THE REPUBLIC OF FIJI

MINISTRY OF AGRICULTURE, RURAL AND MARITIME DEVELOPMENT AND NATIONAL DISASTER MANAGEMENT

THE PROJECT FOR THE PLANNING OF THE NADI RIVER FLOOD CONTROL STRUCTURES

VOLUME Ⅰ SUMMARY

JULY 2016

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

YACHIYO ENGINEERING CO., LTD.
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THE REPUBLIC OF FIJI
THE PROJECT FOR THE PLANNING OF THE NADI RIVER FLOOD CONTROL STRUCTURES

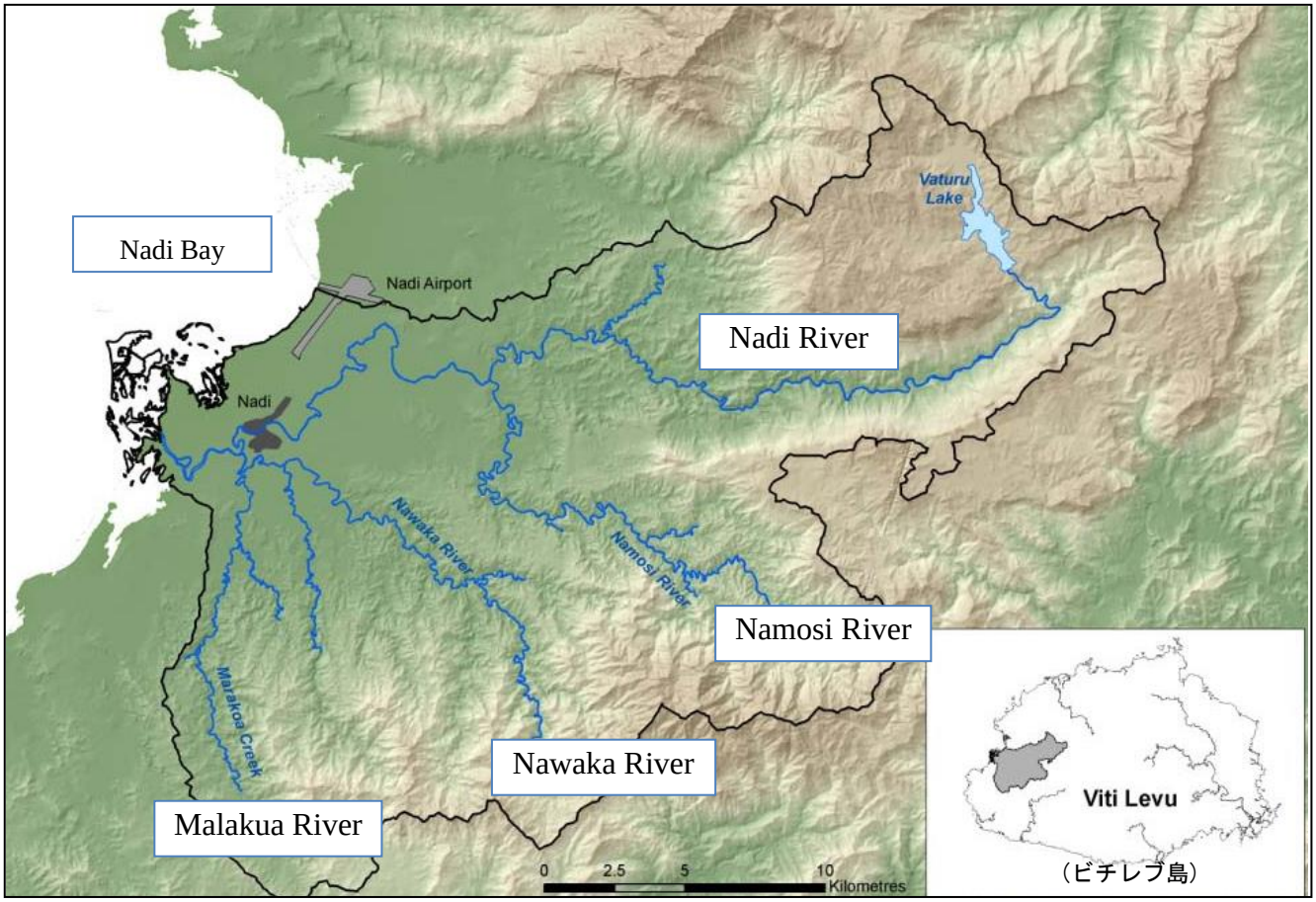
COMPOSITION OF FINAL REPORT

VOLUME I	**SUMMARY**
VOLUME II	**MAIN REPORT**
Part Ⅰ	**MASTER PLAN STUDY**
Part Ⅱ	**FEASIBILITY STUDY**
VOLUME Ⅲ	**DATA BOOK**
Part Ⅰ	**DATA BOOK (1)**
Part Ⅱ	**DATA BOOK (2)**

Exchange Rate: FJD 1 = JPY 54.5, 1 USD=FJD 2.17

(As of April, 2016)

<Map of Project Area>



（出典）Integrated Water Resource Management Demonstration Project

Photo

Photo-1 Inception Report Meeting

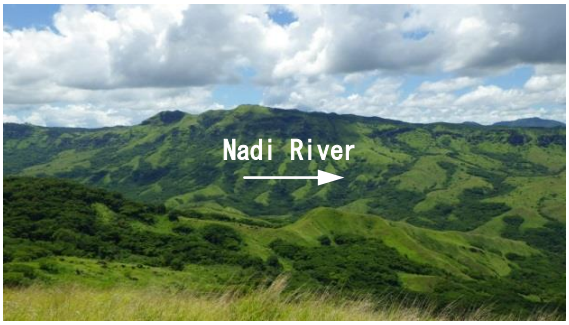


Photo-2 Nadi River Basin (Upstream)

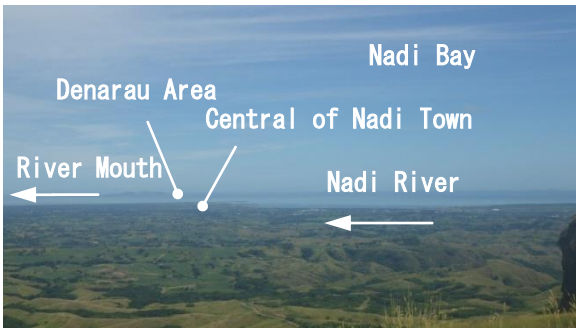


Photo-3 Nadi River Basin（Panoramic view）

Photo-4 Nadi River (River Mouth)

Photo-5 Central of Nadi Town

Photo-6 Nadi River (Middle Stream)

Photo-7 Nadi River (Upstream)

Photo-8 Vaturu Dam (Nadi River Upstream)

Photo-9 Nadi River（Nadi Town Bridge）

Photo-10 Nadi River（Nadi Town Bridge）during Flood

Photo-11 Nadi River（Old Queens Road Bridge）

Photo-12 Nadi River（Old Queens Road Bridge）during Flood

Photo-13 Nawaka River

Photo-14 Retention Dam（Nawaka River）

Photo-15 Counterpart Training in Japan

Photo-16 Seminar in Fiji

Executive Summary of
Flood Control Master Plan and Priority Project
in Nadi River Basin

1. Master Plan

【Basic Concept of Master Plan】

- In the Master Plan, based on the flood and river basin characteristics as well as properties in the upstream, midstream and downstream of the Nadi River, taking into account measures in an entire basin, comprehensive flood control plan consisting of dam, river improvement, retarding basins and ring dikes are proposed.
- Taking into account a long term and the large budget to complete the structural measures, and also taking into account the risk due to flood exceeding design scale, perfect protection measures for flood inundation are not feasible. Therefore, structural measures and non-structural measures such are proposed in the Master Plan..
- In the formulation of the Master Plan, it is an important to clarify priority protected areas from the view point of clarification on the contents of flood control plan and addressing a road map for the integration of short, middle and long term flood control plan. Therefore, Important Protected Area is set and it is prioritized to be mitigated from damage by flood.
- The Master Plan is formulated considering Environmental and Social Considerations and Social Acceptance for flood control

【Target Area of Master Plan】

Target area of Master Plan is Nadi River Basin with catchment area of 516 km^2.

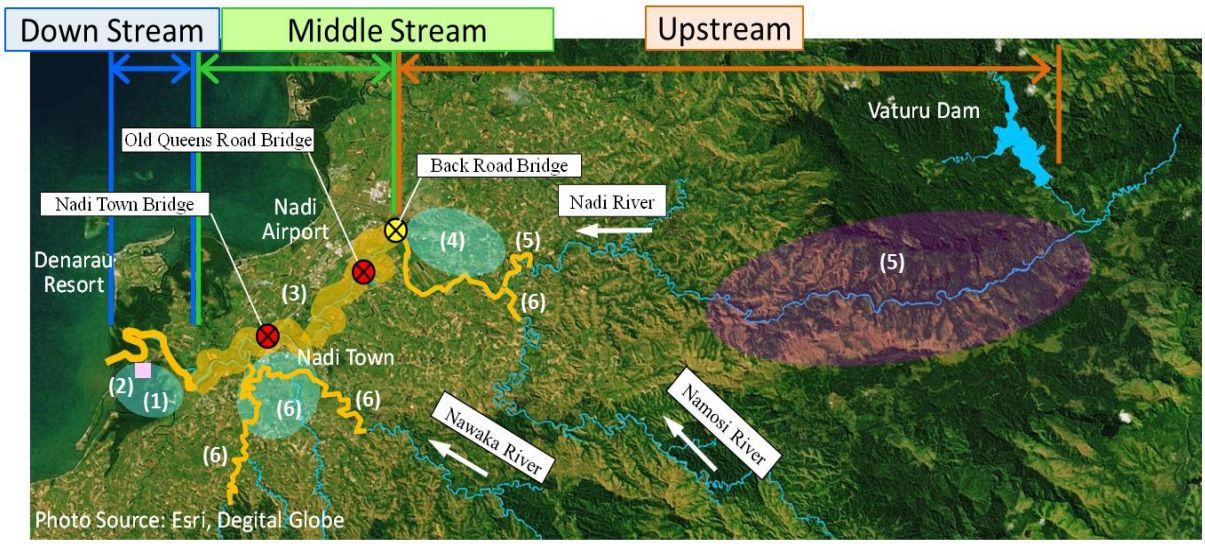
【Target Scale of Master Plan】

Design flood scale for Master Plan is set as 1/50 with regard to previous maximum flood event occurred in March 2012.

【Components of Master Plan】

(1) Structural Measures

Structural Measures as shown in Figure1 and Table1 are proposed in order to mitigate flood damage by targeted flood in Nadi River Basin.



(1)	: Retarding Basin in downstream incl. surrounding dike of retarding basin in downstream : River Improvement in downstream
(2)	: Ring Dike
(3)	: River Widening incl. Rebuilding of 2(two) bridges
(4)	: Retarding Basin A,B in upstream
(5)	: Dam : River improvement in upstream
(6)	: Retarding Basins in Tributaries incl. surrounding dike : River Improvement in Tributaries incl. Rebuilding of 4(four) bridges

Figure 1 Components of Master Plan (Structural Measures)

Table 1 Components of Master Plan (Structural Measures)

	River, Location		Component of the Master Plan		Quantities	Remarks
Structural Measures	1. Nadi River	Downstream	(1)	Retarding Basin and River Improvement in downstream	A=725 ha V=9,715 千m3	—
			(2)	Ring Dike	L=1.8 km	—
		Middlestream	(3)	River Widening[2)]	L=13 km	Including rebuilding of 2 (two) bridges
			(4)	Retarding Basin A	A=35 ha V=795 千m3	
				Retarding Basin B	A=178 ha V=6,920 千m3	—
		Upstream	(5)	Dam and River improvement in upstream	1	
	2. Tributaries	Nawaka Maralua Namosi River	(6)	River Improvement	L=21 km	Including rebuilding of 4 (four) bridges in tributaries
				Retarding Basins (13 sites)	A=340 ha V=11,600 千m3	

(2) Non-Structural Measures

Non-Structural Measures as shown in Table2 are proposed in order to corroborate and complement structural measures and mitigate damage by targeted flood.

Table 2 Components of Master Plan (Non-Structural Measures)

	Effect of Measure (Large Classification)	Major components
Non-Structural Measures	(1) Understanding disaster risk and risk avoidance	1-1) Strengthening of understanding flood risk with flood hazard map 1-2) Strengthening flood forecasting technology
	(2) Enhancing disaster preparedness for effective response	2-1) Strengthening disaster management system
	(3) Disaster risk management, risk avoidance	3-1) Technical assistant for land-use regulation 3-2) Strengthening river basin management
	(4) Economic disaster risk management	4-1) Strengthening economic disaster risk management by regional BCP
	(5) Evaluation and feedback	5-1) Establishing a system of evaluation of Pre-disaster activity / existing measures and feedback

【Implementation Schedule of Master Plan】

Proposed entire implementation schedule of the Master Plan projects is shown in Table3. Target implementation period of Master Plan is proposed as 30 years from the project commencement.

Table 3 Components of Master Plan and Implementation Schedule (Proposed)

	Work Item	20XX-20XX	20XX-20XX																															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	Study on M/P																															
	Detailed Design																															
I. Structural Measures																																
I-A. Priority Project (Short Term Measures)																																
1	**River channel widening works in midstream section**																															
1)	River channel widening works in midstream section, L=13km																															
2	**Retarding basin works in upstream section**																															
1)	Retarding basin (A) works in right bank side in Nadi River, A=35ha																															
2)	Retarding basin (B) works in left bank side in Nadi River, A=178ha																															
3	**Ring dike**																															
1)	Ring dike, L=1.8km																															
4	**Shortcut in tributaries / Surrounding dike works in Nadi River**																															
1)	Shortcut in tributaries, A=0.5km																															
2)	Surrounding dike, L=4.5km																															
I-B. Middle Term Measures																																
1	**Retarding Basin in downstream section (A=km2)**																															
1)	Retarding Basin in downstream section, A=725ha																															
2	River improvement in tributaries																															
1)	Nawaka River, L=8.5km																															
2)	Malakua River , L=8.5km																															
3)	Namosi River , L=4.0km																															
I-C. Long Term Measures																																
1	**Dam construction in upstream in Nadi River (H= m)**																															
1)	Dam construction in upstream in Nadi River																															
II. Non-structural Measures																																
1	**Understanding disaster risk and risk avoidance**																															
1-1)	Strengthening of understanding flood risk with flood hazard map																															
1-2)	Strengthening flood forecasting technology																															
2	**Enhancing disaster preparedness for effective response**																															
2-1)	Strengthening disaster management system																															
2-2)	Strengthening emergency assistance system																															
3	**Disaster risk management, risk avoidance**																															
3-1)	Land use regulations																															
3-2)	Strengthening river basin management																															
4	**Economic disaster risk management**																															
4-1)	Strengthening economic disaster risk management by regional BCP																															
5	**Establishing a system of evaluation of Pre-disaster activity / existing measures and feedback**																															
5-1)	Establishing a system of evaluation of Pre-disaster activity / existing measures and feedback																															

Note: *including loan agreement, EIA, land acquisition, procurement of consultant (D/D, C/S), detailed design, preparation of PQ and tender document and so on.

2. Priority Project

【Basic Concept for selection of Priority Project】

- Taking into account a long term and the large budget to complete the structural measures, and also taking into account the risk due to flood exceeding design scale, perfect protection measures for flood inundation are not feasible. Therefore, Priority Project is selected in order to protect important area and mitigate flood damage.
- Regarding structural measures of Priority Project, components which mitigate flood damage in Important Protected Area is selected after setting Important Protected Area.
- Regarding non-structural measures of Priority Project, protection of human lives, understanding of disaster risks and evacuation are considered as a top priority. Based on this concept, components for understanding of disaster risks and evacuation are selected as Priority Project.

【Components of Priority Project】

(1) Structural Measures

Structural Measures as shown in Figure 3 and Table 4 are proposed in order to mitigate flood damage in Important Protected Area (Figure 2).

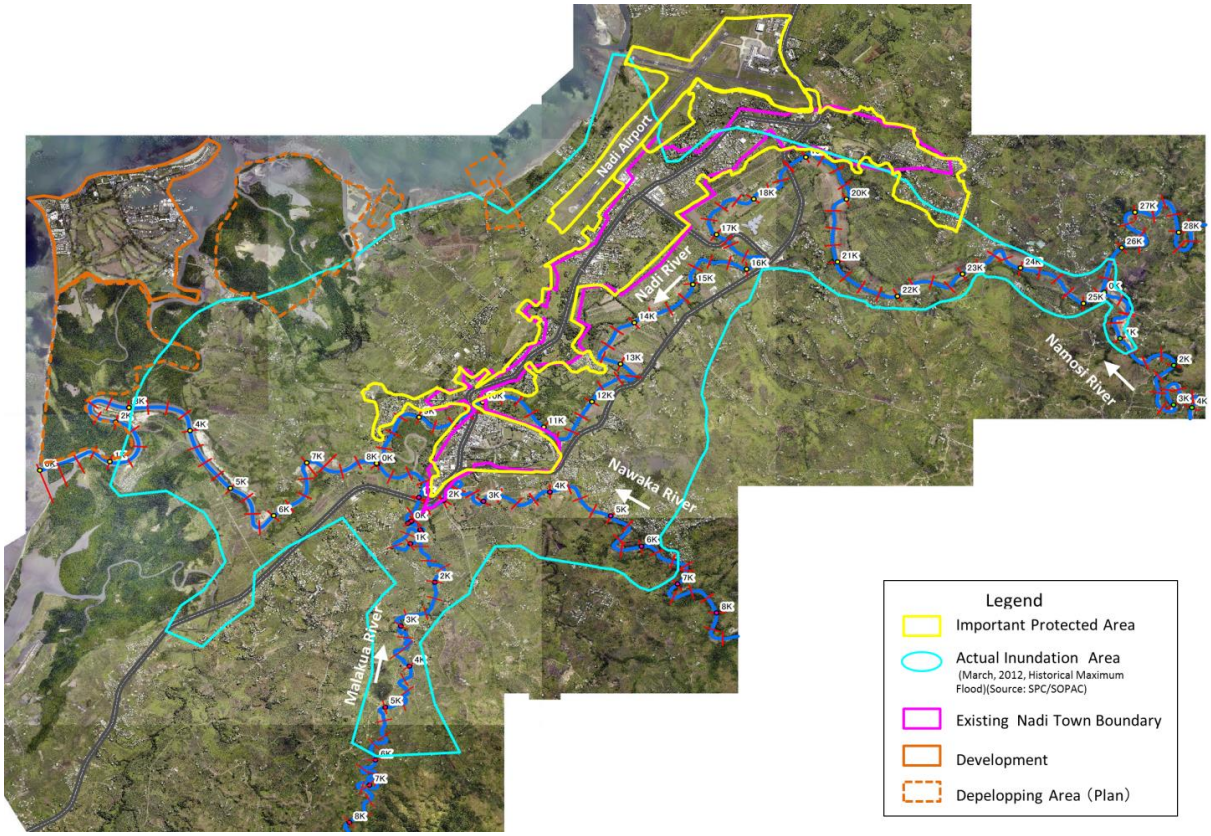


Figure 2　Important Protected Area

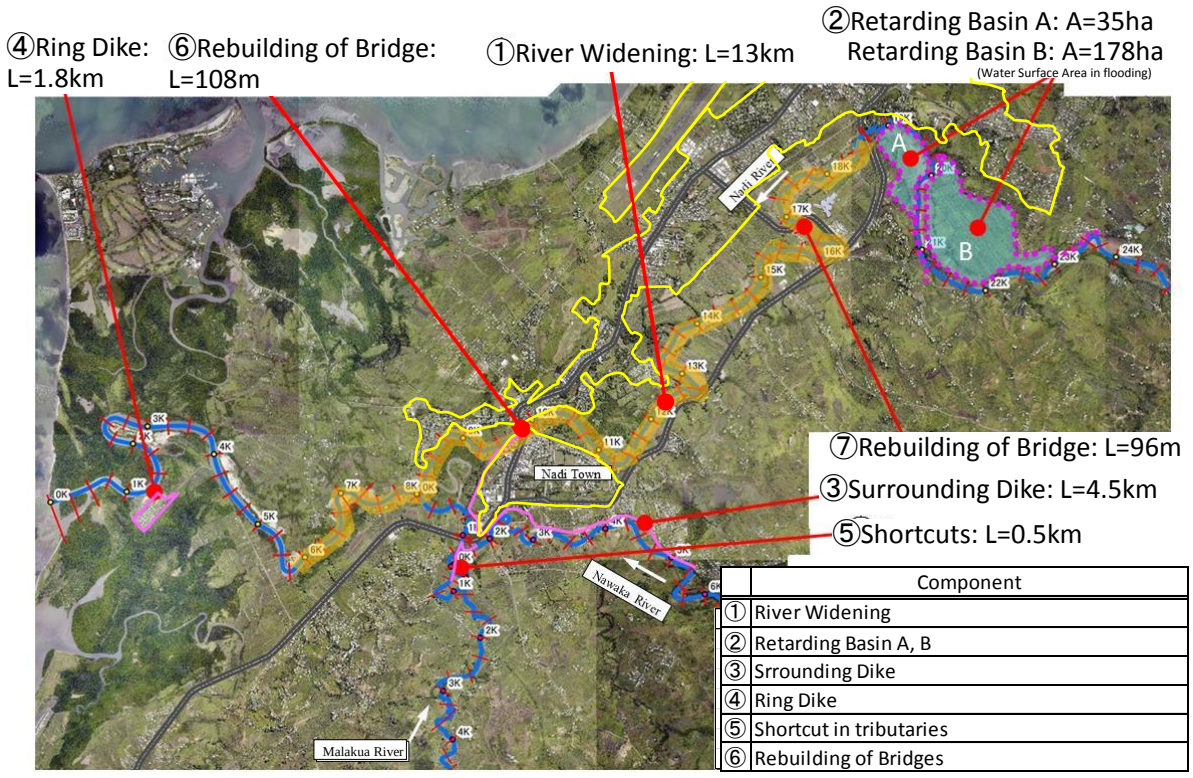


Figure 3 Components of Priority Project (Structural Measures)

