------------------------------|
| 2008 | -1.2k-0.5k | 365 | |
| 2009 | 0.5k-3.7k | 409 | |
| 2010 | 3.7k-7.775k | 498 | |
| 2012 | -1.2k-6.975k | 379 | Conducted after flood in 2013 |
| Total | | 1,651 | |



Source: Based on result of interview survey of LWRM by the project team

Figure 2-49 River Dredging Area

iv. Tide Gate (Drainage Canel)

Tide gate was built as part of drainage channel network by the Ministry of Agriculture. There was no plan documents showing the arrangement and 2 gates were found by field survey (1 had already been built and the other was under construction). The structure form of the gates was flap gate form and water leakage from ocean side of the built gate was found.

Picture 2-6 Tide Gate

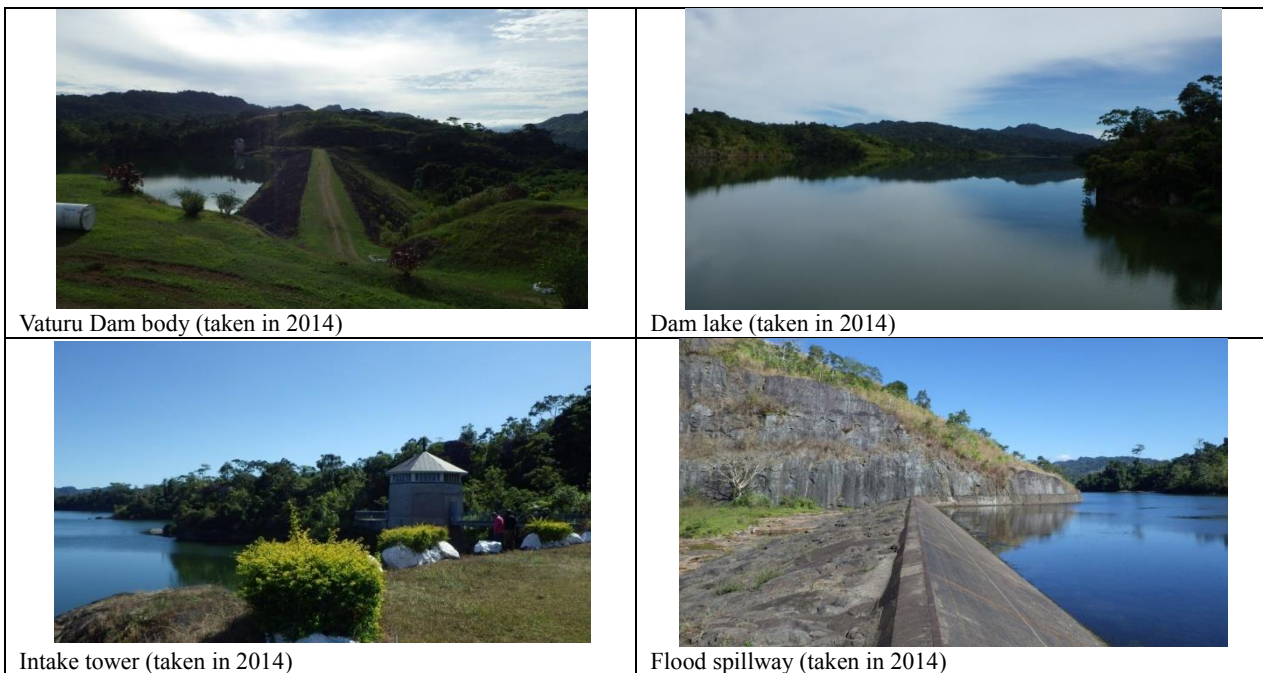


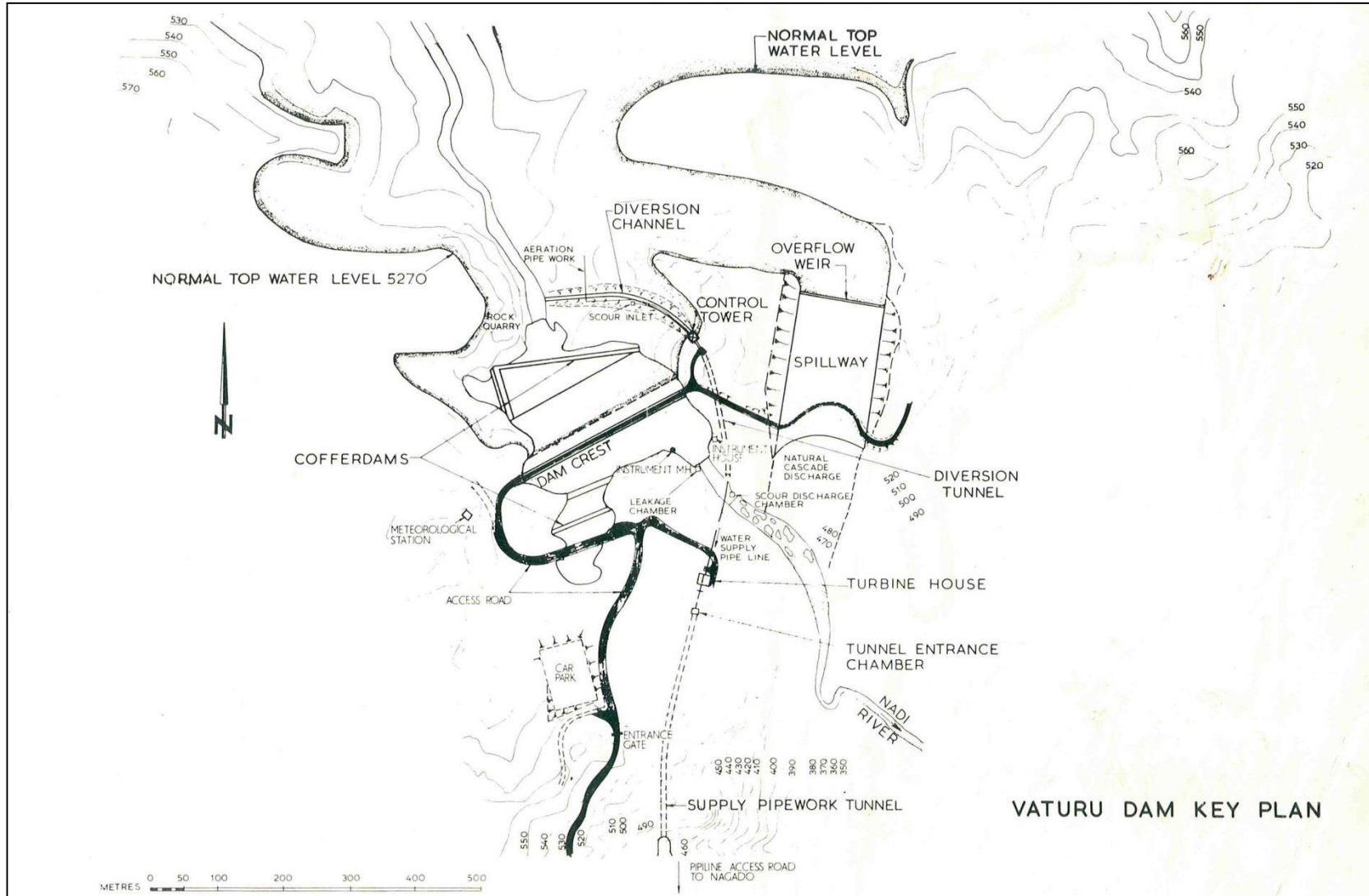
v. Vaturu Dam

Vaturu Dam built in 1982 is located at about 60 km upstream of the Nadi River Estuary. It is rock-fill dam aiming to supply tap water; total water storage volume is 27,000 thousand m³ and the height is 56m. A flood spillway was provided on the left-side bedrock by excavating rock to discharge to the downstream by free-overflow form and then confluent with