Integrated Water Resource Management Demonstration Project

Environmental and Socio-Economic Protection in Fiji: Integrated Flood Management in the Nadi River Basin

DRAFT

Fiji Islands

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Country(s): **FIJI ISLANDS**

Title: Environmental and Socio-Economic Protection in Fiji: Integrated Flood Management in the Nadi River Basin

A. Brief Summary of Project

Overall Objective: To improve flood preparedness and integrate land and water management planning within the Nadi Basin using an integrated flood management approach.

Project Purpose: Improved catchment resilience to flood impacts and better flood preparedness and management within the Nadi Basin using Integrated Flood Management approaches.

Components: (C1) Rainfall; (C2) Run-off; (C3) River Network and Floodplain; (C4) River Water Health; (C5) Coastal Health; (C6) Nadi Basin Flood Management Plan

The project is designed to assist all stakeholders within the Nadi Basin to improve the monitoring of rainfall and hydrological events to improve flood forecasting. This will improve future planning and development in the Basin through the development of a Nadi Basin Catchment Committee, a multi-sectoral committee designed to improve the management of land and water resources within the Basin.

The project will also raise awareness to flooding issues throughout the Basin and will help local communities and other stakeholders to improve their resilience to flooding through an improved understanding of the river network and floodplain interactions. The project will source additional funding for further activities as part of its mandate.

B. Executing Bodies:

1. The Land and Water Resource Management Division of the Ministry of Agriculture
2. The Mineral Resources Department
3. Fiji National Water Committee

C. Cost of Project:

GEF Funding: $500,000 Co-Funding: $tbd

D. Eligibility to GEF

Within the GEF Operational Strategy for International Waters this project tackles water and environmental problems using an IWRM approach across GEF Strategic Programme III: Balancing overuse and conflicting uses of water resources in transboundary surface and groundwater basins (*with a*

specific focus on SIDS to protect community surface and groundwater supplies while reducing sewage releases).

The geographical nature of SIDS allows IWRM approaches to rapidly demonstrate the multiple benefits of tackling water resource management in an institutionally horizontal manner, whilst applying a ridge to reef approach, tackling technical and socio-economic issues with communities and civil society at large to demonstrate equity, efficiency and environmental sustainability.

The project will tackle, through IWRM approaches, many of the issues under GEF Strategic Programmes I and II through identifying and understanding multiple stresses on fragile coastal environments and linking these to freshwater and land management, especially upstream practices; IWRM will contribute to improving coastal and marine fishstocks and biodiversity.

E. Linkage to National Priorities and Programmes:

The proposal is also compatible with the following International and Regional Multilateral Agreements to which Fiji is a signatory:

Convention on Biological Diversity

- The Ramsar Convention on Wetlands
- The Cartagena Convention and Protocols
- The United Nations Convention to Combat Desertification (UNCCD)
- The Strategic Action Programme for the Pacific International Waters
- The Regional Action Plan on Sustainable Water Resource Management

Flooding is a high political priority for Fiji. Programmes for flood warning and disaster response are currently being addressed in Fiji. Flood mitigation programs are also being undertaken. At present they mainly remain the responsibilities of the Public Works Department and Disaster Management Council and the Land and Water Resource Management Division of the Ministry of Agriculture.

The Government of Fiji has embodied in its overall Strategic Development Plan its commitment to the UN Millennium Development Goals (MDGs) and is committed to achieving these goals. In 2004 the Government, through the Land and Water Resource Management Division of the Ministry of Agriculture, Sugar and Land Resettlement, in cooperation with UNESCO proposed the development of a Draft Strategic Plan on IWRM for the Nadi Basin[1]. This plan identified the following IWRM goals for the Nadi River Basin:

[1] Draft Strategic Plan on Integrated Water Resources Management for the Nadi River Basin. Presentation at the National Workshop, Nadi, 7-8 September, 2004. Land and Water Resource Management Division of the Ministry of Agriculture, Sugar and Land Resettlement, in co-operation with the Economic and Social Commission of Asia andf the Pacific and UNESCO.