Table 4 Components of Priority Project (Structural Measures)

	River, Location		Component of the Master Plan	Component of the Priority Project		Remarks
				Main Component	Quantities	
Structural Measures	1. Nadi River	Downstream	(1) Retarding Basin and River Improvement in downstream	—	—	—
			(2) Ring Dike	④ Ring Dike	L=1.8 km	—
		Middlestream	(3) River Widening[2)]	① River Widening Rebuilding of Nadi TOwn Bridge Rebuilding of Old Queens Road Bridge	L=13 km L=108 m L= 96 m	—
			(4) Retarding Basin A	② Retarding Basin A	A=35 ha V=795 千m3	
			Retarding Basin B	② Retarding Basin B	A=178 ha V=6,920 千m3	
		Upstream	(5) Dam and River improvement in upstream	—	—	—
	2. Tributaries	Nawaka Maralua Namosi River	(6) River Improvement	⑤ Shortsut of Tributaries ③-2 Surrounding Dike of Nadi Town	L=0.5 km L=4.5 km	Shortcut and Surrounding dike in tributaries are preceded to construction as part of the master plan
			Retarding Basins (13 sites)	—	—	

(2) Non-Structural Measures

Protection of human lives, understanding of disaster risks and evacuation are considered as a top priority, under condition that the progress of structural measures project will be at initial phase. Therefore, activities accompanied with development and disclosure of hazard maps and development of hydrological devices for awareness of flood risks are proposed as Priority project. In addition, in order to evaluate the effect of non-structural measures in the past or priority projects, and in order to connect to “Better disaster prevention”, evaluation and feedback system on the past projects is also proposed as Priority Project.

Table 5 Components of Priority Project (Non-Structural Measures)

	Category	Measures
Non-structural Measures	Understanding disaster risk and risk avoidance	・ Strengthening of understanding flood risk with flood hazard map ・ Strengthening flood forecasting technology, such as expansion of rainfall gauge, water level gauge and introduction of real-time monitoring camera
	Better Disaster Prevention	・ Establishing a system of evaluation of Pre-disaster activity / existing measures and feedback

【Selection of Implementation Project】

Integrated flood control facilities considering whole river basin have not been installed yet in spite of effectiveness of structural measures and implementation of structural measures such as dam, retarding basin, and river are required urgently. Therefore, structural measures of Priority Project are selected as Implementation Project.

【Objective of Implementation Project】

Objective of Implementation Project is to improve of vulnerability to flood in Nadi River Basin, mitigate flood damage specially in Important Protected Area and contribute to improve living environment of residents by developing flood control facilities such as river widening and retarding basin in Nadi River Basin, which has been damaged by severe flood.

【Components of Implementation Project】

Components of Implementation Project is as shown in Figure 4 and Table 6, which are as same as structural measures of Priority Project.

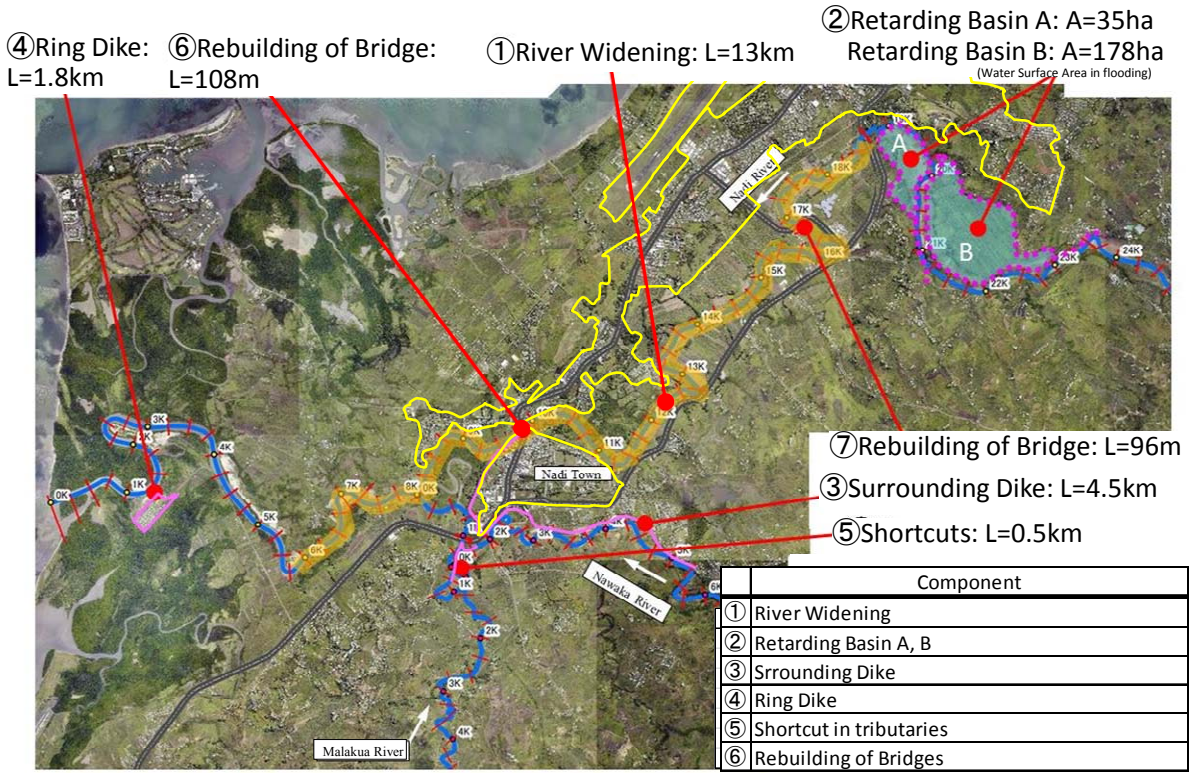


Figure 4 Components of Implementation Project (Structural Measures)

Table 6 Components of Implementation Project (Structural Measures)

	River, Location		Component of the Master Plan	Component of the Priority Project		Remarks
				Main Component	Quantities	
Structural Measures	1. Nadi River	Downstream	(1) Retarding Basin and River Improvement in downstream	—	—	—
			(2) Ring Dike	④ Ring Dike	L=1.8 km	—
		Middlestream	(3) River Widening[2)]	① River Widening Rebuilding of Nadi TOwn Bridge Rebuilding of Old Queens Road Bridge	L=13 km L=108 m L= 96 m	—
			(4) Retarding Basin A	② Retarding Basin A	A=35 ha V=795 千m3	
			Retarding Basin B	② Retarding Basin B	A=178 ha V=6,920 千m3	—
		Upstream	(5) Dam and River improvement in upstream	—	—	
	2. Tributaries	Nawaka Maralua Namosi River	(6) River Improvement	⑤ Shortsut of Tributaries ③-2 Surrounding Dike of Nadi Town	L=0.5 km L=4.5 km	Shortcut and Surrounding dike in tributaries are preceded to construction as part of the master plan
			Retarding Basins (13 sites)	—	—	

【Implementation Schedule of Implementation Project】

Implementation Schedule of Implementation Project is as shown in Table 8.

【Implementation Project 】

Implementation Project Cost is as shown in Table 9.

【Economic Feasibility of Implementation Project】

Total cost of the priority project is JPY21.0 billion (F$385million) and the average annual benefit is JPY 1.88billion (F$34.5million). These figures lead to EIRR 12.0%, B/C=1.2 and NPV JPY1.8billion (F$33million) respectively. This economic valuation is beyond the target investment rate of 10% in Fiji and show the adequate economic effect.

Table 7 Result of Economic Evaluation

Economic indicator	Result	Evaluation
Economic internal rate of return (EIRR)	12.0%	Since EIRR is well over 10% which is applied to the development assistance project in Fiji, the economic effectiveness is high.
Benefit-cost (B/C) ratio	1.20	Since the B/C ratio is over 1.0, the cost-effectiveness is high.
Net present value (NPV)	JPY 1.8 billion (FJD33 million)	Since the value is plus, the cost-effectiveness is high.

Source: JICA study team

【Conclusion and Recommendation】

Implementation Project proposed as one of the Priority Project is evaluate appropriate since it could mitigate severe flood damage and it is feasible technically, economically, socially and environmentally. Therefore, next steps such as securing budget and request for technical assistance as follows are recommended to be conducted by Fiji Government as soon.

(1) Implementation of the Priority Project and establishment of Implementation Structure

(2) Formulation consensus of Government and residents for the Implementation

(3) Commencement of loan procedure for project fund

(4) Commencement of negotiation for land acquisition and compensation

(5) Commencement of consultant procurement and environmental monitoring

(6) Establishment of legislation of flood control

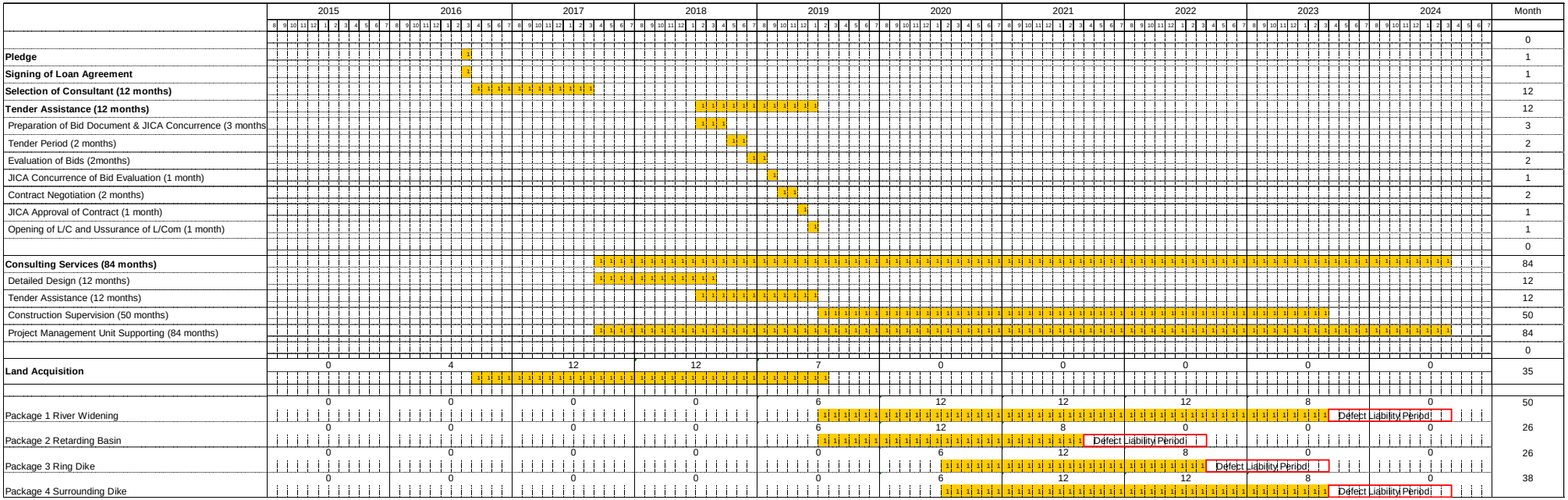
(7) Preparation and consolidation of organization responsible for flood control and capacity building

(8) Preparation of criteria and standard

(9) Permanent securement of maintenance budget for flood control

Table 8 Implementation Schedule of Implementation Project (Proposed)

Implementation Schedule



*Year in above table shows the fiscal year of Fiji (August 1st to July 31th of following year)

Table 9 Project Cost of Implementation Project

(FC&Total: Million JPY, LC: Million FJD)

Item		Total			
		FC	LC	Total	
		million (Yen)	million (F$)	million (Yen)	million (F$)
A. ELIGIBLE PORTION					
Ⅰ)	Procurement / Construction	6,778	134	14,074	258
	Package 1 River Widening, Rebuilding of Bridge	4,213	77	8,432	155
	Package 2 Retarding Basin	1,281	19	2,299	42
	Package 3 Ring Dike	40	1	76	1
	Package 4 Surrounding Dike	392	5	657	12
	Base cost for JICA financing	5,926	102	11,464	210
	Price escalation	529	26	1,940	36
	Physical contingency	323	6	670	12
Ⅱ)	Consulting services	933	18	1,893	35
	Base cost	828	14	1,579	29
	Price escalation	60	3	223	4
	Physical contingency	44	1	90	2
Total (Ⅰ+Ⅱ)		7,711	151	15,967	293
B. NON ELIGIBLE PORTION					
a	Procurement / Construction	0	0	0	0
	Base cost for JICA financing	0	0	0	0
	Price escalation	0	0	0	0
	Physical contingency	0	0	0	0
b	Land Acquisition	0	38	2,093	38
	Base cost	0	34	1,845	34
	Price escalation	0	3	148	3
	Physical contingency	0	2	100	2
c	Administration cost	0	17	903	17
d	VAT	0	30	1,625	30
e	Import Tax	0	0	0	0
Total (a+b+c+d+e)		0	85	4,621	85
TOTAL (A+B)		7,711	236	20,588	378
					0
C. Interest during Construction		351	0	351	6
	Interest during Construction(Const.)	350	0	350	6
	Interest during Construction (Consul.)	1	0	1	0
D. Front End Fee		32	0	32	1
GRAND TOTAL (A+B+C+D)		8,094	236	20,971	385
E. JICA finance portion (A)		7,711	151	15,967	293

US$1=2.17 F$, 1F$= JPY 54.5

Abbreviation

ADB	Asian Development Bank	アジア開発銀行
ADRA	Adventist Development and Relief Agency	アドベンチスト開発救助機関
AusAID	Australian Agency for International Development	オーストラリア国際開発庁
BCP	Business Continuity Plan	事業継続計画
BOM	Bureau Of Meteorology	オーストラリア気象局
CBD	Convention on Biological Diversity	生物多様性条約
CCA	Climate Change Adaptation	気候変動適応
CCL	Climate Change Loan	気候変動対策円借款
CCM	Climate Change Mitigation	気候変動緩和
CHARM	Comprehensive Hazard And Risk Management	統合的ハザード・リスク管理
C/P	Counterpart	カウンターパート
CRED	Centre for the Research on the Epidemiology of Disaster	災害の疫学に関する研究センター
CWO	Commissioner Western Office	西部地域長官室
DEM	Digital Elevation Model	デジタル標高モデル
DF/R	Draft Final Report	ドラフトファイナルレポート
DIS	Drainage & Irrigation Section	排水・灌漑部門
DISMAC	Disaster Management Centre	災害管理センター
DMP	Disaster Management Plan	防災計画書
DOE	Department of Environment	環境局
DOFi	Department of Fishery	漁業局
DOF0	Department of Forest	森林局
DOL	Department of Lands	土地局
DO-N / DO	District Nadi Office / District Office	ナンディ地区事務所／地区事務所
DOW	Department of Works	公共事業局
DRCC	Disaster Ready Community Committee	災害自立型コミュニティ委員会
DRR	Disaster Risk Reduction	災害リスク軽減
DRRDM	Disaster Risk Reduction & Disaster Management	災害リスク軽減・災害管理
DTCP	Department of Town & Country Planning	都市／地方計画局
EDF	European Development Fund	ヨーロッパ開発基金
EIA	Environmental Impact Assessment	環境影響評価
EiE	Education in Emergencies	緊急時の教育
EOC	Emergency Operation Center	緊急対策室
EPGA	Environmental Programme Grant Aids	環境プログラム無償資金協力
EU	European Union	欧州連合
EWS	Early Warning System	早期警報システム
FBS	Fiji Bureau of Statistics	フィジー統計局
FMS	Fiji Meteorological Service	フィジー気象局
F/R	Final Report	ファイナルレポート

FRA	Fiji Road Authority	フィジー道路公社
F/S	Feasibility Study	フィジビリティ調査
FSC	Fiji Sugar Corporation	フィジー砂糖会社
GDP	Gross National Product	国民総生産
GEF	Global Environmental Facility	地球環境ファシリティ
GGP	Grant Assistance for Grassroots Human Security Projects	草根の無償／草の根・人間の安全保障無償資金協力
GIS	Geographical Information System	地理情報システム
GNI	Gross National Income	国民総所得
HFA	Hyogo Framework for Action	兵庫行動枠組み
IC/R	Inception Report	インセプションレポート
IDA	Initial Damage Assessment	初期損害評価
IDD	Irrigation & Drainage Division	灌漑・排水部門
IDM	Introduction of Disaster Management	災害管理の導入
IEE	Initial Environmental Examination	初期環境調査
IRC	International Red Cross	国際赤十字
IT/R	Interim Report	インテリムレポート
IWRM	Integrated Water Resource Management	統合水資源管理
JCC	Joint Coordination Committee	合同調整委員会
JICA	Japan International Cooperation Agency	独立行政法人　国際協力機構
KP	Kyoto Protocol	京都議定書
LRPD	Department of Land Resource Planning & Development	土地資源計画・開発局
LWRM	Land &Water Resource Management	土地水資源管理部
MDGs	Millennium Development Goals	ミレニアム開発目標
MFA&IC	Ministry of Foreign Affairs & International Co-operation	外務・国際協力省
MFSPNDS	Ministry of Finance Strategic Planning, National Development & Statistics	財務戦略計画・国家開発・統計省
MLGUDHE	Ministry of Local Government, Urban Development, Housing &Environment	地方行政・都市開発・住宅・環境省
MLMR	Ministry of Lands & Mineral Resources	土地鉱物資源省
M/M	Minutes of Meeting	会議議事録
MOA	Ministry of Agriculture	農業省
MOU	Memorandum Of Understanding	覚書
M/P	Master Plan	基本計画
MP Radar	Multi Parameter Radar	マルチパラメータ気象レーダ
MRMSNDM	Ministry of Rural & Maritime Safety & National Disaster Management	地域・海上保安・国家災害管理省
MTCP	Ministry of Town and Country Planning	都市計画省
MWTPU	Ministry of Works, Transport & Public Utilities	公共事業・運輸・公益事業省
NBCC	Nadi Basin Catchment Committee	ナンディ流域委員会
NCCP	National Climate Change Policy	国家気候変動政策
NDMC	National Disaster Management Council	国家災害管理評議会