Nadi River itself. Multinomial selection water intake works were provided on the left side of the dam lake and water withdrawn was sent to the water treatment facility in Nagado Village and after the treatment, water was carried to Nadi and Lautoka area. General drawing of Vaturu Dam is shown in the following figure.

According to the Water Authority of Fiji (WAF), formulation of the M/P for future plan of tap water was at final stage in December, 2014. And for heightening of embankment, Australian engineer was submitted to investigation and Feasibility study would be conducted. Besides, application possibility of cascade-type decreasing work would be also conducted so it intended to get detailed documents.

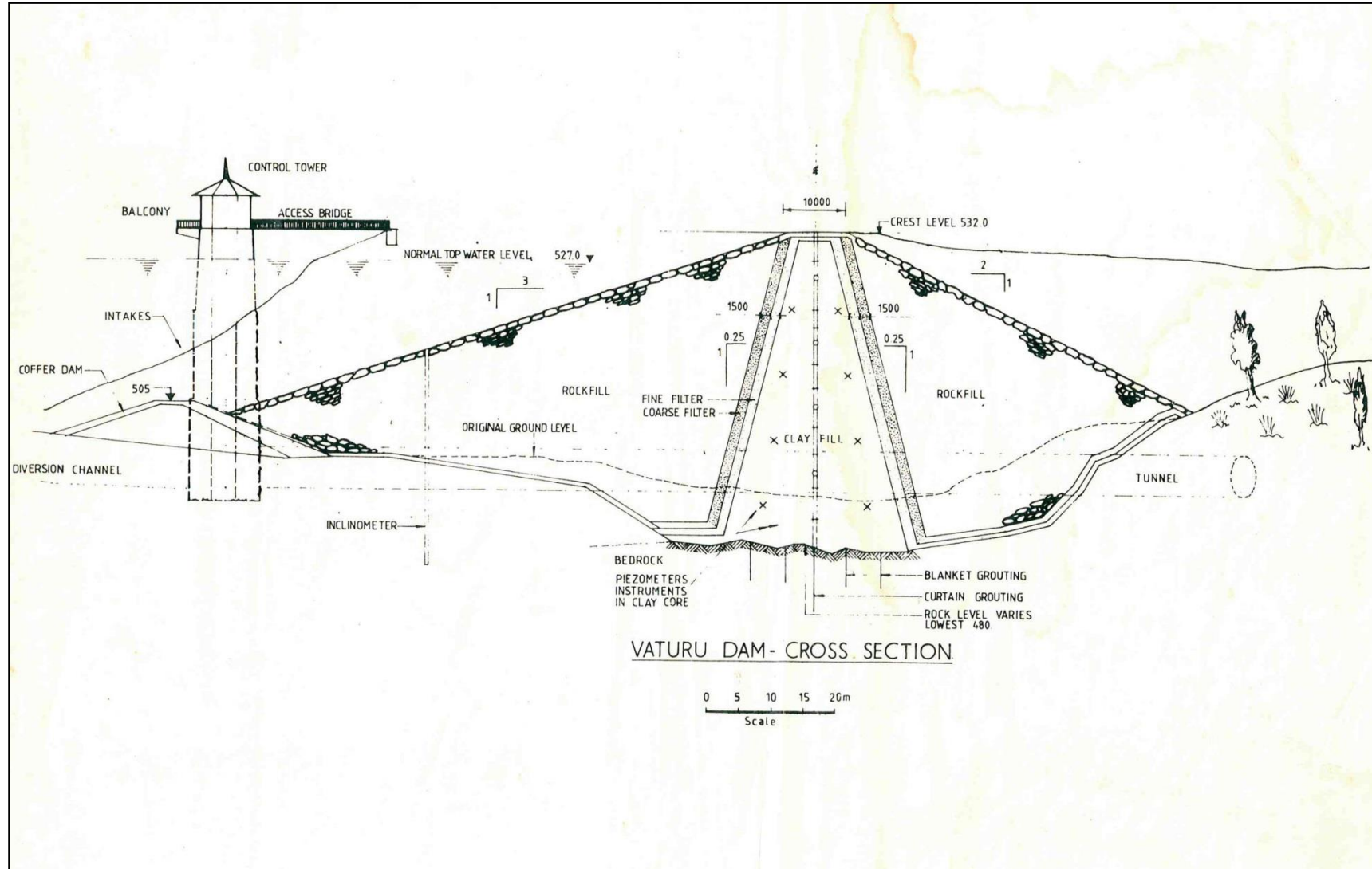
Picture 2-7 Vaturu Dam





Source: Documents provided by WAF

Figure 2-50 General Drawing of Vaturu Dam (1/2)



Source: Documents provided by WAF

Figure 2-51 General Drawing of Vaturu Dam (2/2)

(2) Non-Structural Measures

Many non-structural measures were concluded with the support of international donor organizations including JICA. Specific steps of non-structural measures would be arranged in following chapter.