1. *IWRM Goal 1* – Manage, develop and protect water and related resources to meet the needs of current and future generations;
2. *IWRM Goal 2* – Operate, maintain and rehabilitate facilities safely, reliably and efficiently to protect public investment;
3. *IWRM Goal 3* – Enhance organisational effectiveness

This Demonstration Project will help take this draft plan forward and will assist the Government of Fiji in delivery of the above IWRM Goals for the Nadi Basin.

The EU Programme for Water Governance (PfWG) pilot of the European Union has recently (2006) conducted a pilot programme for IWRM in Fiji at the national level. Relevant recommendations will be adopted in the demonstration project where practical, including:

- An assessment of legislation requirements for integrated flood management within the context of IWRM. This project will work with the EU National Planning Programme to support the Fiji Government on these issues.
- At present no single agency has management control over water resources. Working in the complex Nadi Basin this project will provide recommendations to the Government of Fiji on inter-sectoral planning for water resources and possible management agencies.
- The inclusion of local communities and a wide variety of stakeholders to promote long lasting sustainable change using a combination of top-down and bottom-up approaches.

F. Name and Post of Government Representative endorsing the Demonstration Activity:

1. Director, Land and Water Resources Division of the Ministry of Agriculture, Sugar and Land Resettlement, *Mr. Lakshman Mudaliar*.
2. Director, Mineral Resources Department, *Mr. Kemueli Masikerei*
3. IWRM Focal Point, Mineral Resources Department, *Mr Malakai Finau*

G. Project Objectives and Activities

i). Background:

Water supply is a key long-term issue for most Pacific Island developing countries. The Nadi catchment, located in the western division of Viti Levu island (Fig. 1), has one of the two largest populated centres of Fiji. According to the 1996 Census the Basin has a population of 31,000 people, 54% of which live in rural areas, and the remainder in Nadi Town itself.

The area is a vital link between Fiji and the wider world as it hosts Fiji's only international airport, providing the gateway for Fiji's burgeoning tourist industry and import/export of many products. Currently over 500,000 tourists per year are dependent on this link and projections are for this to grow to 1.1 million in 10 years[2]. The airport also serves as a regional transport hub, enabling most of the Pacific Island Countries to be actively connected. Increasing population, rapid urbanization and industrial development are putting considerable pressure on the water resources of the basin. A summary of current and future dependencies and stressors on water resources in the Nadi catchment is given in Table 1.