NDMO	National Disaster Management Office	国家災害管理室
NEOC	National Emergency Operation Centre	国家緊急オペレーション・センター
NIWA	The National Institute of Water and Atmospheric Research	水・大気研究国立機関
NTC	Nadi Town Council	ナンディ町議会
NZAID	New Zealand Agency for International Development	ニュージーランド国際開発庁
O&M	Operation and Maintenance	運用維持管理
OCHA	Office for the Coordination of Humanitarian Affairs	国連人道問題調整事務所
ODA	Official Development Assistance	政府開発援助
OJT	On the Job Training	実地訓練
PCIDRR	The Pacific Community-focused Integrated Disaster Risk Reduction	大洋州コミュニティ統合的災害リスク削減
PDM	Project Design Matrix	プロジェクトデザインマトリックス
PDN	Pacific Disaster Net	大洋州災害ネット
PDRMP	Pacific Disaster Risk Management (Training) Programme	大洋州災害リスク管理（研修）プログラム
PDRMPN	Pacific Disaster Risk Management Partnership Network	大洋州災害リスク管理パートナーシップ・ネットワーク
PHT	The Pacific Humanitarian Team	大洋州人道チーム
PIFACC	Pacific Islands Framework for Action on Climate Change	大洋州気候変動行動枠組み
PMO	Prime Minister Office	首相府
PMU	Project Management Unit	プロジェクト・マネジメント・ユニット
P/R	Progress Report	プログレスレポート
PRMS	Planning & Resource Management Section	計画・資源管理部門
PRSP	Poverty Reduction Strategy Paper	貧困削減戦略文書
PWD	Public Works Division	公共事業部
RAP	Resettlement Action Plan	住民移転計画
R/D	Record of Discussion	討論議事録
RES	River Engineering Section	河川エンジニアリング部門
SOP	Standard Operation Procedure	標準作業手順書
SOPAC	South Pacific Applied Geoscience Commission	太平洋諸島応用科学委員会
SPC	Secretariat for the Pacific Community	太平洋コミュニティ事務局
SPCZ	South Pacific Convergence Zone	南太平洋収束帯
SPREP	South Pacific Regional Environment Programme	大洋州環境プログラム事務局
TC	Tropical Cyclone	熱帯性サイクロン
TLTB	iTauke Land Trust Board	イ・タウケイ土地信託委員会
ToT	Training of Trainers	指導員研修
UNCCD	United Nations Convention to Combat Desertification	国連砂漠化防止条約
UNDP	United Nations Development Programme	国連開発計画
UNESCAP	United Nations Economic & Social Commission for Asia & the Pacific	国連アジア太平洋経済社会委員会
UNFCCC	United Nations Framework Convention on Climate Change	国連気候変動枠組条約
UNICEF	United Nations International Children's Emergency Fund	国連国際児童緊急基金
UNISDR	United Nations International Strategy for Disaster	国連国際防災戦略

	Reduction	
UNOCHA	United Nations Office for Coordination of Humanitarian Affairs	国連人道問題支援室
USAID	United State Agency for International Development	米国国際開発庁
WAF	Water Authority of Fiji	フィジー水公社
WB	World Bank	世界銀行（世銀）
WMO	World Meteorological Organization	世界気象機関
WMS	Watershed Management Section	流域管理部門

THE REPUBLIC OF FIJI
THE PROJECT FOR THE PLANNING OF THE NADI RIVER FLOOD CONTROL STRUCTURES

FINAL REPORT
VOLUME Ⅰ SUMMARY

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Appendix

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Chapter 1 Introduction

1.1 Background and Necessity of the Project

The Republic of Fiji (hereinafter refer to as "Fiji") plays a central role in the development and economy of the Pacific Ocean Island Nations Region, having headquarters of regional international organizations such as Secretariat of PIF (Pacific Ocean Islands Forum). Stabile and sustainable development of Fiji is important for the Pacific Ocean region as a whole.

Nadi Town, which is located in the target river basin (the Nadi River Basin) of the Project, is the third largest city of 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. About 700 thousand tourists visit Fiji every year through mainly Nadi International Airport, the main gateway to Fiji. On the other hand, the Nadi River Basin is vulnerable to flood disaster. Extensive flood damage has occurred in recent years (January 2009, and March and January 2012). However, systematic and comprehensive flood control planning and/or flood control projects have not been formulated yet, and the Nadi River Basin is facing a natural disaster risk.

Therefore, formulation of flood control master plan for the Nadi River Basin and implementation of flood control project(s) are urgently required, and they are expected to have a very large impact in the near future. Furthermore, the effectiveness of the master plan will contribute to other basin of Fiji and to the development of the Pacific region as a whole.

Considering the above conditions, JICA is dealing with strengthening of disaster prevention of the Pacific region, as disaster prevention program(s) and climate change adaptation program(s), through (1) Capacity Development of Disaster Management of the Government of Fiji (hereinafter referred as "GOF"); (2) Strengthening of Disaster Response Capacity of the Community"; and (3) Strengthening of Capacity of the Climate Observation and Weather Forecasting". JICA implemented the development survey, "The Study on Watershed Management and Flood Control for the Four Major Viti Levu Rivers in the Republic of Fiji Islands" in 1996 to 1998. Nevertheless, no actual measures had been taken. In addition, together with the economic development of the target area, land utilization and asset situation have greatly changed in the last 16 years. The targeted flood and the expected amount of rainfall and its spatial distribution have also changed drastically. Other challenges such as improvement of hydraulic analysis, comprehensive sediment management, impact on coastal environment, capacity development of related organization and so on were also confirmed in the detailed planning survey conducted by JICA in 2014. In this study, considering the background and initiatives conducted by JICA so far, the results of the development survey will be reviewed without prejudice and with the latest technology and knowledge.

Considering the issues of Nadi River Basin, the whole perspective of the Project and the contents of technical specifications of the Project, 3 basic concepts of the Project implementation are proposed as follows: *(1) Formulation of Resilient Flood Control Plan, (2) Capacity Building leading to Improvement of Capability on Disaster Management, and (3) Introducing Japanese Technology, Experiences and Knowledge to Fiji*. Then, by reducing the flood damage of the Nadi River Basin and creating a virtuous cycle of social, environmental and economic condition of Fiji, this project will contribute to the sustainable development of Fiji and the Pacific region.

The outputs of the Project are as follows:

1) The Flood Control Master Plan in the Nadi River Basin

2) The Feasibility Study on the Priority Project(s)

3) Technical transfer to C/P through the Project

Project Implementation Period is from July 22 2014 to July 29 2016 (about 25 months). The entire implementation flow is shown as Appendix-1. Personnel organization and Schedule of the Project team is as shown in Appendix-2. The Joint Coordination Committee (hereinafter referred to as "JCC") and Technical Working Group (hereinafter referred to as "TWG") were organized for ensuring to

implement the project.

Technology transfer was carried out through training as invite seven engineers of counterpart in Japan, the above-mentioned TWG, Fiji of local seminars and during the investigation period and the joint work and technical meetings with Fiji counterparts and the project team.

Result of the project as the final report was submitted to MOA. Final report consist summary report, Main report and Date book.

The JICA Study Team was given a great deal of supports and advice throughout the study period by members of JCC and TWG. Much assistance was also provided to the JICA Study Team by the Fijian counterpart group, governmental organizations, related agencies and local consultants for sub-contract. The JICA Study Team would like to express our deepest gratitude to all persons concerned for the conveniences given by them.

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

2.1 Natural Conditions

(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 3,200km 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 700,000km2 while the total land area is 18,333km2 (almost same area of Shikoku of Japan) accounting for about 3% of the total territory.

The largest island is Viti Levu (area 10,389km^2) 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 Statics: 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 km^2), Kadavu (411 km^2), Gau (140 km^2) and Koro (104 km^2) other than Viti Levu and Vanua Levu. Generally, there are mountains of which altitude is more than 1,000m with steep slope in the mountain range. On the other hand, there is flat area of land which is composed of coral reef.

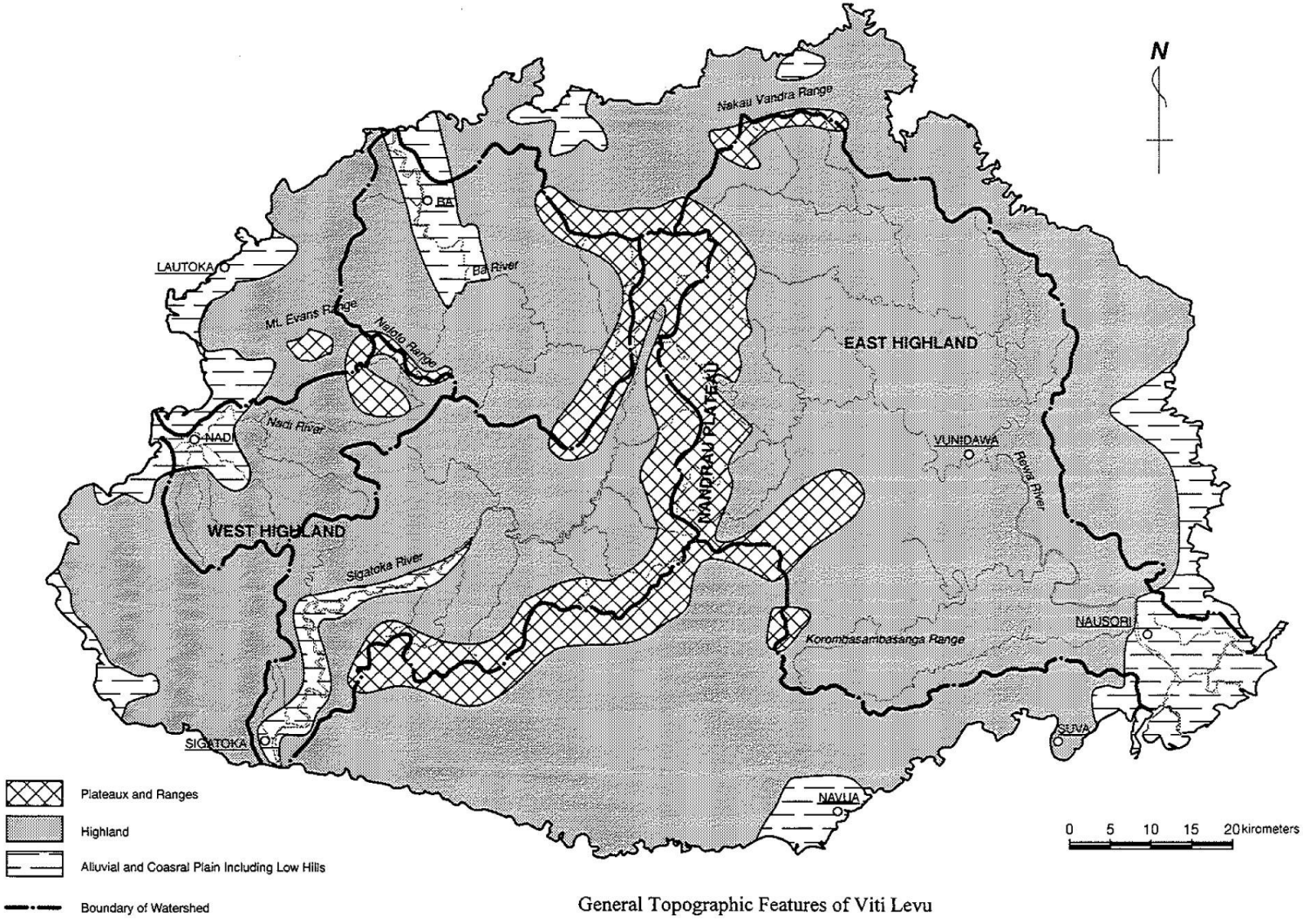
Viti Levu is one of the volcanic islands. The shape of the island is an ellipse with a length 146km in the east-west direction and 106km in the north-south direction. Geographical feature of Viti Levu is divided into two parts, west highland and east highland. The feature division is due to a central mountain range called Nandrau plateau. The highest mountain in the central mountain range is the Victoria Mountain (1,323masl). West highland and east highland are mainly formed from plates-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.

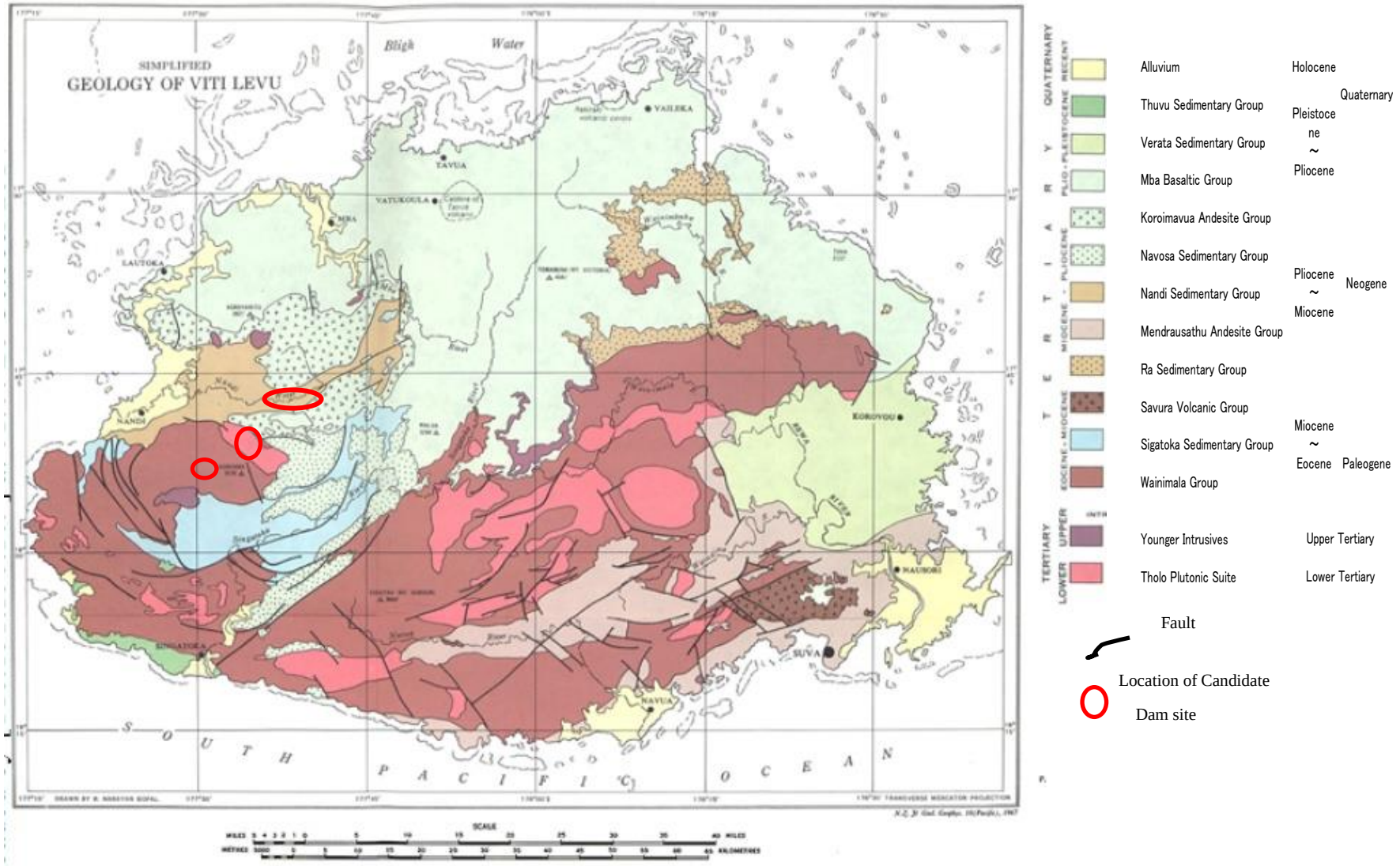
As shown in Figure 2-2, distinguished existing fault system can be seen in the southern part of the island while in the northern part of the island remarkable fault system cannot be seen because volcanic rocks which was formed in the Pliocene epoch widely covers the northern part of the island. Distinguished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



General Topographic Features of Viti Levu

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

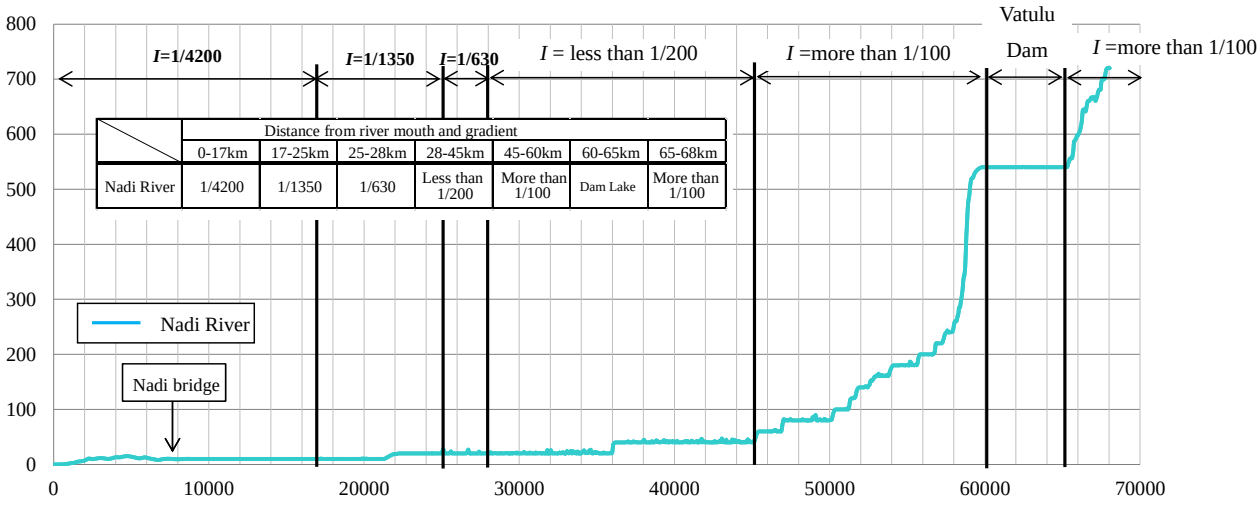
2.2 Rivers and Basins

(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

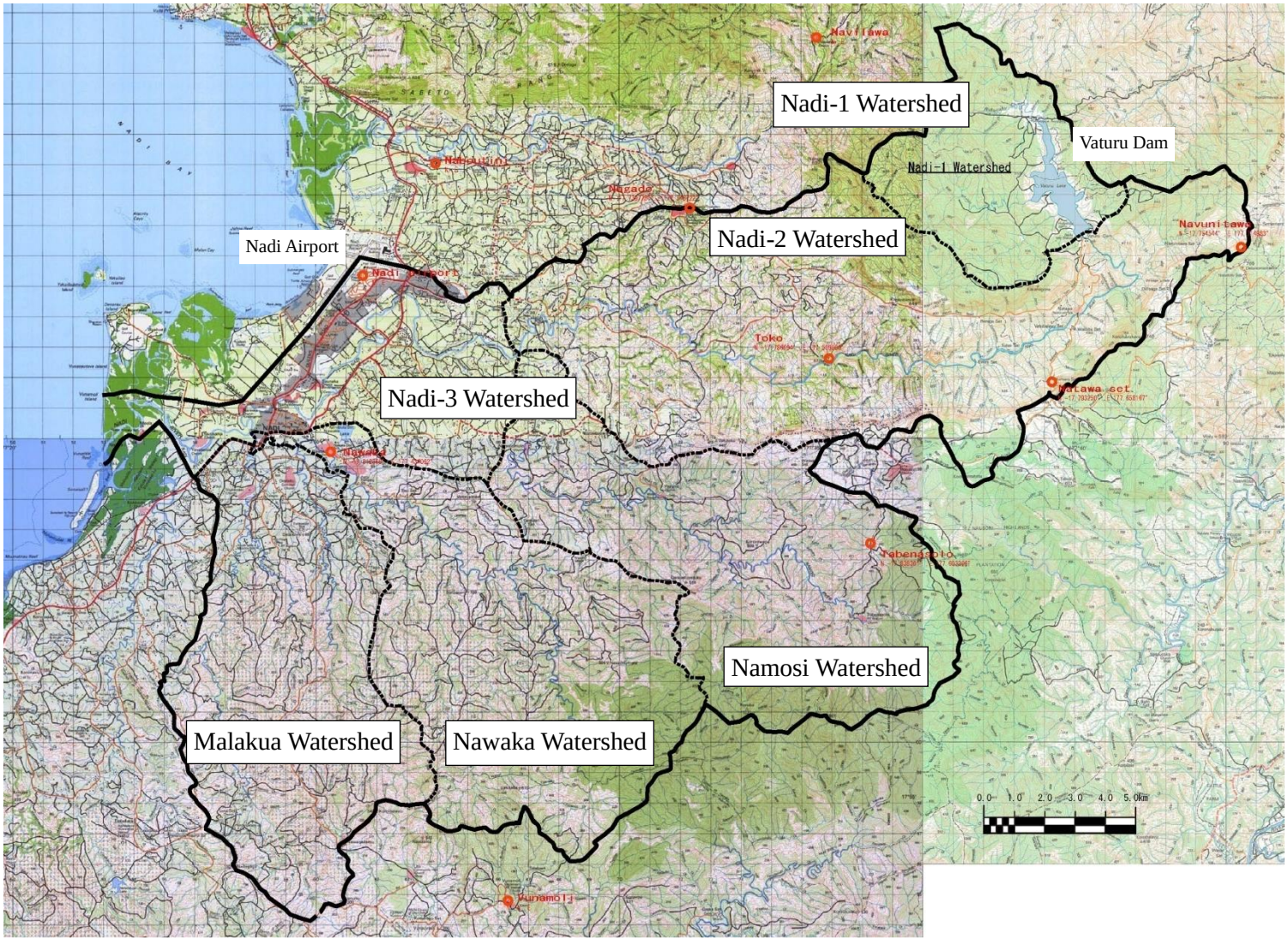
(2) Vegetation and Land Use in the Nadi River Basin