2.8 Related Project

2.8.1 By-Pass Road Plan from Airport to Denarau and Queens Road Improvement Plan

The plan of new four-lane by-pass road from airport to Denarau and Queens Road improvement were was underway. The by-pass road was being implemented by the Fiji Road Authority (FRA), and a private company in China was constructing it. The Alignment of the by-pass road was planned considering the extension plan of the airport runway and road drainage but not Nadi River Flooding inundation. The vertical alignment was planned considering balance of evacuation and embankment based on existing foundation. Improvement plan of Queens Road was planned to include sidewalks and drainage facilities apart from the four-lane traffic road near the intersection. The following figure shows route map of the whole road project.



Source: Based on result of interview survey to MWH by the project team

Figure 2-52 Route Map of the Whole Road Project



Source: MWH

Figure 2-53 By-Pass Road Plan (Section 1D)



Source: MWH

Figure 2-54 Queens Road Improvement Plan (Section 1C) (1)



Source: Fantasy Company Fiji Ltd.



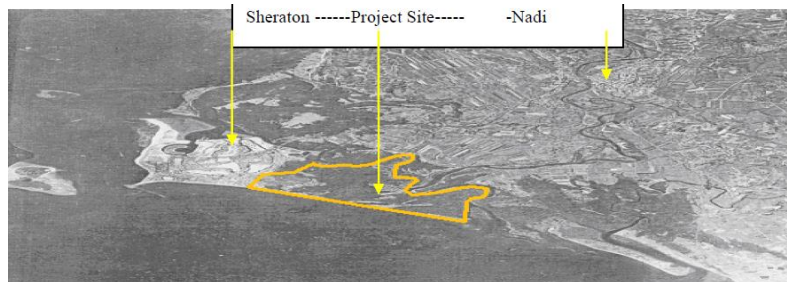
Source: Fiji Plaza Ltd. Sharma Design Group

Figure 2-57 Fantasy Island Development Project, Fiji Plaza Development Project (Not Approved)

2.8.4 Resort Development Project near Denarau Area

(1) Denarau Tourism & Hospitality Development (No.2)

This development project is a comprehensive resort development project by private company including commercial facilities and residences in mangrove forest surrounded by south part of Denarau Island and Nadi River. The EIA report was submitted in October, 2009.



Source: Denarau Tourism & Hospitality Development, EIA Report, 2009

Figure 2-58 Location Map of Denarau Tourism & Hospitality Development



Source: Denarau Tourism & Hospitality Development, EIA Report, 2009

Figure 2-59 Development Outline of Denarau Tourism & Hospitality Development

(2) Nakovacake Resort Development (No.4)

This development project is a comprehensive resort development project by a private company including commercial facilities and residence in mangrove forest surrounded by east part of Denarau Island and Nadi River, (the area surrounded by red line in following figure). The EIA report was submitted in December, 2012.



Source: Nakovacake Resort Development, EIA Report, 2010

Figure 2-60 Location Map and Development Outline of Nakovacake Resort Development

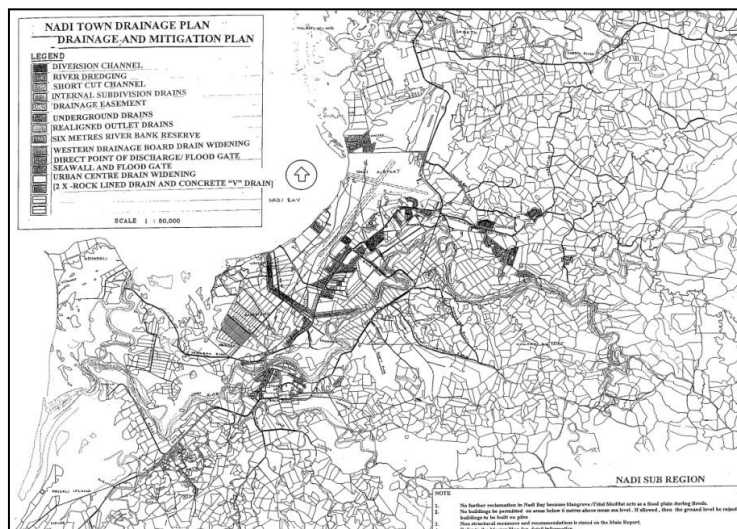
2.8.5 Nadi Town Drainage Plan

Nadi Town Drainage Plan was formulated in August, 2000 by the Department of Town and Country Planning, Nadi Town Council, LWRM, Western Drainage Board, National Disaster Management Committee, Nadi Rural Local Authority, aiming to resolve drainage problem in Nadi Town and decline damage by flood disaster. In this project, the present situation and drainage issue were arranged objectively and towards resolving the problem through long- and short- and mid-term plans. However, these plans were studied without distinguishing the inside and outside inundation floods and it was scientifically unfounded by hydraulic analysis and verification. As one of the policies, this plan contained drainage canal plan and cutoff channel proposed by “The Study for River Basin Management and Flood Control Plan” conducted by JICA in 1996-1998 (hereinafter referred to as “1998 Development Study”. The progress and revised situation was not clear during the 2015 survey but construction of retention dam was conducted by LWRM individually.

Table 2-40 Arrangement Items proposed by Nadi Town Drainage Plan

| Period | Arrangement Items |
|---------------------------|---|
| Short- and Mid-Range Plan | Extension of Drainage Channel and Review of Alignment |
| Long-Range Plan | Construction of Retention Dam, Embankment, Waste Channel and Cutoff Channel |

Source: Nadi Town Drainage Plan (2000-8)



Source: Nadi Town Council, Department of Town and Country Planning

Figure 2-61 Nadi Town Drainage Plan (2000-8)

2.8.6 Water Supply Scheme Master Plan 2013-2033

The Water Supply Scheme Master Plan 2013-2033 was being formulated by WAF and during the survey in January. The content of the M/P for water supply would be outlined in the following part, “Present situation and problem related to water resources”. Due to increasing water supply area and population in Nadi and Lautoka area (including urban and rural areas), necessity of water source development in future and improvement of leakage rate was suggested. Consequently, the development of alternative water sources, heightening of Vaturu dam embankment and development water sources in Nawaka River and Namosi River were proposed because water source in Nadi River Basin was only Vaturu Dam. Besides, it was also proposed to prepare and save utilization of ground water resource as auxiliary water source in rural area, to promote demand management and to advance rain use.