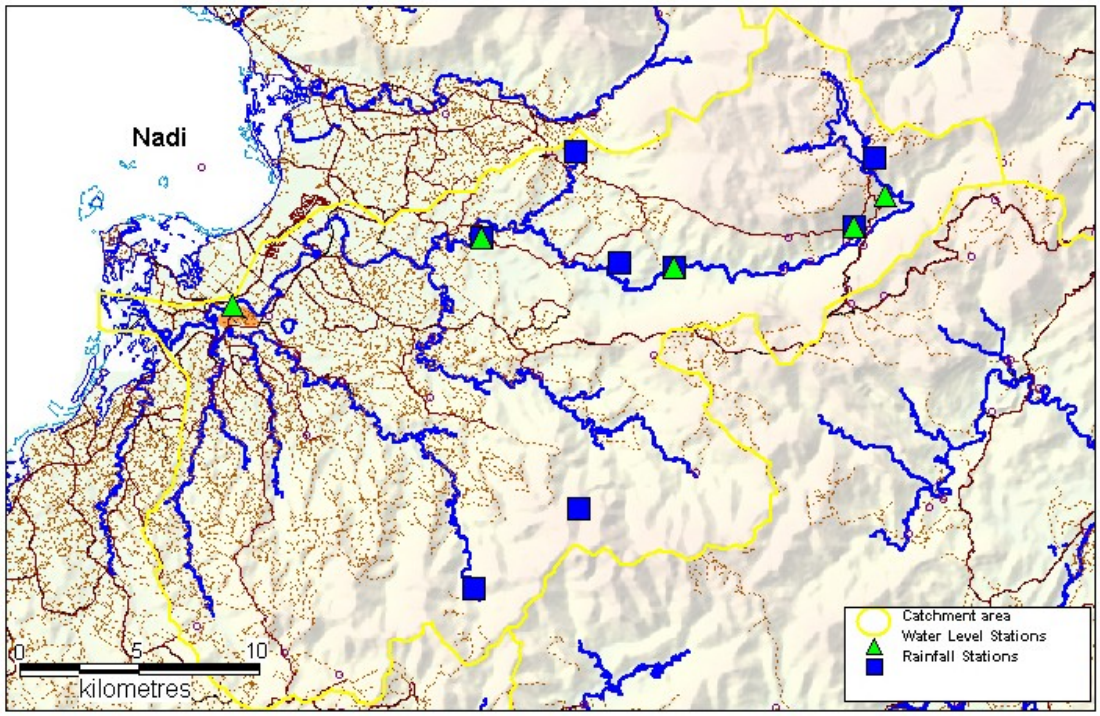

Fig. 1: Nadi catchment on western Viti Levu, Fiji.

Extensive consultation with Fiji Government representatives and local stakeholders has identified the highest priority water resources issue in Fiji as flooding in the Nadi catchment (Fig. 2). Serious flooding in this basin has historically caused loss of life, and damage to property and infrastructure. Critically, social and economic activity is often stopped or severely impeded for weeks to months following these

2 Regional Tourism Strategy – Nadi Corridor. Fiji Tourism Development Plan 2007 – 2016. Fiji Dept of Tourism.

events (with ramifications for the whole Pacific region)[3]. Infrastructural costs for floods in the Western Division of Fiji alone amounted to around FJD$3.8 million in February to April 2007. In-turn, flood hazards are putting major pressure on current and planned developments. The flooding, and some of the factors leading to the problems such as land erosion and channel sedimentation has also had significant impacts on river health, biodiversity and ecosystem services, as well as on the ecosystem health and services of the receiving coastal environments in the estuary and Nadi Bay.

Table 1: Current and future dependencies and stressors on water resources in the Nadi catchment.

a. Tourism

i. Water supply

ii. Sanitation & waste disposal

iii. Infrastructure (e.g., roading)

iv. Demand for fresh food (quality & quantity required)

v. Recreational services (e.g., water quality of marine environments – microbial, nutrients, sediment)

vi. Hazards

1. flooding (part. with climate change)
2. sea level change
3. cyclone events

b. Hydro power development

i. Supply of water

1. variability
2. intensity of events/hazards

ii. Geographic location

1. current landuse
2. land tenure

[3] On average Fiji is estimated to suffer a mean of 10 fatalities and around FJD$20 million worth of total damage to infrastructure, agriculture and homes per year across Fiji from floods. Several weeks after the floods of 2003/4 (resulting in 29 fatalities combined) over 10,000 people remained in need of food rations following the loss of subsistence crops (SOPAC 2006, Flood Warning System for the Navua River, Terms of Reference to NIWA).

iii. Longevity of reservoirs

1. geological constraints
2. landuse/sedimentation

iv. Biosecurity

1. changing water storage patterns allowing new species introductions
2. nutrient enrichment/eutrophication
3. cyanobacterial toxins & potable water supply

v. Recreation

1. opportunities (part. tourism)
2. infringements

c. Urbanisation

i. Demography of population

1. age groups
2. lifestyle requirements/quality of life

ii. Cultural balance/preferences (e.g, more gated communities)

iii. Infrastructure

1. housing
2. roading
3. water supply
4. sanitation & waste disposal
5. basic services

iv. Commercial developments

1. water demand
2. need for natural hazard protection
3. basic services (incl. sanitation)
4. bottled water supply for Fiji (USA & Pacific)

d. Airport

i. ‘Gateway to Fiji’

ii. Airport infrastructure

iii. Support services

iv. Transport access for passengers & freight

v. Jet fuel supply & storage

vi. Meteorological support

vii. Import/export facilities (incl. cold stores)

viii. On-site tourist infrastructure/facilities

e. Rural landuse

i. Ownership (changing titles)

ii. Changing patterns (e.g., away from sugar cane)

iii. Community employment issues

iv. Water quality (microbial, nutrients, sediment)

v. Tillage practices (current & future → sediment issues)

vi. Irrigation (increase quantity and quality of agricultural commodities)

f. Ecosystem services

i. Drinking water

ii. Recreation

iii. Food (e.g., fish)

iv. Washing

v. Materials

vi. Biodiversity

vii. Environmental flows

viii. Flood buffering & floodplain

While flooding in the lower Nadi catchment has been a significant past and present problem, the severity and impacts of the flooding is perceived to have worsened and the return period of these floods appears to be reducing.