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

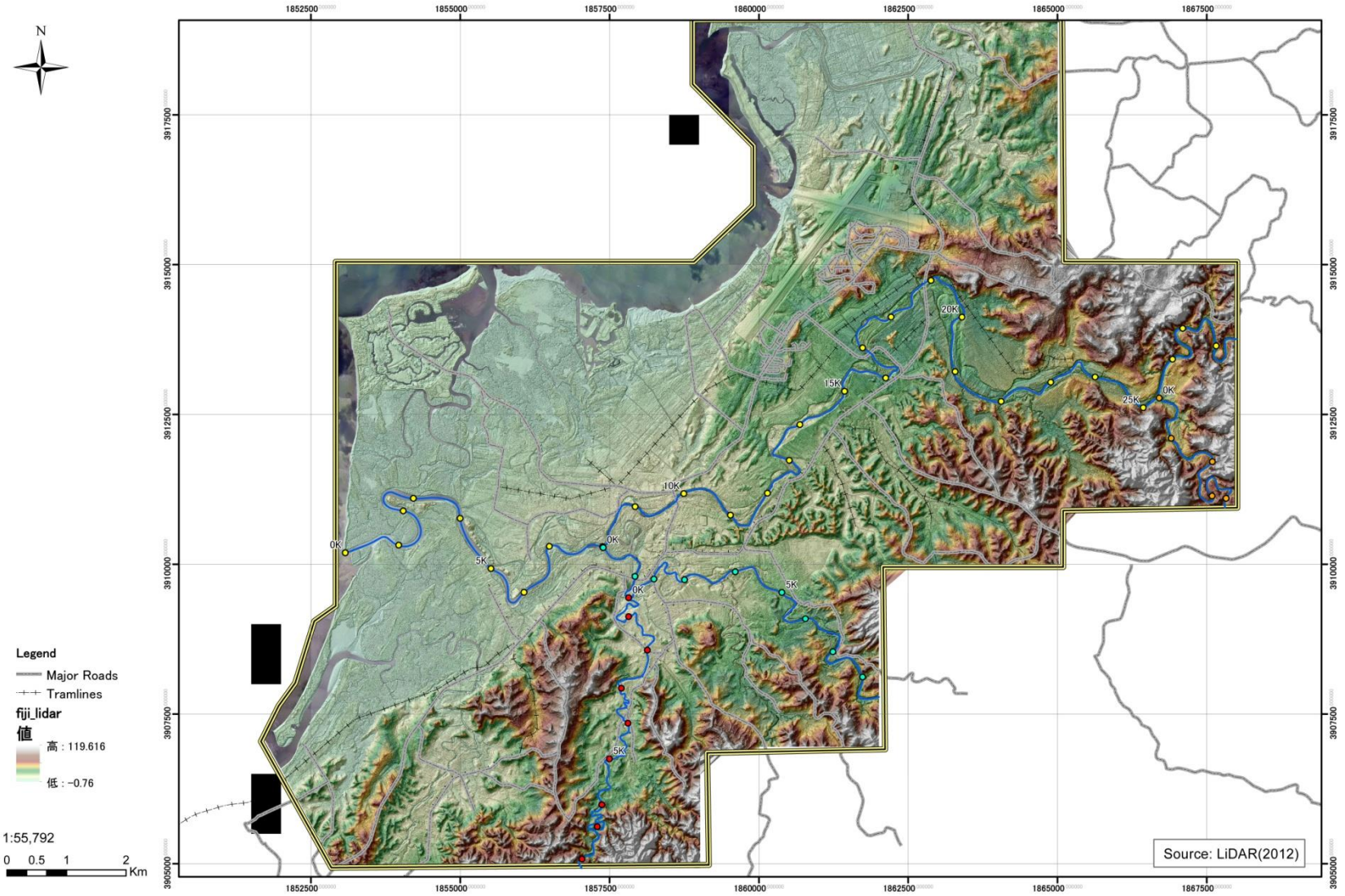
Aquifer in the Nadi River Basin is formed and limited to the alluvium in the alluvial plain. The main water recharge source of the Meigunya aquifer is assumed to be from flood plain and river channel. There are no regulations on the development of groundwater, implementation of boring and construction 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)

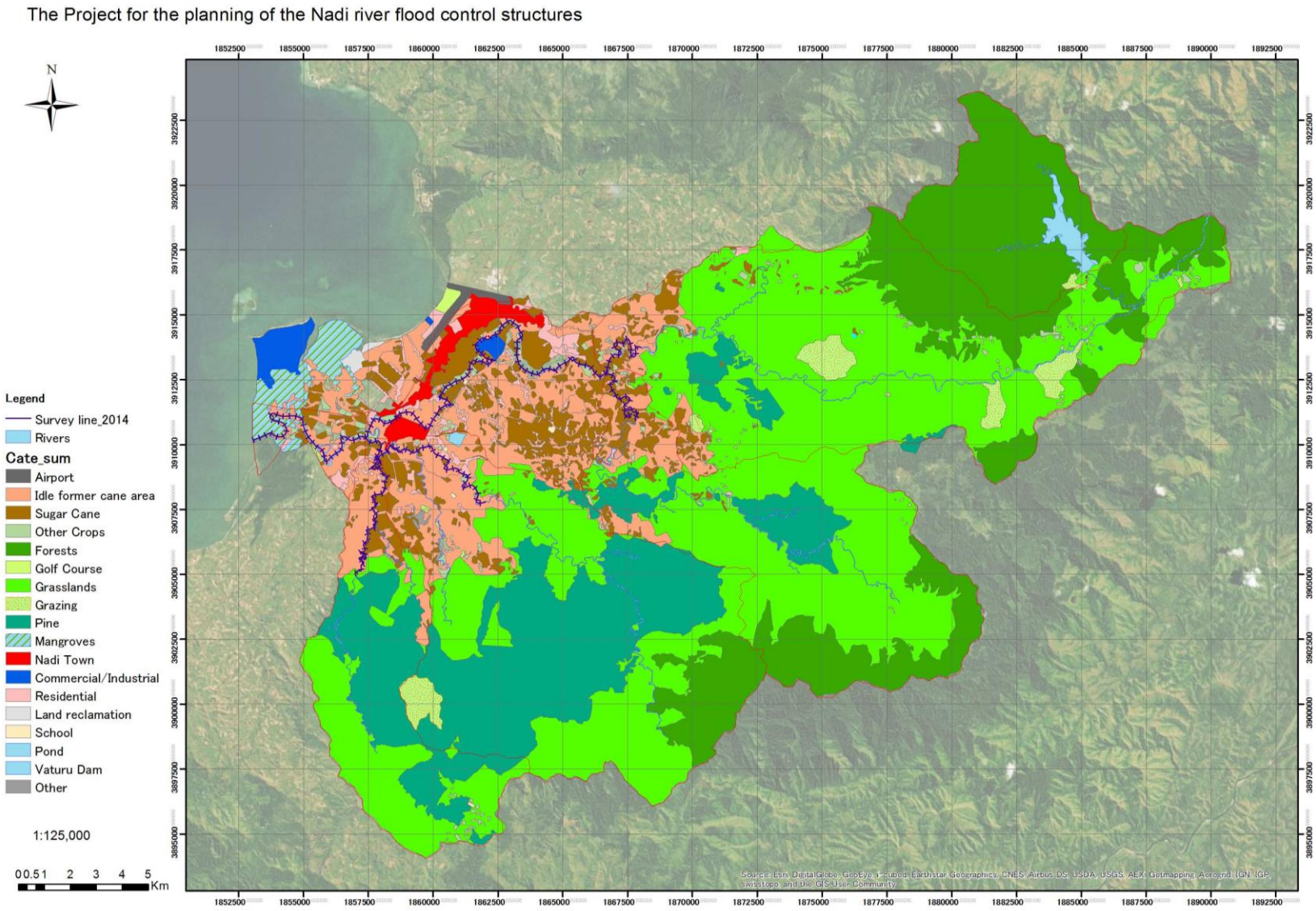
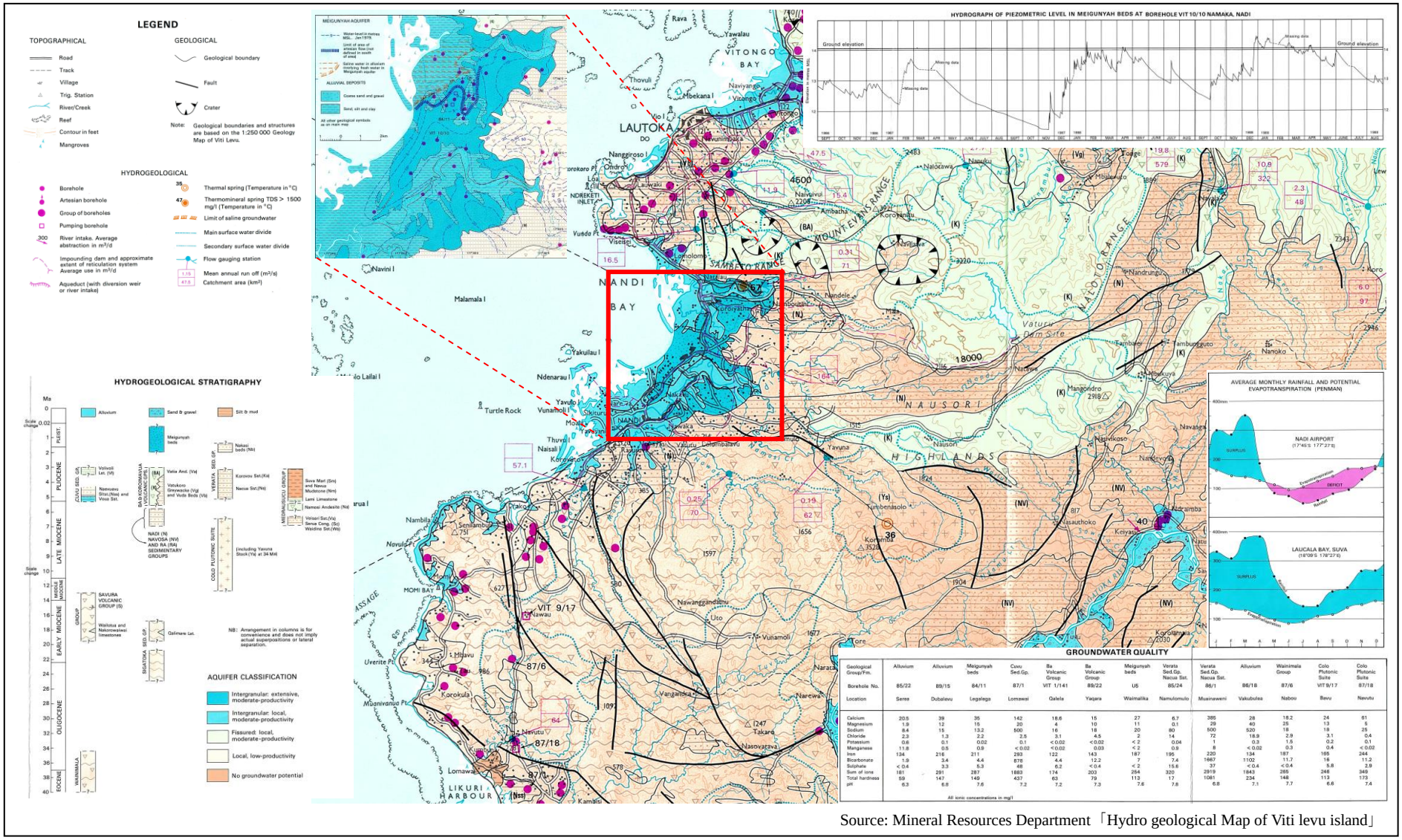


Figure 2-6 Vegetation and Land Use of Nadi River Basin



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

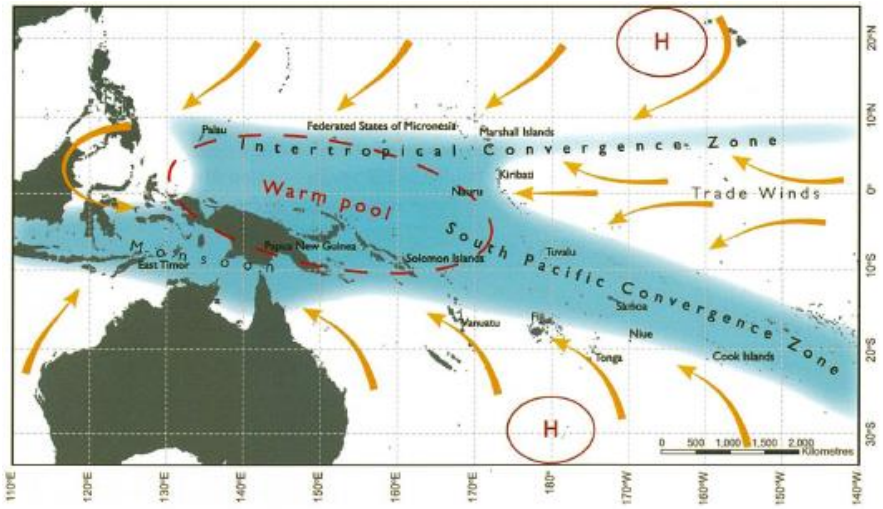
Figure 2-7 Hydro geological Map of Viti Levu island

2.3 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 20 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.

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.



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)

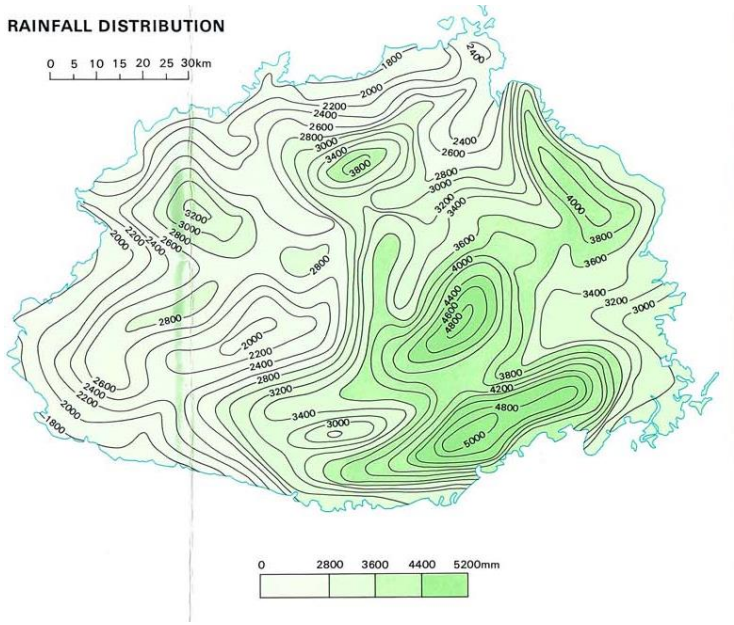
2.4 Weather and Hydrology

(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.

Figure 2-9 shows in pluvial map of Viti Levu Island.



Source: Mineral Resources Department "Hydro geological Map of Viti Levu Island"

Figure 2-9 Precipitation distribution based on 1991 rainfall data

(2) 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.

Table 2-1 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	Tubenasolo (old) Tubenasolo (new)	17°51' 41.92" S 17°49'47.29"S	177°35' 46.53" E 177°36'16.14"E	FMS	Not operating Operating	FMS	Old Telemetry	IWRM, Telemetry from 2010.12
	777701	Navunitawa	17°45'16.36"S	177°42'53.94"E	FMS	Operating	FMS	Telemetry	IWRM, Telemetry from 2010.12
	1777512	Moliveitala	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
FMS: Fiji Meteorological Service
MOA: Ministry of Agriculture
WAF: Water Authority of Fiji
DOF: Department of Forest
Rep1: Detailed Planning Survey for The Project for The Planning of The Nadi River Flood Control Structures

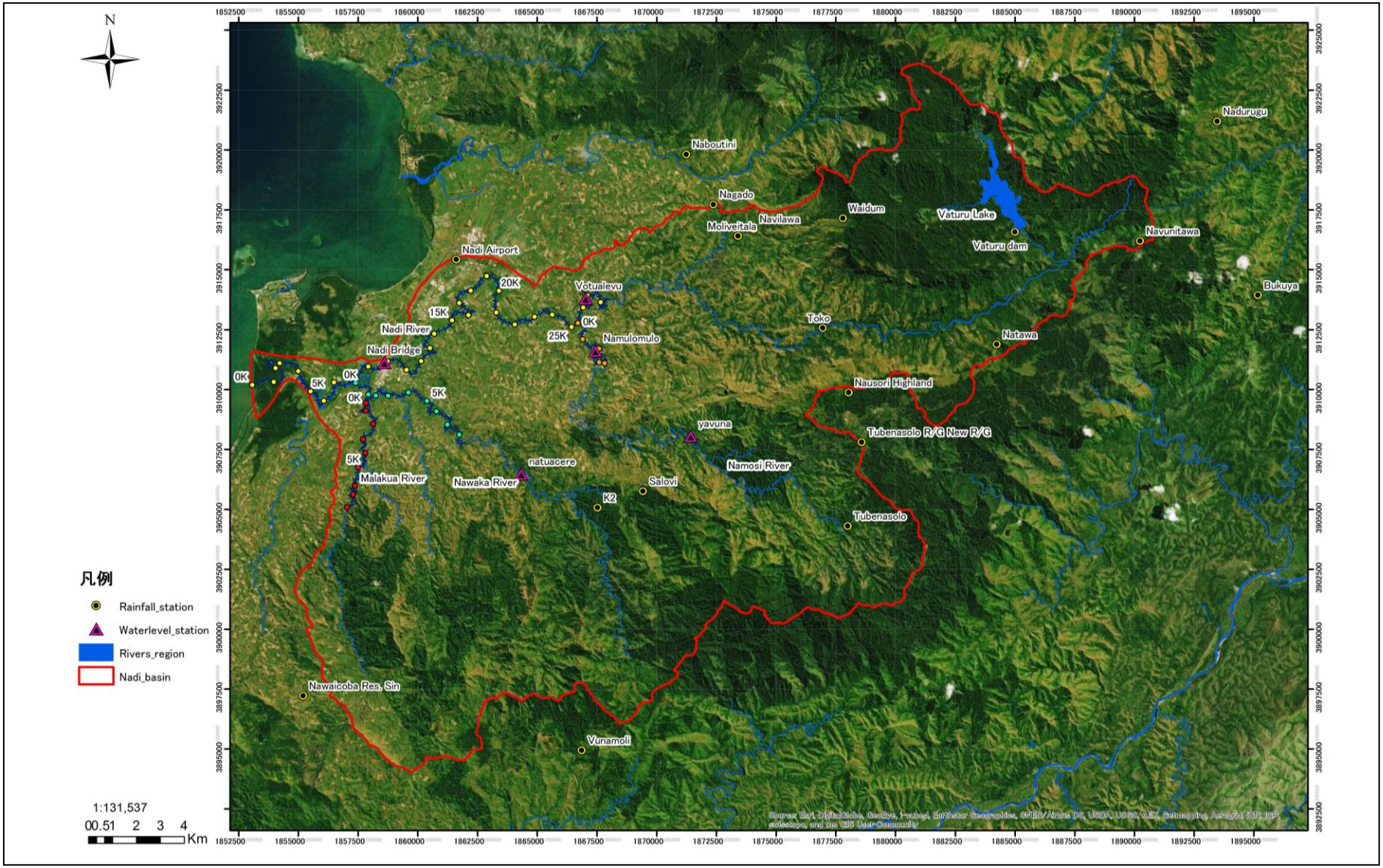


Figure 2-10 Locations of rainfall and water level observatories'

2.5 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 2-2 Main Disaster related to Flood in Fiji (1870-2012)

Year	Month	Date	Disaster[1)]	Number of Deaths (Person)	Human Affected Population (Person)	Estimated 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 Deaths (Person)	Human Affected Population (Person)	Estimated Damaged (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		
	Mar	16-17	TC Hina	3	6,000	
1986	Apr	10-11	TC Martin		5,600	
	Dec	N/A	TC Rajah	1	3,000	14,000,000
1989	Feb	9-15	TD	9		
	May	28-30	TD			
1990	May	21-22	TC Rae	3		26,200,000
	Nov	27-28	TC Sina			approximately F$33million (World Bank, 2000)
1992	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
	Oct	21-23	LP			
2002	Feb	23-24	TD			
	Mar	7-11	SPCZ			
2003	Jan	14	TC Ami	19		22,089,200
	Mar	13-14	TC Eseta			
2004	Feb	6-14	TD			
	April	7-8	TD	12		11,585,392
2005	April	18-20	N/A			
	Oct	26-30	N/A			
2006	Jan	28-29	TC Jim, SPCZ	4	1,049	FJD 26,952.26
	Feb	4	TC Jim, SPCZ	1		
2007	Feb	4-12	TD	0		FJD 2,985,989.00
	Mar	9-14	LP	3		FJD 695,327.00
	Mar	20-25	LP			
	Apr	4-5	TC Cliff	1		
2008	Jan	3	TD	1		
	Jan	28-30	TD, TC Gene			FJD 43,532,149.70 (Estimation)
	Feb	25	SPCZ			
2009	Jan	7-14	SPCZ,TD	11	146,725	FJD 112,990,000
	Jan	28-29	TC Hettie			
	Dec	14-15	TC Mick	3	148,947	31,025,851.61
2010	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:「Summarry of Major Disaster in Fiji 1985-March2010: NDMO」及び「Flooding in the Fiji islands between 1840 and 2009: Simon MCGREE, Stephhen 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 Pacfic Convergence Zone

2.6 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.