2.9 Support Situation related to Flood Control by Japan

Japan has been a main donor for Fiji and since 1979 and it has played a big role in Fiji’s development through international yen loan, gratis financial assistance and technical support. After the 2006 coup, support was limited to specific field but economic support was resumed thoroughly after general election was conducted by democratic process and new government was established in September, 2014.

Japan had standard policy to support Fiji considering Fiji’s national development plans and Japan’s policy of Pacific/Islands Summit which was hold every 3 years since 1997. Key areas of support were (1) Environment and climate change and (2) Overcoming of vulnerability and this study was part of the disaster prevention program. The disaster prevention program supported to establish early warning system against cyclone, earthquake and tsunami by improving the ability of weather forecasters including Fiji’s Weather Bureau and the for disaster prevention ability at community level aiming to keep natural disaster damage in Fiji and neighboring countries to a minimum.

The following table shows the disaster prevention programs recently completed by Japan, those in progress.

Table 2-41 Recently Completed Disaster Prevention Programs and those in Progress by Japan

| No. | Project Name | Scheme | Conducting Period |
|-----|--|--------------------------------|-------------------|
| 1 | The Project for Improvement of Equipment for Disaster Risk Management | Gratis | 2013-2015 |
| 2 | The Strengthening Community Disaster Risk Management Project in the Pacific Region | Technical Proposal | 2010-2013 |
| 3 | Project for Reinforcing Meteorological Training Function of FMS | Technical Proposal | 2014-2018 |
| 4 | Risk Assessment Capacity Support: SPC/SOPAC Disaster Reduction Program | Individual Expert | 2014-2016 |
| 5 | The Project for the Rehabilitation of the Medium Wave Radio Transmission | Feasibility Study | 2014-2015 |
| 6 | Volunteer Dispatch for Meteorological and Disaster Prevention | JOCV/SV | -2015 |
| 7 | Training in relation to Disaster Management | Training according to problems | -2014 |

(1) The Project for Improvement of Equipment for Disaster Risk Management

i. Purpose of Project

The purpose of this project was (1) to observe high tide, anomalous tide level, huge rain and flash-to-ground by cyclone with importation of observation machinery for weather and sea phenomena and communication equipment (2) to monitor and collect observation data at FMS in a real time and (3) to provide and strengthen the system for observation of main factors causing natural disaster in Fiji.

ii. Outline of project (Engineering Works and Supply Equipment)

- Observation system for tide level: 1 site
- Observation system of satellite communications (VSAT): 5 sites
- Wind profiler system: 1 site
- Automatic weather observation system (AWS): 1 site
- Calibration equipment: 1 set
- Detection system of thunderbolt: 6 sites

iii. Total Project Cost and Estimated Support Amount

Total Project Cost: JPY 337 million (Estimated support amount is JPY 300 million from Japan and about FJD 37 million from Fiji)

iv. Project Schedule (Support Period)

The planning started in May, 2013 and the project continued until February, 2015 (19 months in total including detailed design and tender period).

v. Organization for Project Conducting (Conducting Instrument/ Counter Part)

Organization being responsible for supervision: MWTPU

Conducting Instrument: FMS

(2) The Strengthening Community Disaster Risk Management Project in the Pacific Region

i. Purpose of Project

The purpose of the project was to strength the disaster prevention ability at community level.

- High rank target: to strengthen escaping system for inhabitants when flooding
- Purpose of Project: to organize escaping system for inhabitants when flooding by ability reinforcement of NDMO and related institutions.

ii. Project Site

- Fiji: Ba River Basin in Bitirebu Island and target community is 1 or 2 villages
- Solomon: Tamboko Village in Guadalcanal Island

iii. Support Period

From December, 2010 until December, 2013

iv. Conducting Instrument/ Counter Part

National Disaster Management Bureau

v. Results and Activities

[Results]

1. To organize system for swift transfer of inhabitants by warning adequately before flood occurs.
2. To develop management ability for disaster prevention by NDMO

3. To strengthen response capability against disaster of the inhabitants living in target community of pilot project

[Activities]

1-1. To strengthen prospect ability against flood by FMS and WAF

1-2: To organize system for adequate warning system

2-1: To arrange implementation system for community disaster prevention system in target area

2-2: To develop urgent response capability by C/P when disaster occurs

3-1: To conduct disaster drill and educational campaign for inhabitants

3-2: To support risk assessment with the residents playing major roles such as checking rainfall amount, monitoring system of water level, making hazard map and so on

vi. Support from Japan

Expert Dispatch

- Long-term expert for community disaster prevention, escaping plan and disaster drill, operational coordination
- Short-term expert for generalization like prevention against river disaster, disaster prevention plan and reinforcement of system related to disaster prevention, runoff analysis including hydrological and hydraulic, regional disaster prevention plan like simulation against disaster and transfer system of early warning information

Training in Japan:

- Disaster prevention plan
- Flood disaster system
- Escaping plan and disaster drill

Equipment Supply:

- Automatic water level equipment, simple water level equipment, simple waterfall equipment, warning equipment and so on

Expense for other activities:

- Expense for making hazard map, expense for educational campaign toward inhabitants (only one year in Fiji), expense for social survey and so on

(3) Project for Reinforcing Meteorological Training Function of FMS

i. Purpose of Project

- High rank target: The impact caused by meteorological and hydrological disasters are effectively mitigated in the South Pacific countries.
- Purpose of Project: The capability of weather and flood forecasting and warning services are comprehensively and effectively enhanced.

ii. Support Period

From December, 2014 until December, 2018

iii. Conducting Instrument/ Counter Part

Fiji Meteorological Service

iv. Results and Activities

Results

1. The capability of weather forecasting and warning services in all National Meteorological Services (NMS) in the South Pacific are effectively enhanced.

2. The capability for maintenance and operations of weather monitoring/observations, forecasting & warning equipment and systems are enhanced in all NMSs in the South Pacific.

3. The capability of quality control of data is improved in all NMSs in the South Pacific.
4. The capability of dissemination of weather information is improved in all NMSs in the South Pacific.

Activities

The following activities will be conducted to achieve each of the above output.