The causes are likely linked to:

- the location of Nadi town – on the Nadi River, with other tributaries and smaller rivers joining the Nadi river immediately downstream of Nadi town. A substantial part of Nadi town is less than 6 metres above mean sea level and is subject to periodic flooding between November and March. Nadi Town Centre is 6 metres below mean sea level and is therefore subject to flooding throughout the year[4]. The Nadi River has a current flow capacity of 300m^3/s where the river enters the sea;
- basin land-use practices (agriculture and forestry) leading to more rapid runoff[5], and loss of soil[6];
- reduced channel conveyance capacity due to sedimentation;
- increasing variability in weather systems (with higher intensity extreme events);
- increased development on the floodplain in the path of floods (i.e., increasing floodplain 'roughness' which increases flood water levels but slows down rapid flows);
- increasing population in flood-prone areas;
- increasing road/bridge constrictions/barriers to water movement; and
- increased runoff with housing and more paved areas.

A critical future issue that greatly increases the need for the IWRM project is climate variability and the associated expected intensification of high rainfall/cyclone events (and perhaps more frequently) and increased sea levels (reducing the ability of flood waters to drain from these low lying areas).

In the future, flood waters can be expected to stand for longer periods with flood levels much higher than at present. Consequently, progressive pressures are likely to cause the impacts of floods to become worse in the future for the Nadi basin.

4 Nadi Town Drainage Plan, Department of Town and Country Planning, August 2000. See Nadi Town Drainage Plan, Annex C.

5 Research has shown that harvesting of pine forest in Western Viti Levu increased surface stormflow events and total water yield, including increased sediment loads. Waterloo, M.J., *et al*. 2007. Changes in catchment runoff after harvesting and burning of a *Pinus caribaea* plantation in Viti Levu, Fiji. *Forest Ecology and Management*, 251: 31-44.

6 Deforestation activity creates an estimated average soil loss of 87 ha/yr, or 2.151m tons per annum in the Nadi Basin. *JICA Watershed Management and Flood Control Study of the Nadi River (1998)*.

Fig. 2: Typical flooding in the Nadi town centre. At times of bad flooding water flows to a depth of 3.5m down the main street pictured on the right.

The area surrounding Nadi town is a developing peri-urban area where emerging natural resources and water resources issues require attention before problems become acute. Of particular concern is a proposed multi-pronged development in the mid-catchment area. This may include the development of a waterpark, education and entertainment facilities and possible alternative energy and bio-fuel laboratories, processing and education centres. In addition to this, large-scale hotel development and associated infrastructure would be required. Although in the initial development stages at present, any large scale development would have significant impact on the catchment characteristics, with the potential to cause vast changes in infrastructure, water demand, areas of hard surface (increasing quickflow), and people living in the catchment. Although any 'theme park' type development would be limited in size due to land ownership issues, geographical location and demand, even 1 million visitors a year would place great stress on the current infrastructure and ecosystem services. Hotel and staff accommodation alone would be a major problem. Other development along the coast has the potential to change coastal sediment movement – in some places this may already be increasing sediment build up in the Nadi river mouth (such as the draining of 150ha Denarua Island).

Failure to address the impact of flooding occurs because responsibilities for land and water management in the catchment are fragmented or not appropriately assigned (see Table 2), technical assessment capacity has been unable to identify the impacts of development proposals, and assessment of development occurs on an individual project basis without reference to an integrated flood or catchment plan. Institutions often have geographical and functional boundaries – often this is coped with by developing larger institutions with wider geographical and functional boundaries. This can create clumsy and inefficient organisations, out of touch with local situations. There is a need to cut across institutional boundaries to help cope with, and manage the flooding issues in the Nadi Basin.