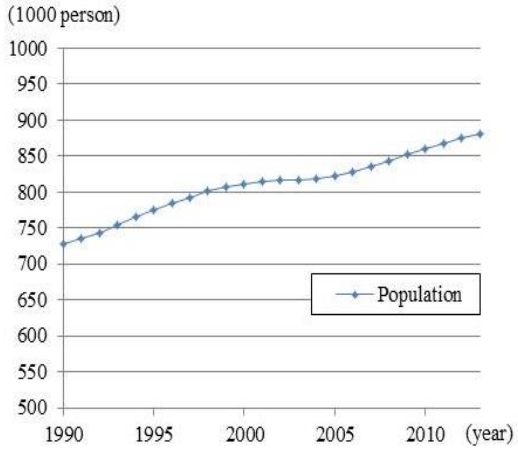
In AR5, the main risks, subject of adaptation and view in small islands of developing states including Fiji were indicated as follows.

- ✓ 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.

Chapter 3 Social and Economic Conditions

3.1 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 the2007 racial composition in Fiji is as followers.57% Fijian (consist of Melanesian and Polynesian), 38 of Indian and 5% of others. As Figure 3-1 shows the population of Fiji is increasing. In 2013, the population had reached 120% of 1990.



Source: United Nations Statistics Division

Figure 3-1 Population Trends of Fiji

The population and the numbers of households in the Nadi River Basin are shown in Table 3-1 based on the Fiji census 2007. The population of the Nadi River Basin is 70 thousand. As shown in Table 3-3, residents are not concentrating in Nadi Town and widely dispersed in the vicinities and peri-Urban Areas.

Table 3-1 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 3-2 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	

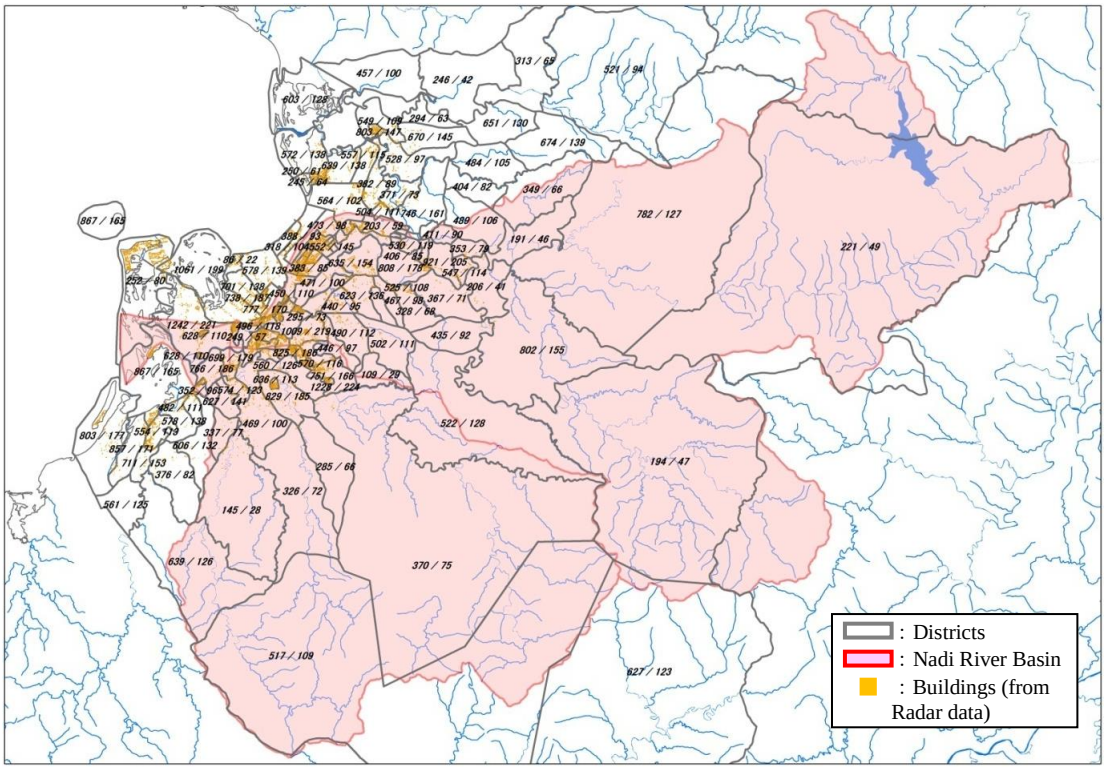
Source: Fiji Statistic Bureau, 1.4 Populations of Towns and Urban Areas by Ethnic Origin and Sex on 16 September 2007[p]

Trends of population in Nadi River Basin and vicinities are shown in Table 3-3 similar to the national trend, the population of the area is increasing.

Table 3-3 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

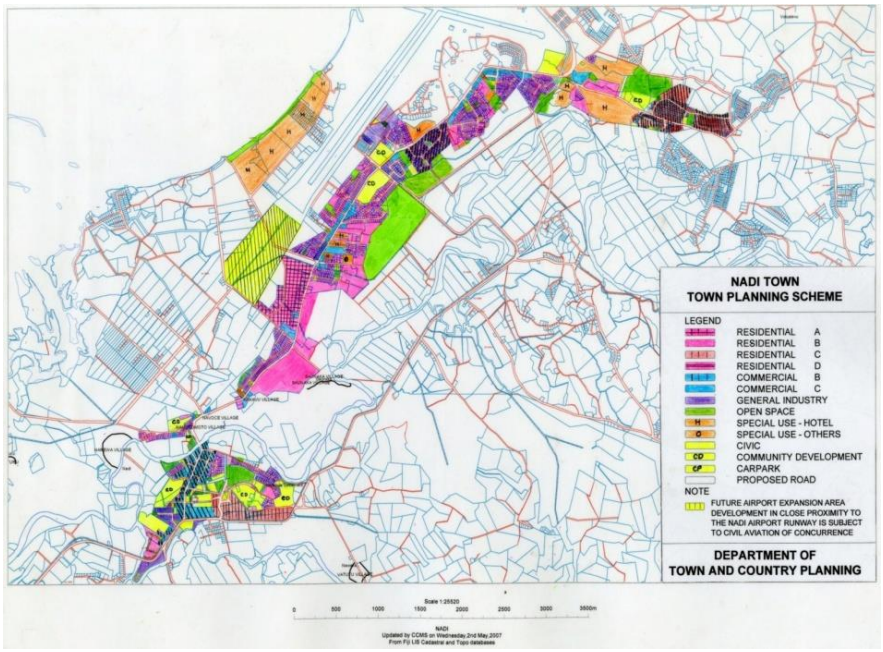


Source: Fiji Statistic Bureau GIS data (Nadi Basin_Pop_HH.DAT)

Figure 3-2 Population and Number of Households in Nadi River Basin (Numbers on the map shows "Population / number of households")

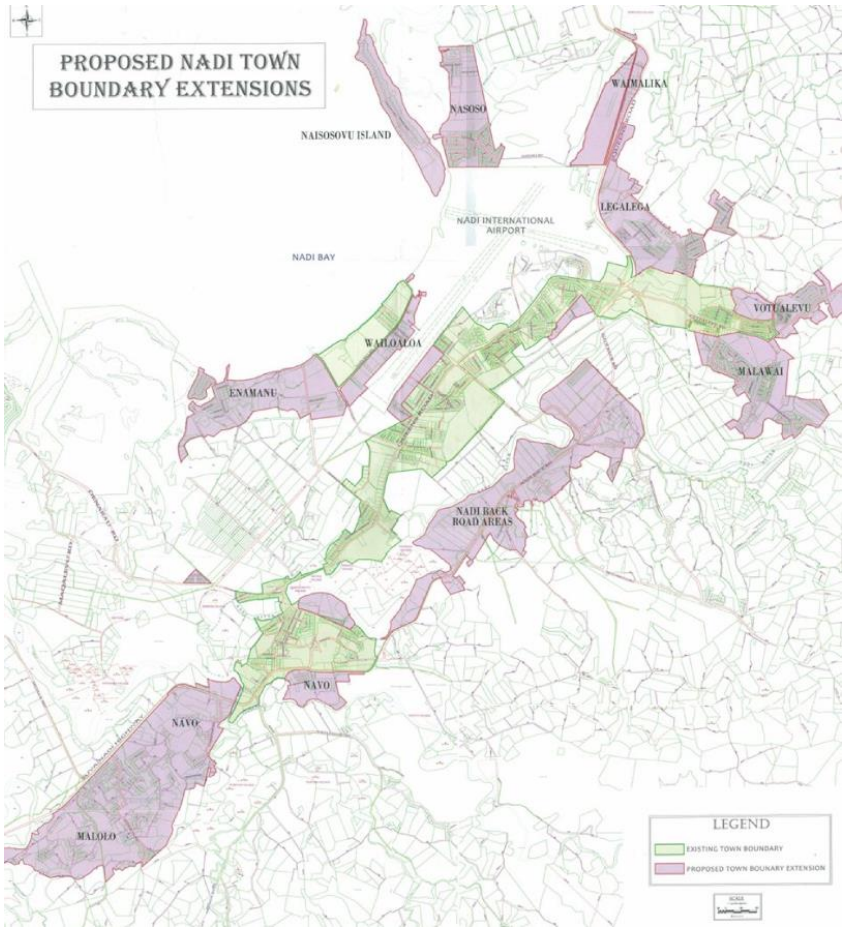
3.2 Urban Area

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 3-3. In addition, NTC has the plan to expand the boundaries. The proposed area of expansion is shown in Figure 3-4.



Source: Nadi Town Council

Figure 3-3 Nadi Town Area by Nadi Town Planning Scheme



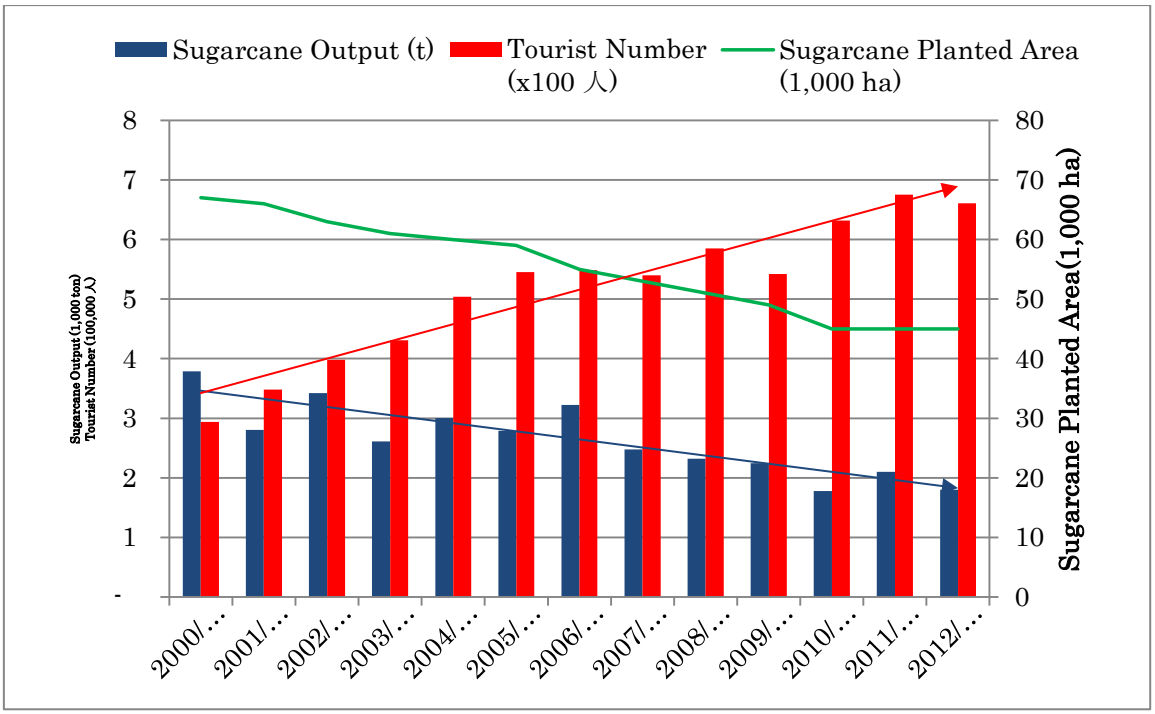
Source: Nadi Town Council

Figure 3-4 Proposed Nadi Town Boundary Expansions

3.3 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 3-5 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 3-5 Trends of Number of Tourist and Production of Sugar

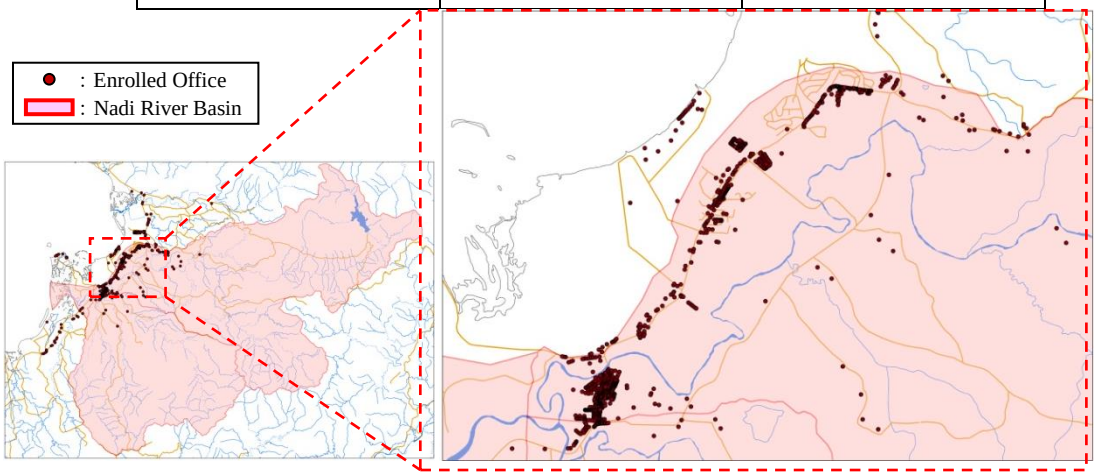
The industries in the Nadi River Basin accept the primary industry, summarized in employment statistics in 2012. The number of business is shown in Table 3-4.

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 3-4 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 3-6 Number of Businesses in the Nadi River Basin

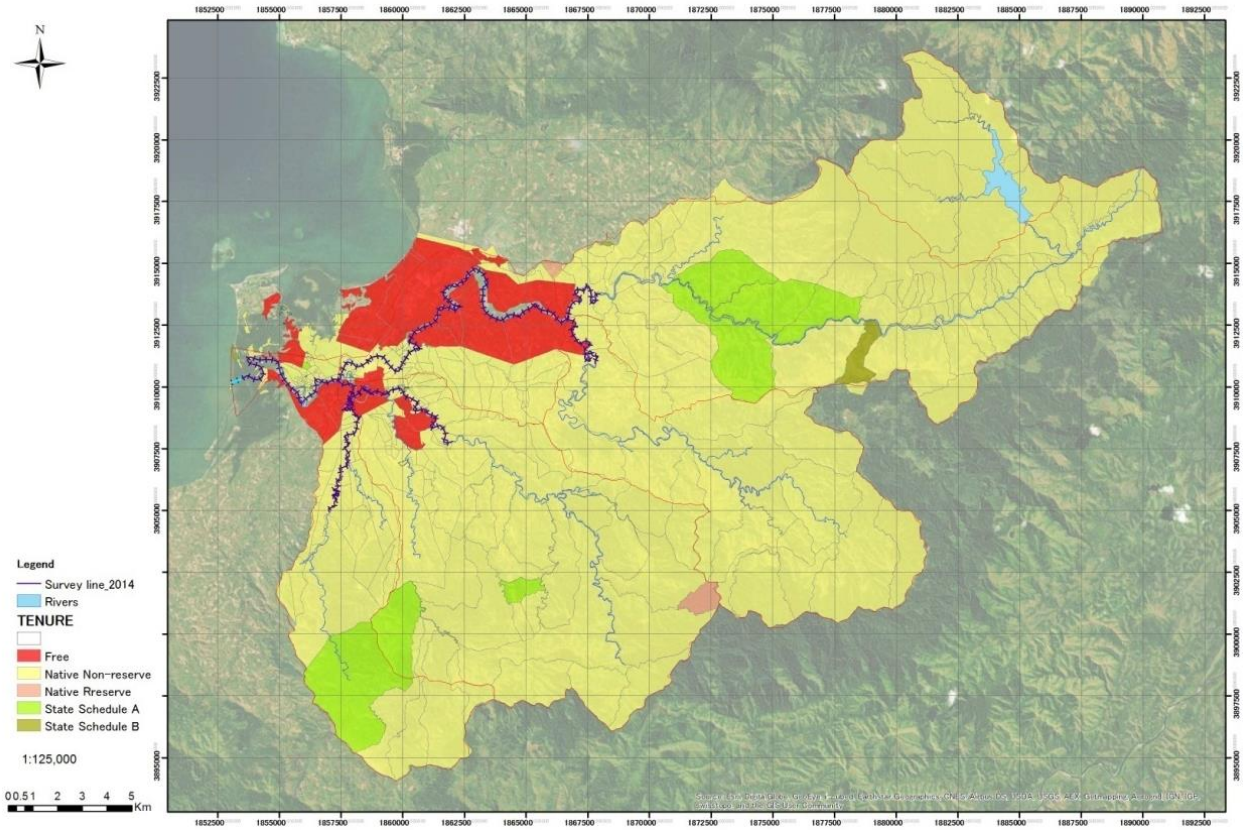
3.4 Land Ownership

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 3-5 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 3-7 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.