1. Implementation of technical training to strengthen the effective and efficient planning and management of work programs for FMS personnel.
2. Implementation of training to further strengthen the capability of facilitating lecturers.
3. Implementation of needs survey in each targeted country.
4. Implementation of third country training through inviting personnel from the South Pacific countries.
5. Implementation of monitoring and follow-up (transfer evaluation) after third country training.

v. Support from Japan

- Long-term expert
- Short-term expert
- Third country training
- Necessary equipment

(4) Risk Assessment Capacity Support: SPC/SOPAC Disaster Reduction Program

i. Purpose of Project

- High rank target: To strengthen ability to make decision on plan and investment related to disaster risk management in countries on the Pacific
- Purpose of Project: To strength relationship with activities to decrease the disaster risk

ii. Support Period

From April 1, 2014 until April 30, 2016

iii. Target Site

14 countries on the Pacific as JICA support target (Fiji Base)

iv. Results and Activity

Results

1. To revise support policy of JICA's disaster prevention field in the Pacific state.
2. To organize the common system of the existing and present project results
3. To use effectively the risk information system in the Pacific states, which had been developed as part of the disaster risk assessment in the Pacific state and PCRAFI.

Activities

1. To correct and analyze information related to the existing and present projects including interview survey on disaster prevention instruments in countries concerned.
2. To review support policy of JICA's disaster prevention field in the Pacific state based on the above analysis results.
3. To organize common system of the existing and present project results and precept getting through project and to propose how to use the risk information system in the Pacific states effectively through the above process.
4. To examine the assistance measures and advice for SOPAC to organize cooperation in the target area.

v. Support from Japan

- Long-term expert

(5) The Project for the Rehabilitation of the Medium Wave Radio Transmission

i. Purpose of Project

The purpose of this project was to transfer warning information to the whole nation and swiftly re-establish a public AM radio which had not been broadcasted since July, 2013 (was out of order in 2010) by establishing AM radio transmitter, antenna and facilities of FBC.

ii. Target Site

- Naulu Rewa region located 10 km northeast of the capital city, Suva.

iii. Outline of project (Engineering Works and Supply Equipment)

Equipment Supply:

- Equipment: AM radio transmitter, power supply for antenna
- Facilities: Repair and rebuilding of existing facilities

Consulting service and Soft component:

- Detailed design and supervision of construction supply management

iv. Conducting Instrument/ Counter Part

FBC; Fiji Broadcasting Company

2.10 Support Situation from International Support Instruments related to Flood Control

A lot of projects to develop regional disaster prevention ability to strengthen the resilience of each community to disaster and to advance disaster management ability of the government institutions were conducted in Fiji focusing on SPC/SOPAC.

The international donor projects completed and those in progress are summarized in the following section.

(1) Secretariat of the Pacific Community/ South Pacific Applied Geoscience Commission (SPC/SOPAC)

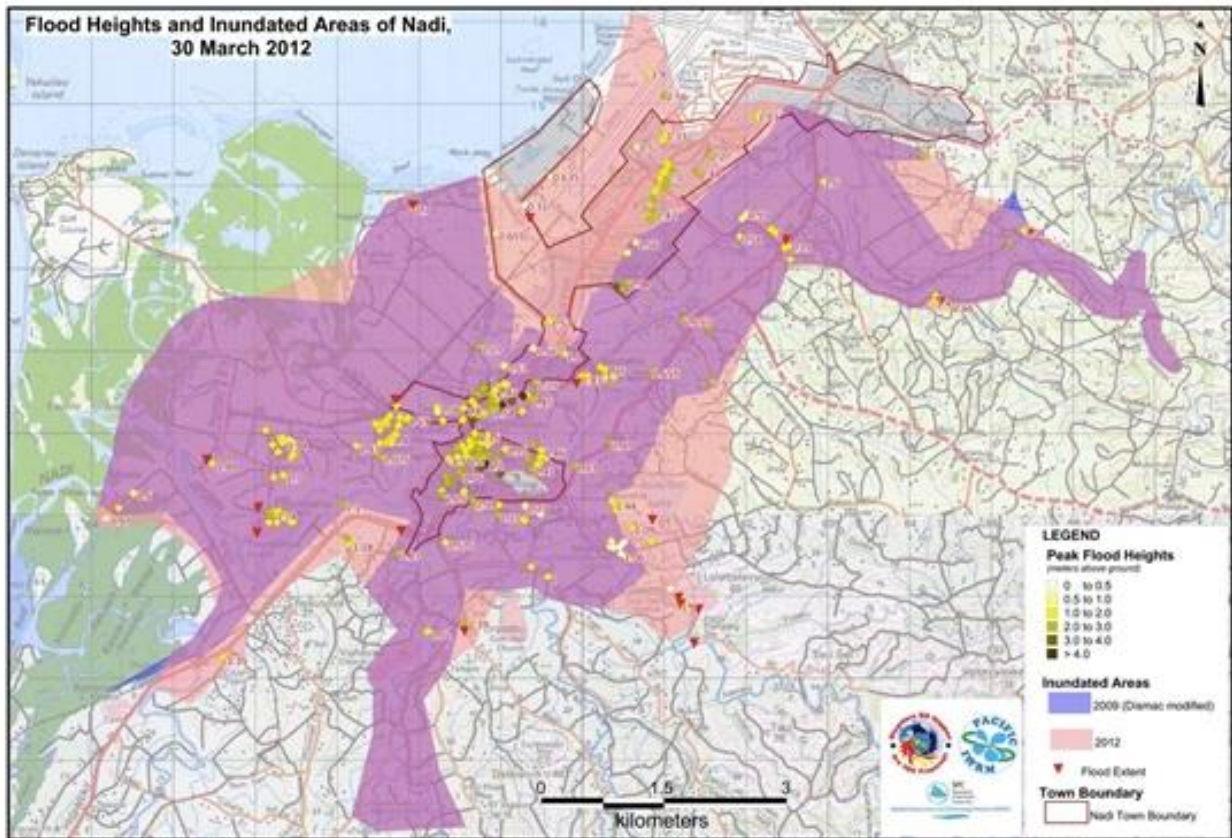
SPC/SOPAC conducted many projects in Fiji as executing agency which was set up by another international support instruments. In recent years, it conducted projects in various fields including projects in disaster risk management field, educational field and water resource field. The projects SPC/SOPAC conducted are shown in following table.