3.5 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 3-6 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 3-7 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 3-8 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 3-9 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"

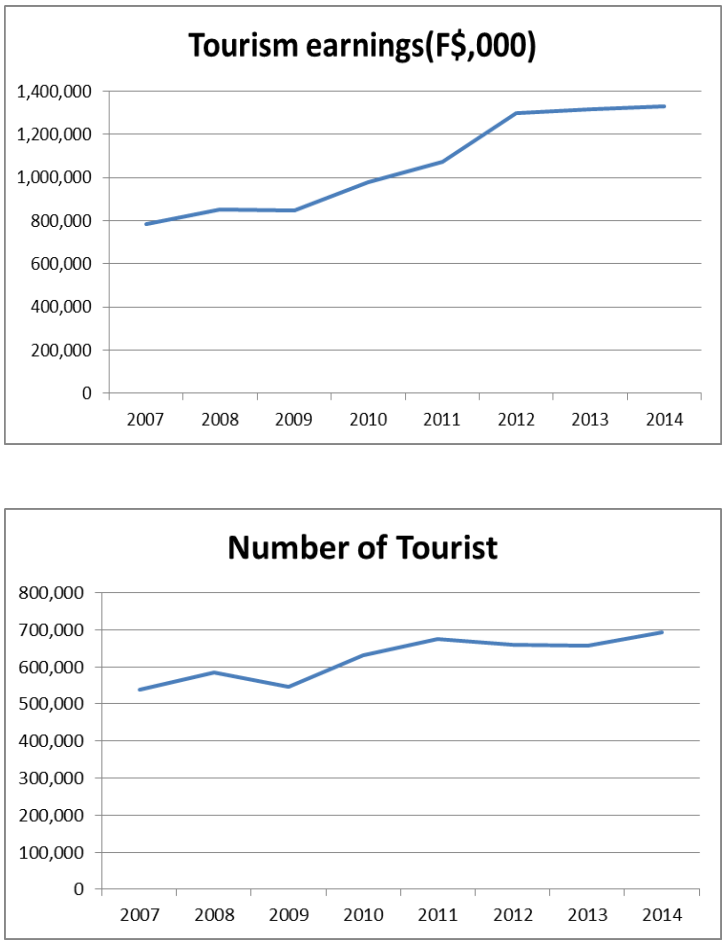
(2) Economic Situation in Nadi Area

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 3-10 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 3-8 Transition of Tourism Earnings and Number of Tourist in Fiji

3.6 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 3-11 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$,000)	292,367	157,709	257,539	135,454	(76,529)	(228,975)
Surplus/Debt ratio of GDP	6.2%	3.3%	5.1%	2.5%	-1.4%	-3.8%
Governmnet Total Debt(F$, 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 3-12 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 3-13 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 Estimates2014, 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 3-14 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)

Chapter 4 Government Organization and Legal System

4.1 Legal Framework and Policy

4.1.1 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.

4.1.2 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 raw 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.

4.1.3 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 4-1 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.

4.1.4 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

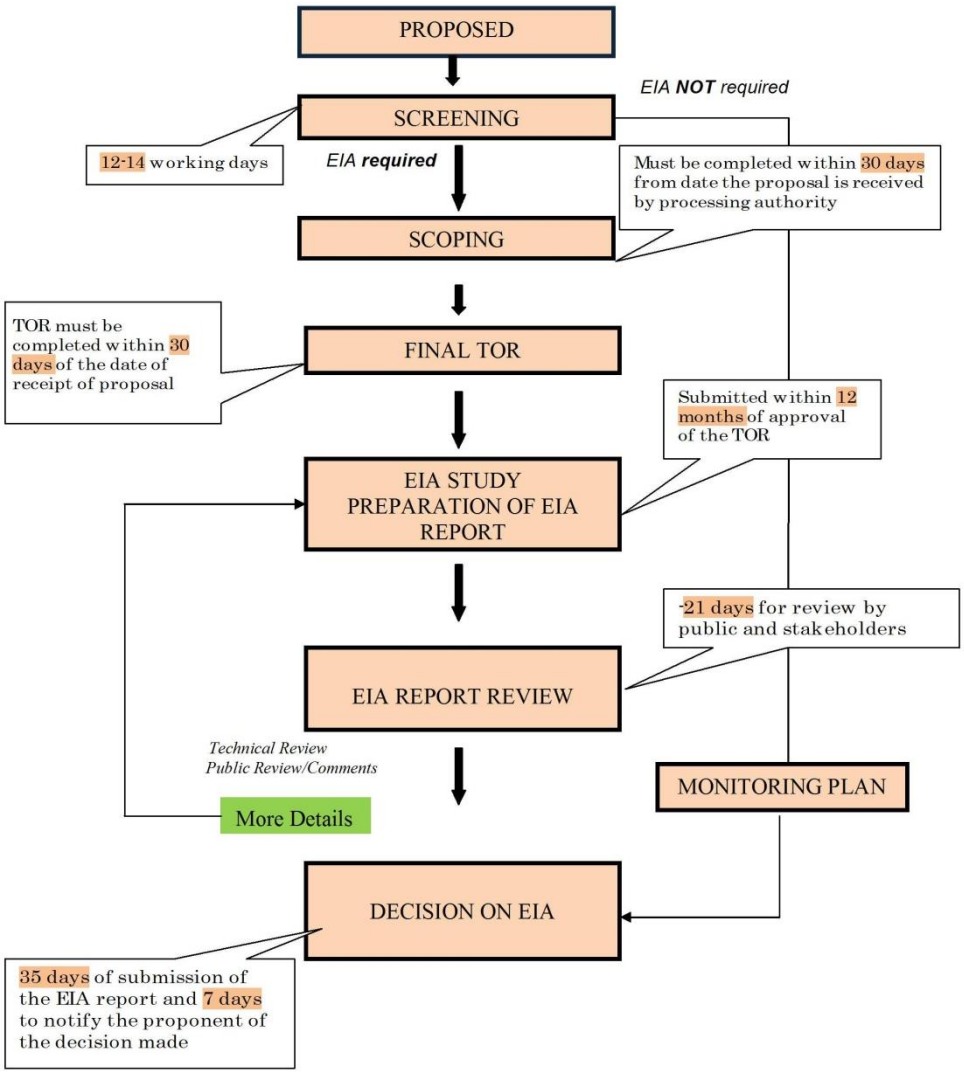
Environment, DOE.

For regulation of this law, Environment Management (EIA Process) Regulations 2007 and Environment Management (Waste Disposal & Recycling) Regulations2007 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 4-1.



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

Figure 4-1 EIA Process in Fiji

4.2 Government Organization and Structure

4.2.1 The Ministries and Departments of the Fiji Government

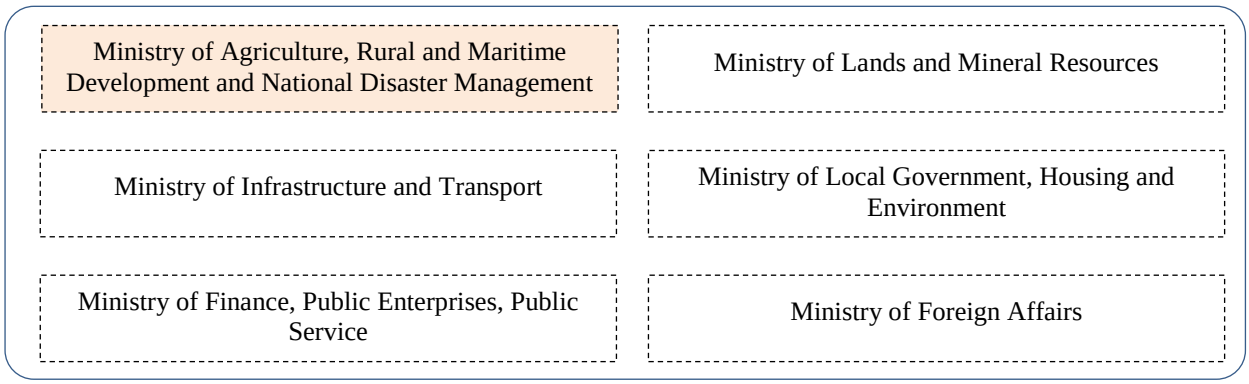
The Government of Fiji consists of 17 ministries and department, including the Prime Minister's Office. The list of the ministries as of 2014 is shown in Table4-2.

Table 4-2 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

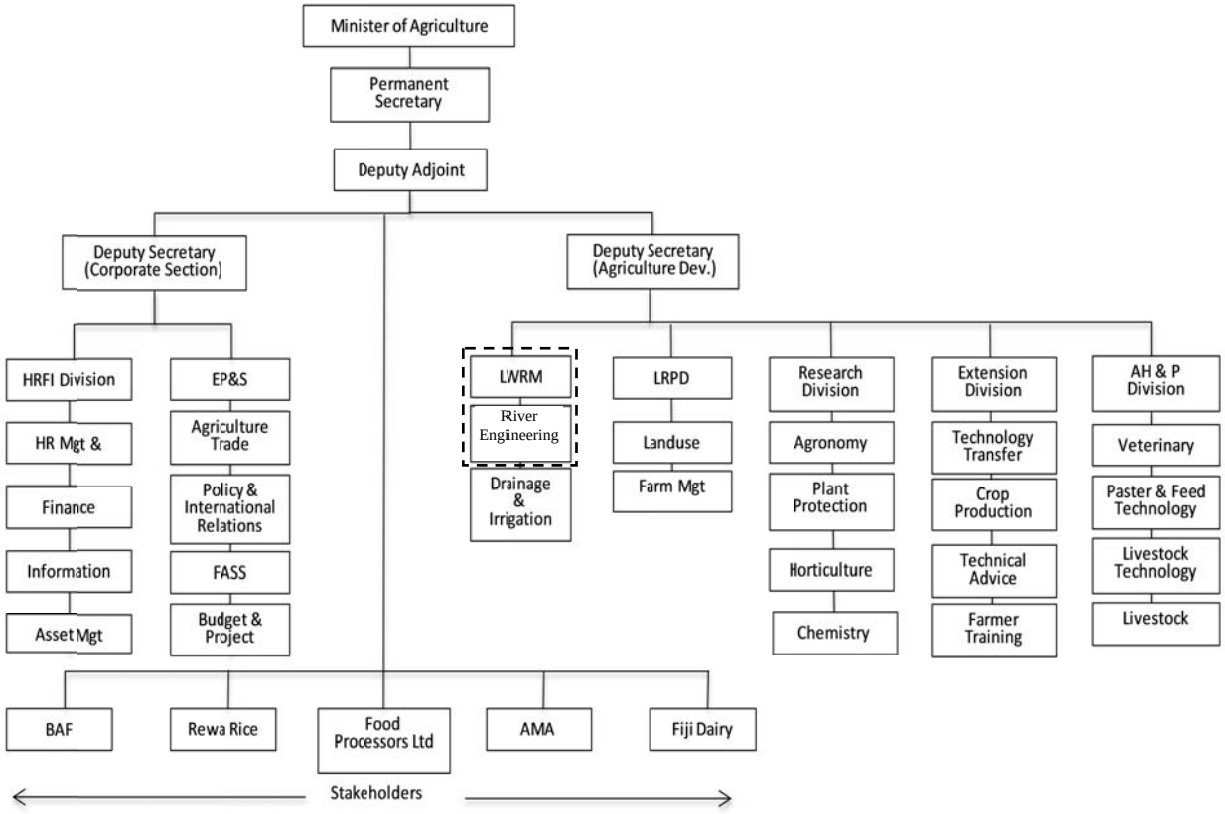
Note: Counterpart Ministry for the Study Team

Figure 4-2 Ministries related to Flood Control in Fiji

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

(1) Organizational Structure

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 4-3 Organizational Structure of Agriculture Section

A) 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

B) 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 4-3 Key Functions of Divisions in the Ministry

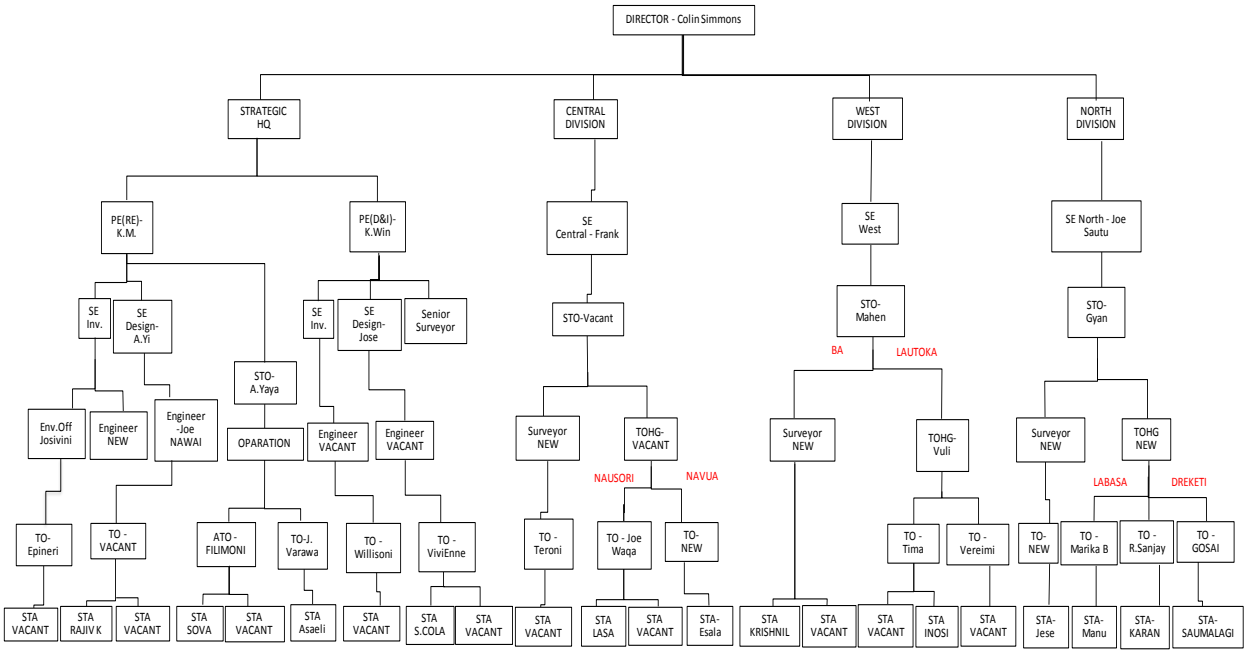
Division	Functions
Economic Planning & Statistics	● Formulate the agricultural sectors development policies with appropriate strategies and subsequent program activities in accordance with the government strategic plan ● Conduct marketing research on market opportunities and facilitate the private sector 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	● 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.	● 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

C) 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 4-4 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.

D) 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.

(2) 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.

i. Watershed Management Project

This project has being 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 4-4 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 km²	Constructed in 2006
	Namosi II Dam	—	—	Under construction in February, 2015
Nawaka River	Vaturu Dam	6 km Upstream from confluence with Nadi River	94.51km²	Constructed in 2009
	Taci Dam	11 km Upstream from confluence with Nadi River	69.77 km²	Constructed in 2010
	NawakaⅢ3 Dam	16 km Upstream from confluence with Nadi River	30.9 km²	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 m²	Under planning

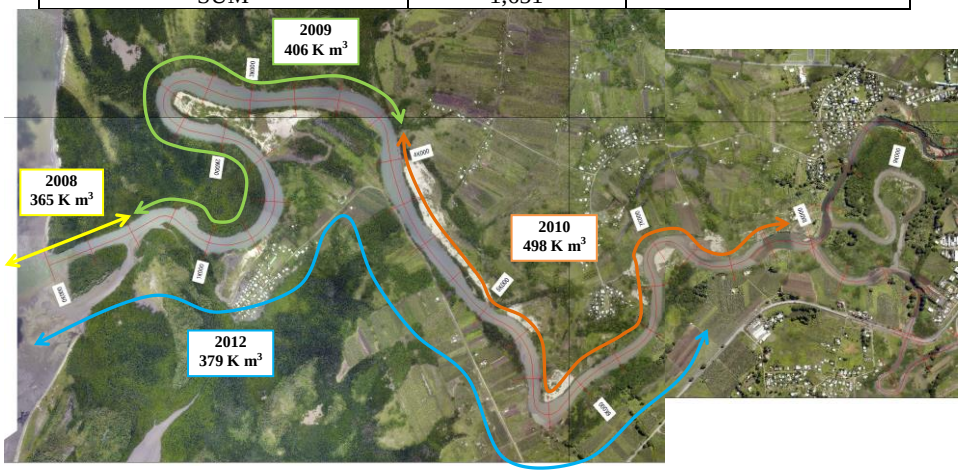
Source: Medium Term Capital Expenditure Programme, 2015

ii. River Dredging Project

River dredging had been conducted from 2008 to 2012 in Nadi River estuary and 1,651thousand m^3 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 4-5 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

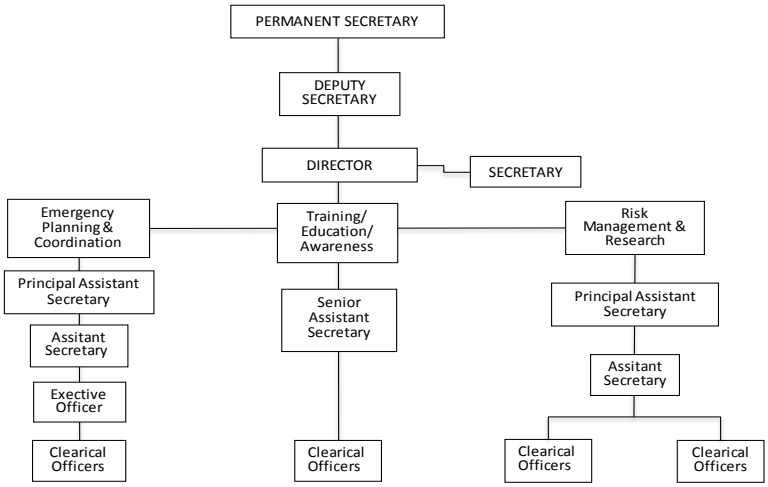
Figure 4-5 Area of River Dredging

4.2.3 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.

(1) 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.