Table 2-42 Projects conducted by SPC/SOPAC

| No. | Activity | Outline | Implementing Organization | Supporting Organization | Project Period |
|--|---|---|---------------------------|---|----------------|
| <i>Field of Flood control and Measure against Flood Disaster</i> | | | | | |
| 1*2 | Integrated Flood Management in the Pacific: Nadi pilot project | To organize flood inundation model in Nadi Town and neighboring area and to study of measures against flood disaster. Flood. The actual map of floods (of 2009 and 2012 flood) was made in this project and LiDAR survey and flood analyses were conducted. | SPC/SOPAC | <i>World Bank Global Environment Facility for Disaster Reduction and Recovery</i> | 2010-2014 |
| <i>Field of Disaster Risk Management</i> | | | | | |
| 2*1 | Pacific Catastrophe Risk Assessment and Financing Initiative : PCRAFI | To organize Pacific Risk Information System (PacRIS) and to provide web-based | SPC/SOPAC | <i>GFDRR, ACP-EC (Supported by</i> | Underway |

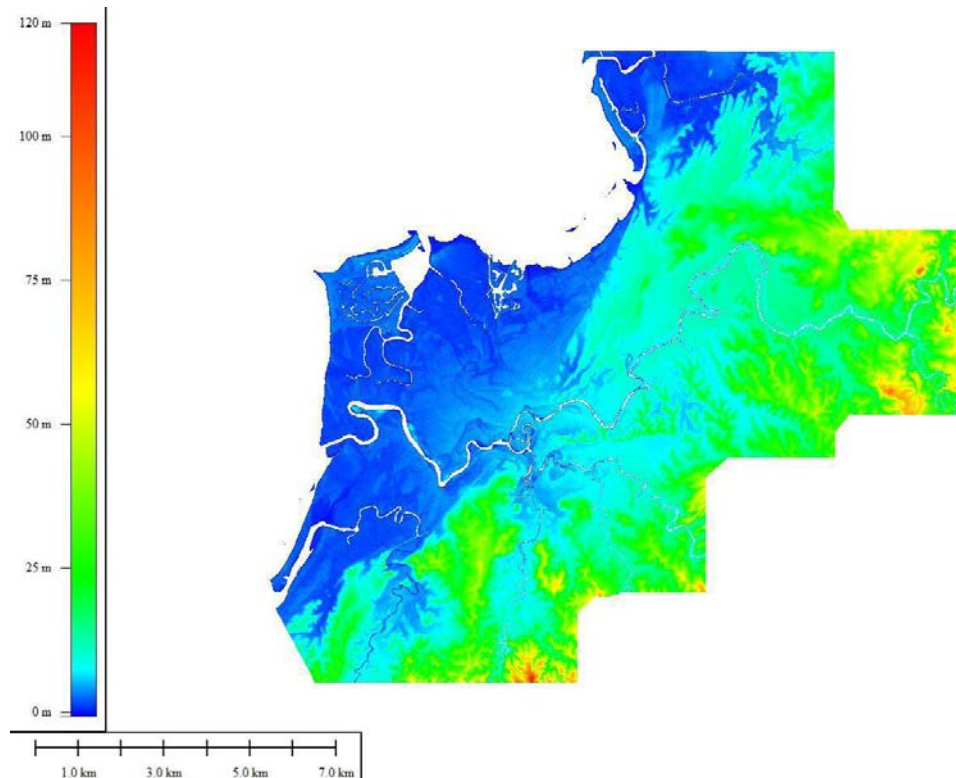
| No. | Activity | Outline | Implementing Organization | Supporting Organization | Project Period |
|--------------------------------|---|---|---------------------------|--|------------------------|
| | | disaster risk and evaluation tool by to the Pacific countries. | | WB, ADB) | |
| 3*2 | Development and implementation of a joint DRM/climate change national adaptation plan | To formulate Comprehensive Management Plan in Fiji to make measures as Fiji government related to climate change and disaster risk management and | SPC/SOPAC | AusAID national Action Plan Facility EU Development Fund including ACP DRM Facility | 2012-2013 |
| 4*2 | Improve capacity and performance of disaster management agencies through materials and training | To develop disaster management system | SPC/SOPAC | USAID Pacific Disaster Risk Management Program 2 | 2010-2013 |
| 5*2 | Improve capacity and performance of disaster management agencies through country-specific materials and training | To conduct training course in 4 areas in Fiji to support immediate action centers, initial damage evaluation, disaster risk reduction, shelter management and disaster drill. | SPC/SOPAC | USAID Pacific Disaster Risk Management Program 2 | 2010-2013 |
| 6*2 | Provision of disaster risk assessment tools including financial instruments to reduce vulnerability to natural disasters | To organize risk profile used in phase 3 of PCRAFI | SPC/SOPAC | PCRAFI Phase 2 | 2010-2012 |
| <i>Field of Education</i> | | | | | |
| 7*2 | Integration of climate change and disaster risk management into primary and secondary education (curricula, teacher education) and technical and vocational education and training | To make educational tool set by picture aiming to raise priority of climate change and disaster risk management in educational system | SPC/HDP | AusAID PACCSAP SPC/GIZ CCCPIR | 2011-2013 2011-2015 |
| <i>Field of Water Resource</i> | | | | | |
| 8*2 | Improve water resource and wastewater management through policy and legislative reform and encourage implementation of effective Integrated Water Resource Management (IWRM) and Water Use Efficiency (WUE) plans through a demonstration project | To organize system for integration of the stake holders and committee of Nadi River Basin. To support water and public health program after the 2013 flood. | SPC/SOPAC | GEF IWRM/EU | 2009-2013 |

Source: *1 PCRAFI website <http://pcrafi.sopac.org>. *2 SPC climate change and disaster risk management support activities in Pacific Island countries and territories 2013, SPC



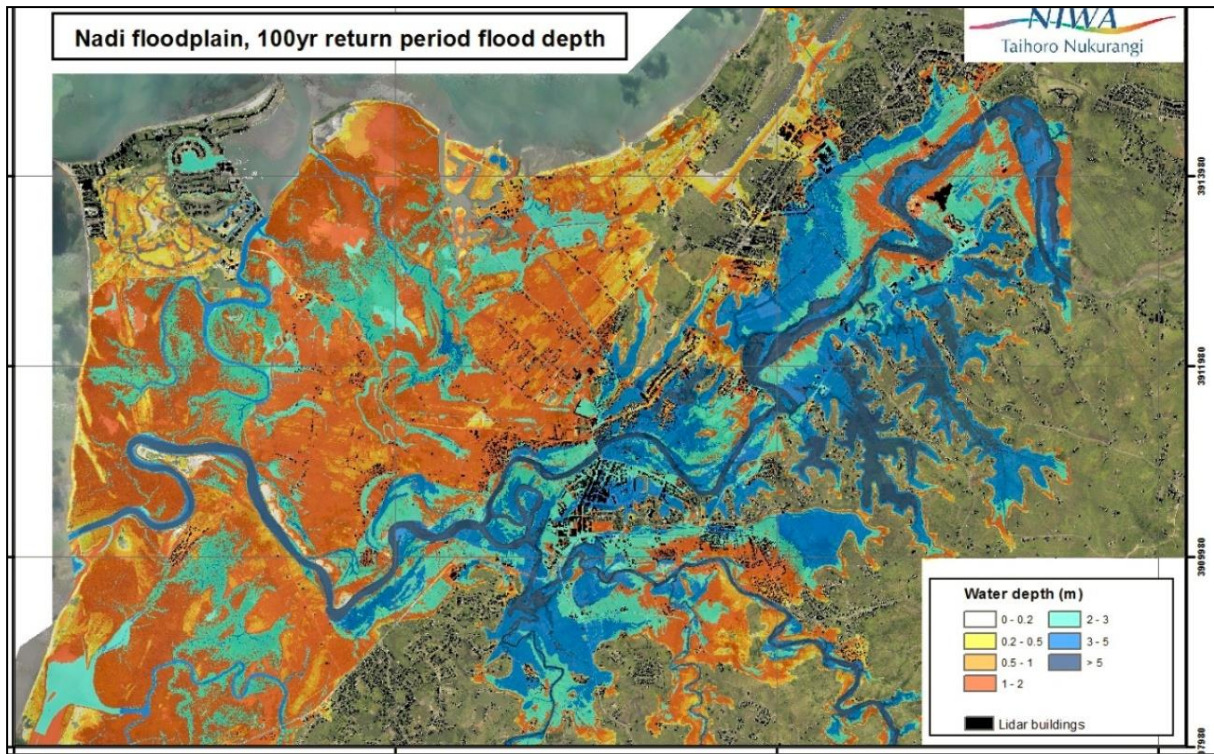
Source: Nadi Integrated Flood Management Project, SPC/SOPAC

Figure 2-62 Preparation of Actual Inundation Map in 2009 and 2012 Floods



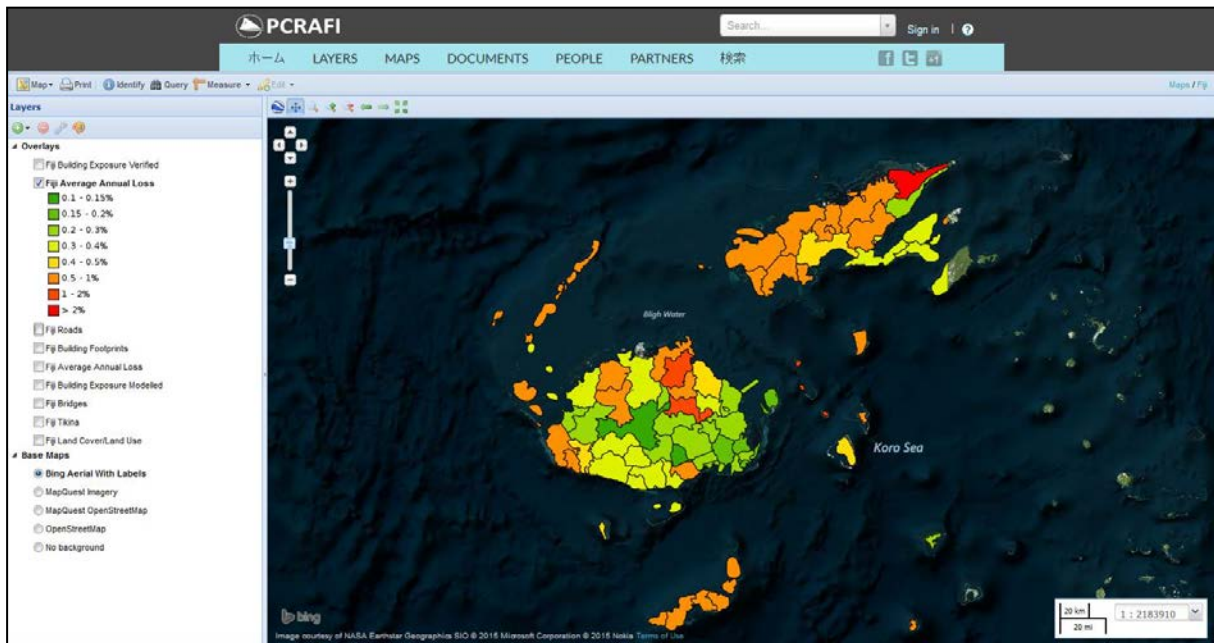
Source: SPC/SOPAC “Aerial LiDAR and Photographic Survey Nadi Integrated Flood Management Project, October 23rd 2012”, 2012

Figure 2-63 Results of LiDAR Survey



Source: Nadi Flood Risk Assessment, NIWA

Figure 2-64 Zone Map of Inundation in Nadi Town (by 100 years probability rain)



Source: PCRAFI <http://pcrafi.spc.int/maps/497/view>

Figure 2-65 Yearly Average Economic Loss Map by Natural Disaster

(2) Global Environmental Facility (GEF)

GEF which brings UNDP, UNEP and WB executing agency together is main fund mechanism related to globe environmental conservation toward developing countries. In Nadi River Basin, SPC/SOPAC conducted PI- IWRM: Pacific Islands Integrated Water Resources Management Program (thereinafter referred to as IWRM project) in 2006-2012 receiving fund from GEF. In IWRM project, the study about water resource management including flood control in Nadi River Basin was conducted and weather and hydrological observation network, early warning system and NBCC (Nadi Basin Catchment Committee)

were also established.