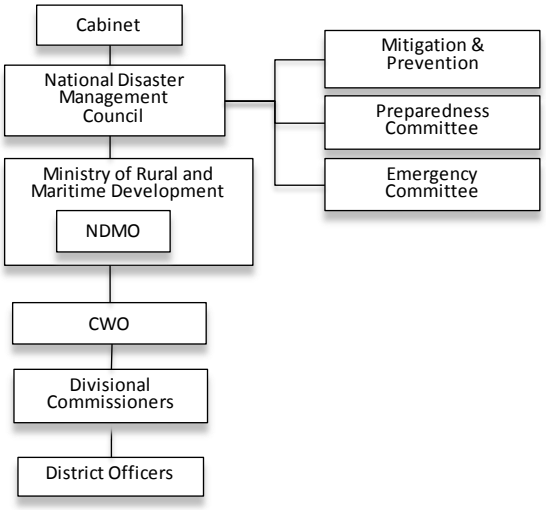


Source: National Disaster Management Plan, National Disaster Management Council and Government Agencies, 1995

Figure 4-6 Organizational Structure of NDMO

(2) Organizational Structure of National Disaster Management

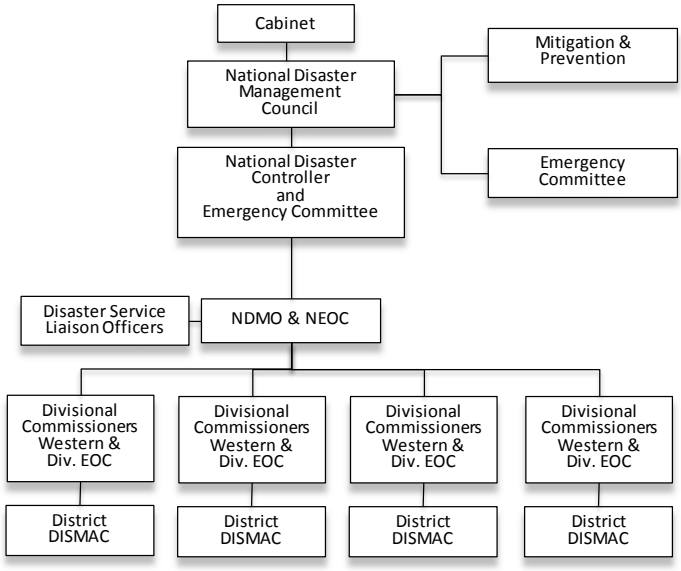
The Fijian Government has established an institutional structure to respond to disasters in accordance with National Disaster Management Plan 1995. There is a permanent structure as well as a structure which is activated during emergency operations. These two structures are illustrated in the following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



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

Figure 4-7 Permanent Bodies of the Disaster Management Structure

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



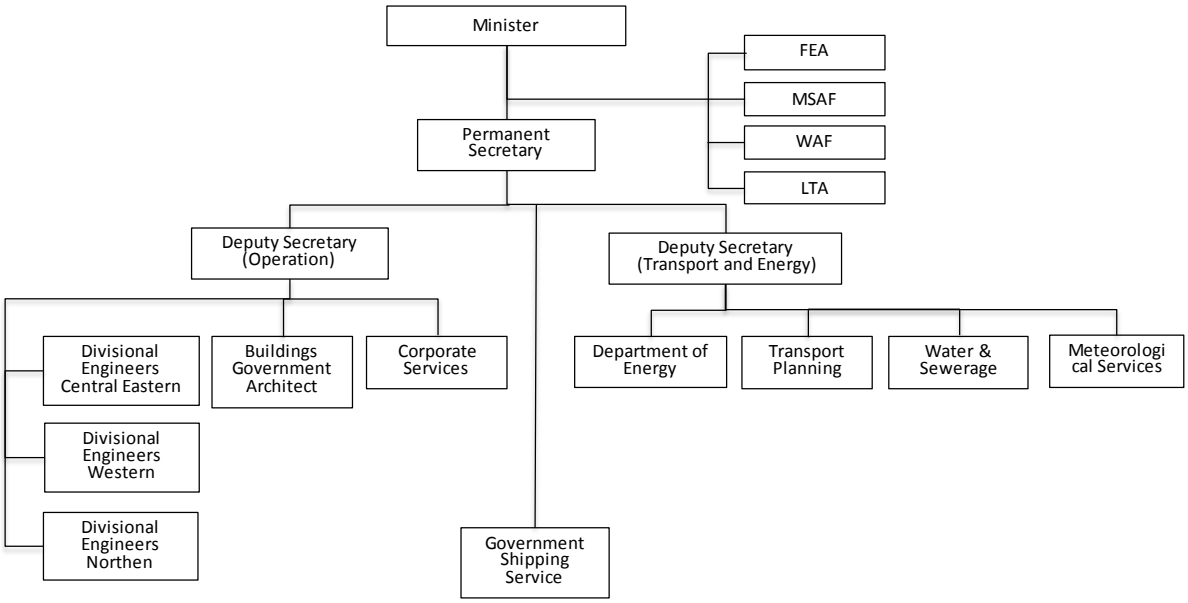
Source: National Disaster Management Plan, National Disaster Management Council and Government Agencies, 1995

Figure 4-8 Disaster Management Structure for Emergency Operation

4.2.4 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 4-9 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.

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.

Chapter 5 Upper Level Plan, Plans Related to Flood Control

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

5.1.1 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 spiritualties and interfaith dialogue.

(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.

(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 this framework.

5.1.2 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.

5.1.3 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.

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.

5.2 River Management Plan

Cutoff cannel 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.

5.3 Related Project

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

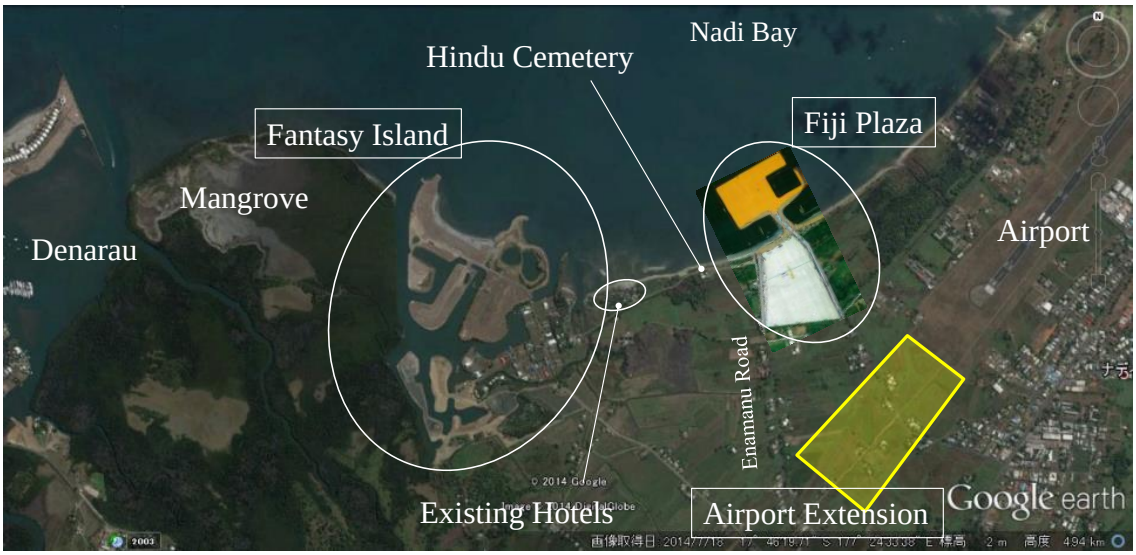
The plan of new four-lane by-pass road from airport to Denarau and Queens Road improvement were was underway. The by-pass road was being implemented by the Fiji Road Authority (FRA), and a private company in China was constructing it. The Alignment of the by-pass road was planned considering the extension 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 5-1 Route Map of the Whole Road Project

5.3.2 Runway Extension Plan of Nadi International Airport

There was plan to expand Nadi Airport and extend the existing runway toward west part. The Project area is shown in figure below.



Source: Prepared by the project team

Figure 5-2 Location Map of Development Plan near Nadi Bay

5.3.3 Resort Development Project in Coastal Area in Nadi Bay and Fantasy Island Project

Resort development projects such as casino and hotel buildings were underway in Denarau area, coastal area of Nadi Town. Besides, Fantasy Island Area in Nadi Bay, hotels facing toward the bay and marinas were being built. Fiji Plaza Project was examined by a private-sector in Nadi Bay and stakeholder conference on this site was held but EIA was not conducted (as of January, 2015) and project development was not approved. It is necessary to pay attention to these projects because there is possibility of establishing outlet in Nadi Bay for drainage canal which is one of flood control measures.

The following figure shows the location map of Fantasy Island and Fiji Plaza with their plans.

Source: Fantasy Company Fiji Ltd.

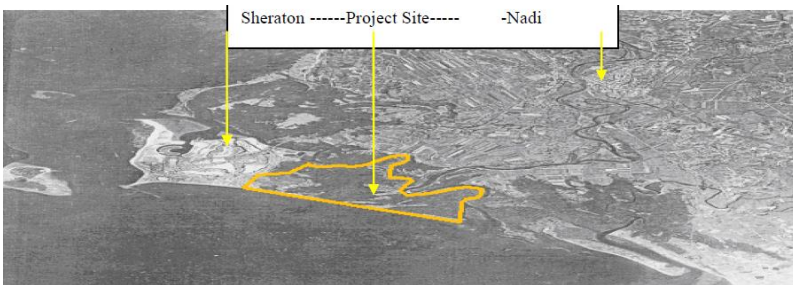
Source: Fiji Plaza Ltd. Sharma Design Group

Figure 5-3 Fantasy Island Development Project, Fiji Plaza Development Project (Non Approved)

5.3.4 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

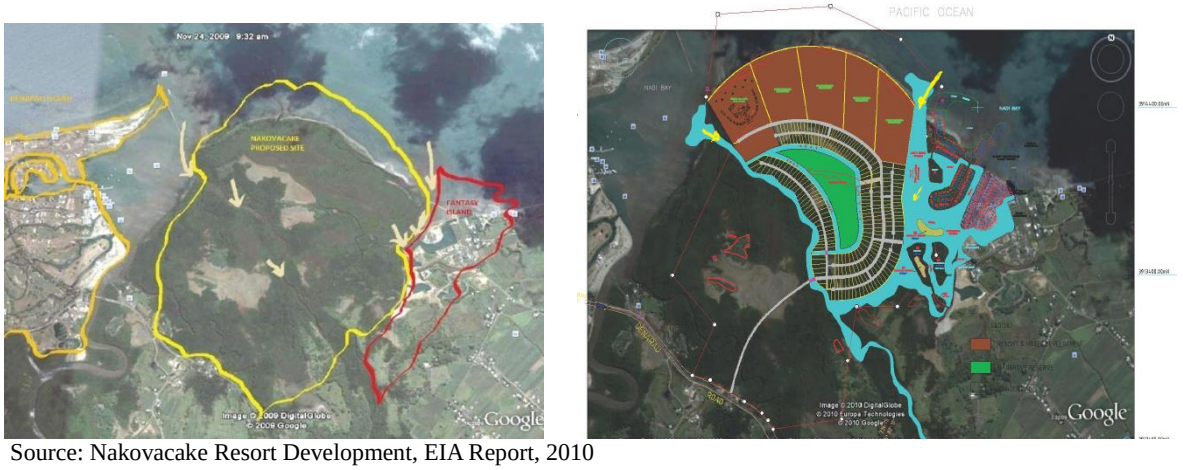
Figure 5-4 Location Map of Denarau Tourism & Hospitality Development

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

Figure 5-5 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.

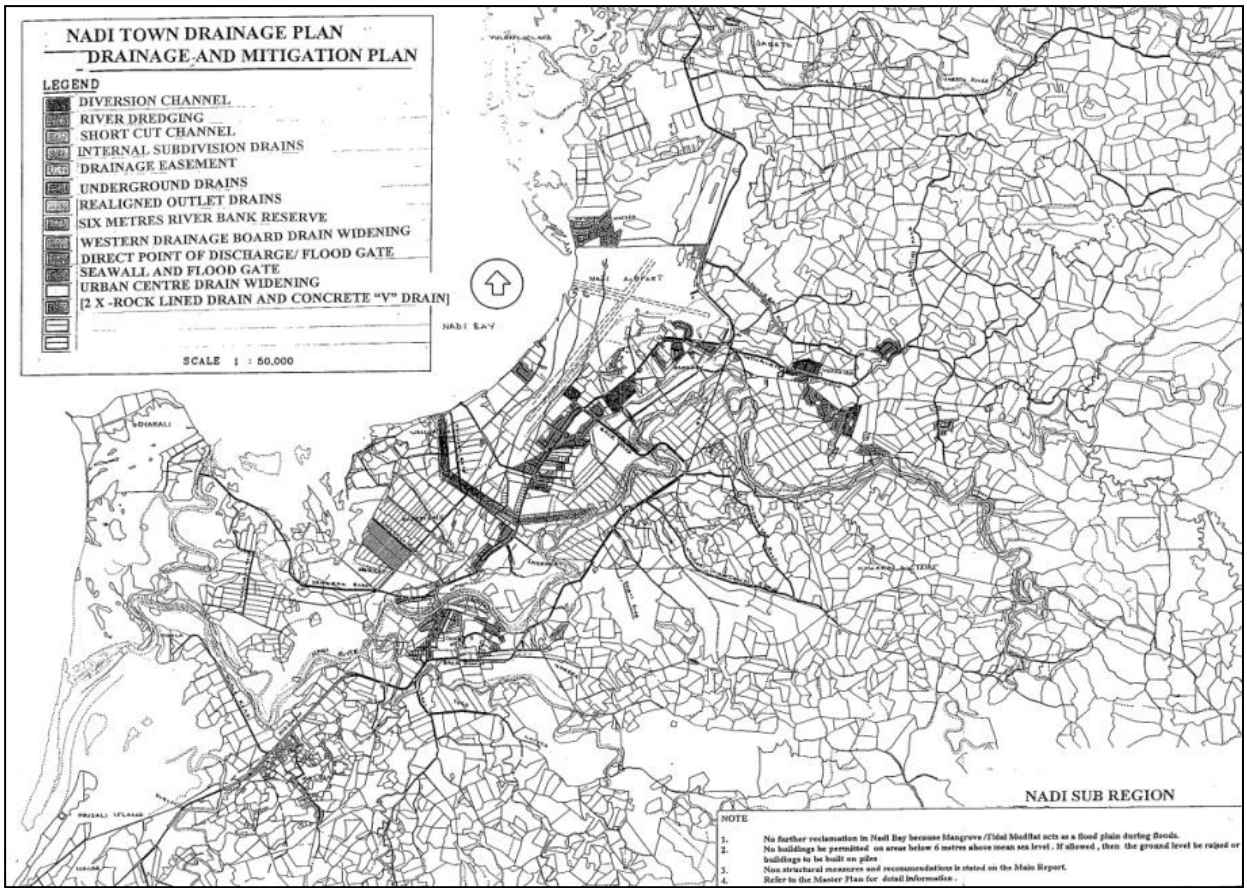


Source: Nakovacake Resort Development, EIA Report, 2010

Figure 5-6 Location Map and Development Outline of Nakovacake Resort Development

5.3.5 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.



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

Figure 5-7 Nadi Town Drainage Plan (2000-8)

5.3.6 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.

Chapter 6 Summary of Present Conditions and Issues of Flood Control and Basin Management in Nadi River

6.1 Summary of Present Conditions and Issues of Flood Control and Basin Management in Nadi River

6.1.1 Summary of Present Conditions and Issues of Flood Control and Basin Management in Nadi River

(1) State and Problems of Flood Control

A) Flood Control Plan

Cutoff cannel 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.

- ✓ Systematical flood control plan considering whole river basin and flood control facilities have not been established yet. Therefore, comprehensive flood control plan using both structural measures, such as dam, retarding basin, river improvement and diversion channel, and non-structural measures is required.
- ✓ Although the diversion channel and river channel short cut were proposed in the JICA Study in 1998 in the Nadi River, revision of flood control measures including the review of design scale is an urgent need, because the large-scale floods both in the Nadi River and in the tributaries occurred since 1998.
- ✓ Own design standards / criteria and guideline of flood control planning are not established in Fiji. It is required to refer to certain technical standards to develop a flood control plan. The characteristics of river basin and river course in Fiji and Japan are considered to be similar since both Fiji and Japan are the island countries, and the rivers are flowing from the mountains and flow through low-lying land to the sea in a short time, and the flood / runoff characteristics is also considered to be similar. Therefore, Japanese guidelines, such as "The Japanese Ministry of Land, Infrastructure, Transport and Tourism, Technical Criteria for River Works: Practical Guide for Planning and Survey" and "Handbook for Examination of River Planning" and so on can be utilized as a reference to develop a flood control plan.
- ✓ In the future, development of own guideline or technical standard for flood control planning in Fiji and training and capacity development of river engineer will be desired

B) Design of Flood Control Structures

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. Same as flood control planning, own design standards / criteria and guideline of flood control facilities are not established in Fiji.
- ✓ Under this situation, since the river channel characteristics of Fiji and Japan are similar and the technology and knowledge for designing, such as hydrology, physics, geo-technique, river engineering,

and concrete technology and so on are universal, design criteria of Japan can be utilized same as flood control plan. Therefore, Japanese guidelines, such as "Government Ordinance for Structural Standard for River Administration Facilities" and "The Japanese Ministry of Land, Infrastructure, Transport and Tourism, Technical Criteria for River Works: Practical Guide for Designing" and so on will be utilized as a reference for designing.

- ✓ Regarding as flood control structural measures in Nadi River Basin, such as excavation, embankment, revetment, dam, retarding basin, and diversion channel are considered as the flood control facilities to be designed at the moment, but the certain facilities will be selected in the M/P and priority project. Here, main design items and basic concept for design criteria regarding river works in the Nadi River basin are described in Appendix-5. Even though, the content in Appendix-5 is a draft and it will be revised in line with progression of project.
- ✓ In the future, development of own guideline or technical standard for design of flood control facilities in Fiji and training and capacity development of river engineer will be desired. In addition, it is important to keep the design documents and review them later.

C) Construction of Flood Control Structures

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.

- ✓ Same as flood control planning and design, own design standards / criteria and guideline of construction are not established in Fiji. Therefore, same as flood control planning, Japanese guidelines for constructions will be utilized as a reference. On the other hand, it is important to consider Fiji's local construction conditions such as rainy season and working conditions.
- ✓ In the future, development of own guideline or technical standard for design of construction in Fiji and training and capacity development of engineer will be desired.

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

- ✓ Same as flood control planning, design, and construction, own design standards / criteria and guideline of operation and maintenance of flood control facilities are not established in Fiji.
- ✓ In addition, operation and maintenance such as periodical inspections and rehabilitation works after damaged are not implemented enough because of budget problem and lack of number of engineers. Therefore, establishment of operation and maintenance system will be urgently required.
- ✓ Under above situation, it is required for C/P to understand importance of operation and maintenance of flood control facilities such as retarding basin and dikes, and establishment of operation and maintenance system included in flood control master plan as one of non-structural flood control measures.

(2) Present Conditions and Issues of Water Use

Present water use in the Nadi River Basin is mainly for drinking and Vaturu dam, located upstream of the Nadi River is the only source for the water supply in the basin, and groundwater is not used. Irrigation system and water intake for irrigation are not existed since the agriculture land uses only rain water in the

Nadi River Basin. Moreover, there is no large-scale of water use of industrial water use.

WAF is the administrator of water supply and has been established in 2007 as a government corporation by Fiji government. The main purpose of WAF is providing access to good quality drinking water and waste water services. WAF secures water resources during and after disasters as a part of flood disaster counter measures even though, WAF does not play an important role in the disaster prevention. On the other hand, utilization of multipurpose dam is now being examined, and the flood control is considered as one of the purposes. Moreover, Water Supply Scheme Master Plan 2013-2033 (Draft) is currently under development by WAF.

- ✓ River water is used not only for daily life water, such as drinking water, but also for agriculture and fishery. Therefore, preserving river water quality and discharge and water use management to prevent illegal use of river water is required.
- ✓ Presently Fiji has some agencies responsible for the water sectors, but there is no agency responsible for integrated water resources management (IWRM). An organization vested with the authority and responsibility to carry out IWRM is, therefore, recommended to be established.

(3) **Environment**

Mangrove grows thickly near the Nadi River mouth and it contributes to the diversity of ecosystems, such as a habitat for fishes and mud crab, and sugar cane and grass field spread in the basin create good natural environment. And a part of the upstream of Nadi River (Nausori High land) is designated as conservation area

The information of natural environment in the Nadi river Basin is limited. Only appeared in existing EIA reports, fish inventory research. There is no continuity monitoring activities of water or air pollutions.

- ✓ Preserving natural riches of river environment and great scenery of river is one of the important topics the of river management.
- ✓ Flood discharge and sediment movement situation to the coastal area will change depending on the flood control facilities, and it might cause the decrease of mangrove, coastal erosion and sedimentation and so on. Therefore, comprehensive understanding of the sediment management from the source of sediment to coastal area, impact assessment, and examination of mitigation measures have to be considered at the stage of selection of flood control measures.
- ✓ Moreover, coastal area has been developed as a resort area, such as Denarau Island, since 1980s and land issues, such as Native Land issue are typical problems in Fiji particularly in the basin. Furthermore, there is a regional development planning, such as Nadi Town Scheme in the region. Considering the above issues, environmental and social impacts caused by the flood control plan / facilities should be examined based on the concept of "Strategic Environmental Assessment (EIA)", which will examine the alternative solutions from the early stage of planning. Moreover, EIA process should be in line with the legal system of Fiji and it should be conducted at the stage of execution of priority projects.

6.1.2 Present Conditions and Issues of Legal System and Policy

Political framework of natural disaster management in Fiji has been established for around 20 years. The main purpose of the framework is not disaster prevention or disaster risk reduction but disaster response. The policy which was made by Fiji government contributed to the improvement of the institutional capacity and to the establishment of bases for administrative functions for disaster response through establishment of NDMO and other institutional mechanism.

On the other hand, dramatic change of climate pattern, which is happening in the world, affects by not only increasing the sea level, but also by causing huge cyclone, and the climate change coupled with recent urbanization is viewed as a direct threat to the Pacific countries. The international society also points out the necessity to move from disaster response to disaster prevention.

- ✓ Even though disaster risk reduction is mentioned in the political documents, implementation of flood control measures is not positive response but rather passive response. Disaster prevention and risk reduction should be given more importance in the framework of flood control, and both social and

engineering approaches for disaster prevention and risk reduction are required.

- ✓ There is no legal framework / system for technical concept, such as retarding basin and diversion channel in Fiji, since flood control measures targeting the entire river basin have not been implemented before. Detail regulations / concepts for flood control facilities such as retarding basin and so on should be examined in cooperation with Fiji government in order to implement the flood control measures which will be proposed in this project.
- ✓ Regular process for land acquisition will be applied even for the lands which will be affected by river works and construction of diversion channel and so on, like other public works. Land acquisition and its process are required.
- ✓ The act and the plan regarding national disaster management will be revised considering climate change and occurrence of disasters. NDMC decided the revision of Natural Disaster Management Act in 2015. Since the National Land Act is also under discussion for revision, the revised contents have to be reflected in the river management project at the stage of implementation.

6.1.3 Present Conditions and Issues of Institution and Structure

Even though each organization's division of duties specifies the approach to disaster response and they are making efforts to prevent the disaster, there is no organization responsible for the reduction of the flood disaster risk considering the entire river basin and for implementing a comprehensive river management for flood prevention at the moment. Therefore, an institution or an organization which can implement integrated river management is required to be established in the future.

- ✓ Institutional mechanism which enables a comprehensive river and river basin management aiming at flood disaster risk reduction and integrated flood control is required.
- ✓ Capacity building of planning, designing, construction planning, and operation and maintenance of flood control facilities in order to implement the planning of flood disaster risk reduction and flood control measures is required.
- ✓ As for implementation of river basin and river management, comprehensive approach including hydrological and meteorological data acquisition, land issue and civil engineering work is required and cooperation with FMS is important. Moreover, present organizational structure of LWRM puts emphasis on "Reduction of flood which poses a risk for agricultural crops, livestock, property and human life". Therefore, improvement of manpower resources and technical knowledge related to flood prevention are necessary for implementation of comprehensive river basin and river management.
- ✓ Present disaster prevention measure focuses on emergency response and disaster response, and disaster prevention and disaster risk reduction are not emphasized. Therefore, disaster prevention and disaster risk reduction should be emphasized and mainstreamed in each plan and policy, and development of organization / structure to take the lead in disaster prevention is required.

6.2 Present Conditions and Issues of Flood Control Measures in Nadi River Basin

6.2.1 Present Conditions and Issues of Flood Control Structures

Systematical flood control plan considering the whole river basin and flood control facilities have not been established in the Nadi River Basin, and only local protection work to protect village and agricultural land and small-scale retention dam have been established.

- ✓ Rainfall, runoff and flood should be analyzed based on scientific basis to understand the flood characteristics in the basin at the beginning, and then a comprehensive flood control plan should be developed. Examination of flood control measures / facilities considering priority protection area, safety level of flood control, priority level of construction section and its feasibility is required in the second place. Moreover, since completion of structural measure needs long period of designing and construction and so on, it is important to utilize / implement non-structural measures to supplement the lack of structural measures.
- ✓ The main study items required to consider structural measures are shown below.

- Rainfall analysis, run-off and flood analysis and evaluation of flow capacity based on scientific evidence.
- Planning of design scale, setting of design rainfall, examination of flood discharge
- Planning of design reference point, setting of important protected area
- Study of flood control measures, optimal combination of flood control measures
- Flood control planning and river channel planning
- Stage development plans and annual plans, etc.

6.2.2 Present Conditions and Issues of Non-Structural Measures

A lot of projects regarding strengthening of institutional capacity, disaster prevention training and education, and community-based disaster prevention are conducted by international aid agencies as a non-structural measures. Even though these projects are conducted relatively well, they are conducted sporadically and have challenges of continuity.

- ✓ On the other hand, development of hydrological observation network, flood forecast based on technical and analytical methods, and establishment of early warning system and information dissemination system are not focused on compared to the capacity building projects mentioned above. Since development of hydrological observation network and results of flood forecast and so on will be utilized as fundamental information in order to issue flood warnings and to judge the necessity of evacuation, it is important to utilize / implement non-structural measures to supplement the lack of structural measures.
- ✓ As for non-structural measures, 6 measures described below are considered as the assumed characteristic measures in the Nadi River basin.
  - Development of regional disaster management plan
  - Development of flood hazard map
  - Implementation of disaster prevention education and training
  - Regulation of land use
  - Early warning system
  - Flood damage analysis

6.3 Present Situation and Issues on Water Resources

6.3.1 Present Situation of Water Resources

(1) Water Resources Management Facilities

The present water source of the Nadi River Basin is the Vaturu Dam located at the upper reach of the Nadi River. The water from Vaturu Dam is purified at Nagado Water Treatment Plant (WTP) and supplied to Nadi and Lautoka areas, about 100% of the domestic water of Nadi and 75% of that of Lautoka. The remaining 25% of the domestic water of Lautoka comes from the other three intakes; namely, Buabua Intake, Nalau Intake and Varaqe Intake. The supplied water amount from Vaturu Dam was reported as 83.27 ML/d in 2013.

(2) Water Resources in the Nadi River Basin

The water resources in the Nadi River Basin is comparatively blessed with the annual rainfall amount of 1,500 mm to 3,000 mm, and the water resources is utilized for domestic water, agricultural water and exportable mineral water.

Presently, Nadi urban areas depends 100% on Vaturu Dam for domestic water, and its reservoir, and groundwater is not utilized. Though there are large agricultural fields such as sugar cane (9200 ha), dry field (4,000 ha) and grazing field (9,300 ha), they are mostly rain-fed agriculture and there is no irrigation systems and irrigation intakes at national level in the Nadi River Basin. Also no large scale industrial water intakes exist.

(3) Hydropower Generation

Hydropower generation for Fiji depends on Wailoa Hydropower Station on the Wailoa River and in the upper basin of the Rewa River which takes water from Monasavu Dam. The Fiji Electricity Authority

(FEA) has a plan to conduct a study for a cascade hydropower station on the Ba River, at downstream of the existing hydropower station. Although there is a potential to develop a hydropower station in the Navua River Basin, the priority is low because of the lack of infrastructure such as access roads. There is no plan for hydropower development on the Sigatoka River and Nadi River, but there is a hydropower station built at the Nagado WTP in the Nadi River Basin.

In order to cope with the drought periods and power demands, the FEA has been developing thermal power generation facilities. The contribution of the hydropower is about 50-60%; the rest is mostly generated from thermal power. Although there is solar and wind energy generation, the contribution is less than 1%. Since the economic efficiency of thermal power generation depends on the oil price, the efficiency of thermal power generation is one of the major issues for Fiji.

(4) Water Resources Management Organization

The implementation agency was the Land and Water Resources Management Division of the Ministry of Agriculture as the leading agency in cooperated with the Department of Mineral Resources of the MLMR and the Fiji National Water Committee. NBCC (Nadi Basin Catchment Committee) was also established, but after the completion of the project, the NBCC became inactive.

As for Water Resources Management each of the water sectors like water supply/sewerage, agriculture and environment has a responsible agency, but definite agency with the sole responsibility for IWRM has not been established to date. In 2001, the Fiji National Water Committee was established as a coordination committee for water resources management, but has not been able to conduct its coordination functions because of delay of enactment of the National Water Policy. The National Water Policy is expected to be enacted within 2015.

The National Water Policy was prepared as "National Water Policy Document in 2005 (Draft) by the Mineral Resources Department (MRD). Since then it has been examined, and will be expected to be enacted as "National Water Resources Management and Sanitation Policy" within 2015. The policy is to cover surface water, groundwater, sea water and rain water as water resources and to give a policy of integrated management of water resources (quantity and quality).

(5) Outline of the Water Supply Scheme Master Plan for 2013-2033 (Draft) prepared by WAF

In Nadi and Lautoka areas, the water service population (both urban and rural) is predicted to increase due to the expansion of water service areas. As the result, it will be necessary for the WAF to increase its current capacity by about 1.6 times the water supply capacity in 2013 was 96 ML/day for Nadi and Lautoka, but in 2033 the water demand is estimated to be 150 ML/day (1.6 times).

As an emergency response to the current NRW situation (over 50%), the water supply master plan (M/P) has set up a plan to reduce the NWR to 20% with the replacement or rehabilitation of the pipe networks. Alternative water resources development plans have been proposed; namely, (1) raising the top of Vaturu Dam Spillway which is free overflow type to increase of reservoir capacity, (2) developing water resources at the Nawaka River and (3) developing dams at the Namosi River. Other proposals are to prepare for groundwater development, introducing low water consuming devices to reduce water consumption, and to promote demand management and rainwater harvesting.

6.3.2 Usage of Water Resources

(1) Surface Water

The Nadi River Basin the usages of surface water are agricultural use except the surface water of Vaturu Dam Catchment. Management of agricultural water is the Ministry of Agriculture. Agriculture in the Nadi River Basin is said that sugar cane is 70% and other crops (root crops, vegetables, and fruits) is 30%, but share of crops are varied annually. Agriculture in the Nadi River Basin is rain-fed agriculture. However, currently some farmers are conducting irrigation by pumps from the Nadi Rivers because of drought and cash crop markets.

According to Nadi Agriculture Office, there are 250 farms taking water from the Nadi River and 50 farms using groundwater. Average size of irrigation farms is 1.5 acre (0.607 ha) and irrigated areas are 182 ha, which is 1.4% of Agricultural area (13,200 ha), and annual use is estimated 0.73 million m^3. But irrigation area in the Nadi River Basin is supposed to increase because the national policy is to increase cash crops to

exports and increase non-sugar crops.

(2) Groundwater

The Mineral Resources Department (MRD) of MIMR is responsible for groundwater. Presently there are no permits and licenses system for drilling boreholes and drilling boreholes are conducted freely and the situation of groundwater use is not grasped by MRD.

According to MRD, about 4%~9% of the annual rainfall is estimated to be recharged. If we estimate 4% ~5% of the annual rainfall to recharge, large amount of groundwater may be expected as water resources. In order to conduct optimum groundwater development it is necessary to introduce groundwater management (monitoring and control).

Groundwater uses now are agriculture, domestic water sources in communities in the alluvial plain, mineral water for export, but not used for water resources of urban domestic water. According to the agricultural office in Nadi, farms using groundwater for irrigation are about 50 farms (estimated farm area: 30 ha). Groundwater for irrigation farms and domestic water for rural communities depend on the groundwater of fissure type and Meigunyah Aquifer.

6.3.3 River Basin Conservation

The forest area in the upper reach of the Nadi River is changing to farm land and grass land by logging and devastated.

The forest area covers 48% of the Nadi River Basin and for soil and requires sustainable forest management for soil and water conservation of the basin. In order to reduce sediment discharge and conserve the forest area it is necessary to recover the forest area by planting at thin wood area and grass land. Dense Natural Forest (3,943 ha) in the Nadi basin is identified only at the watersheds of Vaturu Dam and the upper reach of the Sigantoka River basin, and the other basins requires to promote to reforest of natural forest and grass land (11,455 ha).

However, the forest area belongs to land owners and no national property. In order to promote maintenance and management of the forest area, afforestation and control of logging it requires to discuss with landowners. Because it is necessary to pay guaranty money to the land owners in order to designate a forest area for control of logging, it is advisable to recover the forest area to have sustainable production.

6.3.4 Issues for Water Resources

(1) Introduction of water resources management system

Presently the Republic of Fiji has some agencies responsible for the water sectors, but there is no agency responsible for integrated water resources management (IWRM). Therefore, it is recommended to establish an organization vested with the authority and responsibility to carry out IWRM.

(2) Effective use of water resources

As for the water resources in the Nadi River Basin (516 km^2) the surface water resources of Vaturu dam (38.6 km^2) is only used. The current potential not small and the water resources are expected to be effectively used.

As for groundwater, it is said that it has no quality problems for drinking water use, and it is possible for Nadi area to utilize groundwater as supplementary water supply resources. It is, therefore, necessary for the Department of Mineral Resources of the MLMR to grasp the potential of the groundwater resources and to manage the groundwater resources efficiently. The forest area which covers 48% of the Nadi River basin is required to be conserved from sustainable water resources aspects.

Examination of integrated water resources use such as new water resource development and study on potential of groundwater will be an effective use of the water resources and countermeasure against drought.

6.4 Present Situation and Issues on Comprehensive Sediment Management

Regarding sediment movement in the Nadi River Basin, it is considered that sediment movement is relatively balanced as sediment dynamics currently because extreme bed reduction and deposition is not observed by site survey so far.

Comparing Nadi main stream with tributaries, sediment is relatively fine at Namosi tributary and sediment runoff characteristics seem to be different between Nadi main stream and tributaries.

Sand beach has spread out at the coastal area of the estuary of Nadi River and sand beach is utilized as fishing grounds and tourist destination. It is considered that sediment movement of sand which composes sand beach is important to sediment analysis.

- ✓ In order to analyze impact on sediment movement and river bed fluctuation by flood control structural measures and evaluate impact on them numerically, it is required to observe data related to sediment movement which is not observed and recorded in the Study area. Therefore, it is required to implement various kind of field survey such as riverbed material investigation, sediment volume investigation, flow discharge observation, and so on in order to grasp present conditions. In the case of Nadi River basin, there is a particular need to pay attention to actual conditions and impact by flood measures regarding the movement of the fine ingredients (wash load) which are thought to affect seashore line change.
- ✓ On the other hand, even if numerical evaluation for sediment movement and impact by flood control structures in the future is conducted with field observations and analysis, results of analysis include uncertainty because the results are predicted using only short term data from 10 to 20 years. Therefore, in the long term, it is important to propose a periodical survey plan of river cross section and a periodical monitoring plan of sediment in the flood control master plan proposed in the Study in order to adapt an impact by flood control structures.

6.5 Present Situation and Issues on Seashore

Regarding seashore in the Nadi River Basin, it is considered that seashore is relatively balanced as sediment dynamics currently because extreme seashore erosion and sand deposition is not observed by site survey so far, and waves are gentle because seashore is surrounded by coral reef. Regarding sand drift direction, by observation results of current flow direction and current flow velocity and analysis of shoreline changes in the coastal areas so far, a fixed direction is confirmed in Nadi River estuary and Denarau are at west coast.

Seashore in the Nadi River Basin is very shallow and especially in Nadi Bay. At the Nadi River mouth, estuary terrace is formed by sediment which is flowing out from the Nadi River. Sediment material constituting beach has become finer as seawater depth is deeper, of which content rate of fine-grained fraction is more than 50% at a deeper position than 5.0m and more than 98% at a deeper position than 7.5m where most of sea bed materials is occupied by fine particle fraction. On the other hand, seashore is composed of mainly sand fraction or the like. Therefore, it is required to analyze considering particle size distribution of sediment flowing out from river in shoreline change analysis.

In addition, according to the Denarau district officials, coastal erosion has progressed in west coast part and it was confirmed in the field survey. It is said that sand nourishment and sand covering is conducted, but at present, details of that are unclear. In addition, Denarau district is artificially reclaimed area in the past. Therefore, it is required to evaluate based on the sediment transport direction and shoreline change analysis results of the coastal zone.

- ✓ In order to analyze impact on shoreline change by change of sediment volume by flood control structural measures and evaluate impact on it numerically, it is required to observe data and information which is not observed and recorded in the Study area. Therefore, it is required to implement various kinds of field survey such as grasp of shoreline changes with shoreline survey and bathymetry survey, superposition of aerial photographs and charts, seabed material analysis, observation of direction of sand drift and current flow, and so on. Target area for investigation is not only Nadi River mouth but also Nadi Bay which might be an exit of diversion channel.
- ✓ On the other hand, even if numerical evaluation for shoreline change and impact by flood control

structures in the future is conducted with field observations and analysis, results of analysis include uncertainty because the results are predicted using only short term data from 10 to 20 years. Therefore, in the long term, it is important to propose a periodical survey plan of shoreline and a periodical monitoring plan of shoreline in the flood control master plan proposed in the Study in order to adapt an impact by flood control structures.

6.6 Present Situation and Issues on Climate Change

The perspective of governmental organization on the Fifth Assessment Report, AR5 of the intergovernmental panel related to climate change, IPCC, has not been presented. As for the island countries including Fiji, the followings are the issues and prospects pointed in AR5.

- ✓ Interaction between average sea level rise of the world and high water level phenomenon in 21 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.

Issues of Climate Change are as follows;

- ✓ Present safety level of flood control of the Nadi River is only for occurrence probability of once in several years or less so that there is a constant flood risk. Therefore, immediate establishment of flood control facilities are required. In flood control, it is important to set target scale of flood control and to establish flood control facilities to suit the target scale first of all.
- ✓ In addition, it takes long period and huge budget to construct all flood control facilities in Master Plan. Therefore, it is necessary to establish facilities urgently for important protected area as priority project and continuously establish facilities for other areas remained step-by-step. Safety degree against flood will be improved according to establishment of facilities step-by step in whole river basin.
- ✓ Therefore, adaptation to climate change and extra ordinal flood is considered as one of risk management and mitigation plan after achieving the target of flood control master plan.
- ✓ As for effect on flood by climate change and excess flood, since there are limitations to protect a target area against flood damage by structural measures, it should be combined with non-structural measures, such as land regulation, early warning system and so on for risk reduction. Regulation, early warning system and so on is required from the point of view of disaster risk reduction.

6.7 Present Conditions and Issues of Land Use and Regional Development

Nadi town is located in floodplain and it is vulnerable to flood damage topographically. On the other hand, Nadi town is commercial capital for tourism and urbanization is accelerating with an increase in population and development of industry. Currently, there is a risk that future flood damage will be increased by implementation of disorderly urban development because there is not a comprehensive flood control master plan and urban planning considering flood risk, etc., development planning, land use regulations are not implemented.

- ✓ In planning Mater Plan in the Study, it is required to consider existing town planning and development plans and to corroborate other plans (refer to 4.8(3), (4)). The town scheme of Nadi Town shows the asset concentration area, it can be referred to as a candidate for important protected area in the flood control plan.
- ✓ In addition, some of the area might be utilized as a retarding basin as a part of flood control measures, and those areas will be needed to be tolerant of inundation once in several years or decades. Therefore, countermeasures, such as land regulation, establishing the building which has an inundation tolerance, institutionalization of land compensation for retarding basin are needed to be implemented at the same time.
- ✓ Moreover, after approval of Master Plan, it is desired to review town scheme considering flood risk

and implement town development and regional development in parallel with implementation of countermeasures for flood control against river flood and for drainage against rainfall.

- ✓ Nadi Town Council, as part of its preparation to extension of its town boundary and in becoming a city in 2017, simultaneously is revising its town planning scheme. Preparatory works have already begun on this exercise with both the Nadi town Council and Ministry of Local Government, through the Department of Local Government and the Department of Town and Country Planning. New chapters into the town planning schemes revision include climate change, disaster management and resilience and hazard mapping for Nadi.

6.8 Present Conditions and Issues of Environmental and Social Consideration

Environmental and Social Consideration is important view for project implementation by international aid agencies in the donor countries, and it is also important view for the Study.

Currently, there is an EIA scheme in Fiji and it is necessary to follow the scheme under laws to implement project. On the other hand, there is some difference between Fiji's scheme and JICA Guidelines. The information of natural environment in the Nadi river basin is limited. Only appeared in existing EIA reports, fish inventory research. There is no continuity monitoring activities of water or air pollutions.

Moreover, there is a unique land ownership system in Fiji. Buying and selling of land is basically prohibited and it is required to get consensus from landowners to secure native land, except free hold land bought and sold freely and state land owned by Fiji Government.

- ✓ The Priority Projects are considered as Part1 Project of the Environment Management Act in Fiji. Part1 Project is required to implement EIA and to get the approvals of EIA Administrator.
- ✓ The EIA process in Fiji proponent of EIA to hire a registered consultant for technical assistance (Environment Management (EIA Process - Regulations, part 4). Therefore, after the Study Team hands over the result of the study to GOF, registered consultant shall he hired to implement the EIA study for project.
- ✓ The Fiji legal system does not allow trade of lands. Land acquisition with the exception of Free Hold Land (free for trade) and State Land (owned by GOF) needs to obtain the consent from land owners. The Department of Lands (DOL) has responsibilities for formation of agreements such as conditions of lease, compensations etc. DOL will negotiate with land owners through TLTB.
- ✓ No cut-off date specified in the Fiji laws. The World Bank’s safeguard policy on the existing ADB project is referred to as an example for setting a cut-off date.