(3) The Asian Foundation (TAF)

TAF conducted training program related to disaster risk management for islands on the Pacific state in the past. Training was to organize a low-budget early warning system made by low-budget and alert system aiming to develop disaster risk management ability at community level, to operate urgent operation centers at regional level and to conduct primary disaster damage evaluation.

The following table shows the contents of the projects conducted by TAF in recent years

Table 2-43 Project Contents conducted by The Asian Foundation

| No | Project | Outline | Counter Part | Year |
|----|---|--|---|------------|
| 1 | Pacific Disaster Risk Management (Training) Program II | To conduct training for disaster risk management ability development in the Pacific countries. To advance capacity building of system and reader related to disaster risk management thorough cooperation with C/P. To support low-budget early warning system organization. | National Disaster Management Offices in the Cook Islands, Fiji, Federated States of Micronesia, Marshall Islands, Samoa, Solomon Islands, Tonga, and Vanuatu; Secretariat of the Pacific Community Applied Geoscience and Technology Division (SOPAC) | 2011, 2012 |
| 2 | Pacific Islands Disaster Risk Management Program - National Disaster Management Office – Fiji | To conduct training on urgent operation center at region level and initial damage evaluation (western, northern, central and eastern areas) | - | 2009, 2010 |

Source: TAF (<http://www.asiafoundation.org/>)

(4) The Asian Development Bank (ADB)

ADB is conducting Technical Assistance for Strengthening Disaster and Climate Risk Resilience in Urban Development in the Pacific project at that moment. This project aims to mainstream the inclusion of climate risk information and disaster risk information of each country in the urban development and facility plan.

Table 2-44 Contents of the projects conducted by ADB

| Project | Project Type | Outline | Conducting Situation |
|---|------------------------|--|------------------------|
| Technical Assistance for Strengthening Disaster and Climate Risk Resilience in Urban Development in the Pacific | TA | To utilize climate risk information and disaster risk information for urban development and facility plan by disaster management committee in Pacific state. | Under Conducting |
| Fiji Flood Rehabilitation Project | Collecting information | Collection of information | April 2012 – July 2014 |

Attention: *1 TA = Technical Assistance

Source: ADB 46162-001 Strengthening Disaster and Climate Risk Resilience in Urban Development in the Pacific

(5) United Nations Development Program (UNDP)

UNDP conducted the projects mainly focusing on ability reinforcement of government system. The project underway was “Pacific Risk Resilience Program: Working towards resilient communities in the Pacific” which aimed to strengthen government system and community to manage disaster risk and adapt climate change. The major project was development of risk governance on government level and this instrument aimed to insert way of thinking that disaster risk management and climate change adaptation to development plan and budget on whole of government level by making disaster risk management and climate change adaptation to the mainstream. Moreover, for community level risk management, they indicated reinforcement of community resilience against disaster. This project was conducted aiming to integrate adaptation with disaster risk management and climate change conducted at each community level.

Table 2-45 Contents of the project conducted by UNDP

| Project | Target Country | Project Period | Outline |
|---|-------------------------------------|------------------------------------|---|
| Pacific Risk Resilience Program: Working towards resilient communities in the Pacific | Solomon Vanuatu Tonga Fiji | November, 2013-October, 2017 | The Pacific Risk Resilience Program (PRRP) attached importance to reinforcing system of the organizations related to disaster risk management and climate change adaptation by government. The main components are the following. 1. Risk Governance: To become the mainstream to introduce disaster risk management and climate change adaptation into all development plan and budget at government level 2. Risk Management on Community Level: To strength community recuperative capacity and to integrate with disaster risk management and climate change adaptation and disaster risk management at community level. |

Source: UNDP pamphlet “Pacific Risk Resilience Program –Working towards resilient communities in the Pacific-”

(6) World Meteorological Organization (WMO)

WMO has conducted Coastal Inundation Forecasting Demonstration Project (CIFDP) as The WMO-IOC Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM).

(7) Australian Agency for International Development (AusAID)

AusAID has supported large-area through SPC/SOPAC SPREP (Secretariat of the Pacific Regional Environment Program), bilateral support and projects through NGO. AusAID placed emphasis on marine phenomenon observation, weather observation, and establishment of forecasting facility, organization of climate database and disaster prevention at community level. The following are the main AusAID projects:

- ✓ Pacific Community-focused Integrated Disaster Risk Reduction (PCIDRR)
- ✓ Climate Change and Sea Level Rise Monitoring Program
- ✓ Vulnerability and Adaptation Initiative

NDMO was the C/P for PCIDRR project which composed of training with the aim of developing community level knowledge related to disaster prevention decreasing the disaster risk.

(8) New Zealand Agency for International Development (NZAID)

The main target of NZAID to reduce poverty and it conducted 10 items program projects on education, environment, gender, improvement of growth and living means, health, urgent humanitarian support, leadership and reign, peace building and war prevention, and trade and development through SPC/SOPAC and SPREP (Secretariat of the Pacific Regional Environment Program)

(9) EU

EU support has mainly focused on disaster prevention measures and especially preparation before disaster. Fiji office of EU supervised large-area projects in the Pacific state and SPC/SOPAC conducted the projects related to disaster prevention and water resource management.

EU conducted capacity development project for NDMO aiming to improve operation and ability of NDMO under EDF10 (The 10th European Development Fund) at that moment. Before the military coup, EU had achievement to support bridge construction on Rewa River.

(10) USAID

USAID has conducted training aiming to develop disaster management ability of system and knowledge and visibility of damage evaluation and disaster risk through SPC/SOPAC.

(11) Save the Children

Save the Children has conducted project on education and protection of children in emergency period, such as disaster. Project titled “Education and School Safety Policy in Emergencies” aiming to spread this project and disaster drill was underway and the Ministry of Education of Fiji was the C/P of the project.

Table 2-46 Contents of the project conducted by Save the Children

| Project | Target Country | Conducting Period | Outline |
|---|----------------|-------------------|--|
| Education in Emergencies and School Safety Policy | Fiji | - | This project is conducted by with UNICEF with the Fiji's Ministry of Education as C/P. To formulate "Education in Emergencies and School Safety Policy" aiming to develop disaster management in the schools of the whole country Specifically to develop safety of school facility, organize disaster management system for schools and educate on risk reduction. From the new 2015 school term onward, disaster drill would be conducted at every beginning of the term and activity following disaster management plan would be also conducted at each school. |