Current development in the floodplain is also of concern as it impacts the quality of groundwater used for water supply. The lower Meigunyah aquifer is one of Fiji's most important groundwater resources but existing measures to protect the quality of the aquifer may no longer be sufficient. The entire Nadi

catchment area, including the lower floodplain, includes various uses of water and land – ranging from tourism, industrial to agriculture usage as well as commercial extraction and bottling of mineral water (*Diamond Aqua Waters at Nasau, Nadi*). Managing and servicing the different requirements of land users becomes increasingly difficult where water quality needs to be maintained for public health and environmental needs, balanced with flood protection and management within a large catchment area.

Previous work in Ba town on Community Flood Preparedness highlighted the need for better inter-agency coordination, mainly between the Fiji Meteorological Service and the Public Works Department (Hydrology) for the installation of automatic monitoring equipment, and between Ba District DISMAC[7], Ba Police, and Ba Town Council for the establishment of best possible flood warning and emergency response measures at the local level[8]. The study recommended that significant research was required to instigate a similar flood preparedness approach in Nadi town to estimate flood hazard, flood frequency, and to identify significant features of the built/social environment unique to Nadi town. The Government of Fiji is currently committed to install flood warning systems within the Ba and Nadi River Basins. The EU funded HYCOS project will upgrade the Rewa River Flood Forecasting and Warning System to reduce flood risks for communities on the Rewa floodplain[9].

Table 2: Key Governance Responsibilities Within a 'Flood Processes Framework'

Key Flood Hazard Processes	**Organisation With Governance Responsibilities/Interests**	**What Do They Control?**	**How Can They Help With IWRM?**
Flood generation	Fiji Met Service Public Works Dept LWRM	- Met/Climate information - weather/cyclone/hazard predictions	- awareness - flood warning - provision of data to technical agencies
Runoff	LWRM + other division Public Works Dept Fiji Sugar Cane Town & Country Planning Min of Provincial Development	- development of retention dams - roads, drains and bridges - land development and	- construct dams analyse flood run offs - review of drain and road design criteria

7 Fiji's Disaster Management Council (DISMAC)

8 Ba Community Flood Preparedness Project: Final Report. S. Yeo, 2000. SOPAC Technical Report 309.

9 Pacific HYCOS Project Implementation Plan (SOPAC, December, 2007).

	Native Land Trust Board	zoning -Issuance of Native land leases	- enforce control measures - police lease conditions
River network/flood plain	Director of Lands LWRM MRD Public Works Dept Nadi Town Council Town & Country Planning Provincial Development & National Disaster Management Office Police Operations Fiji Sugar Cane Airports Fiji Ltd Commercial interests Dept of Tourism Transport, Works & Energy Dept Min of Provincial Development Min for Environment	l-land ownership - drainage systems - -roads, bridges, water supply - District Administration - monitor and assess disasters - law and order, - - tourism development Environment management	Gap in floodplain planning Streams & Rivers Act: Administered by Min. Lands & Mineral Resources
River receiving environs	Central Board of Health Town & Country Planning Public Works Dept	Rural Local Authority	- monitoring river systems

	Lands & Minerals Dept Dept of Environment LWRM MAFF Min for Environment ???	- issue of licences for gravel extraction - River monitoring - water withdrawals	Control extraction of gravel - monitor river system - control water withdrawal
Coastal receiving environs	Dept of Water & Sewage (T, W & E Dept) Dept of Environment MAFF Lands & Minerals Dept Local villages – native rights/Native Land Trust Board Transport Dept Min for Environment Min. of Tourism Fiji Islands Visitors Bureau ????	Environment management - seabed ownership - ownership and usage Coastal monitoring	Monitoring - control

Integrated Flood Management and IWRM

Integrated Water Resources Management (IWRM) is concerned with the multi-sectoral management and use of water, bringing both economic and social benefits to all users whilst retaining the integrity of the environment.

Where rivers reach the sea there is the need for IWRM approaches to link with Integrated Coastal Zone Management[10] practices. In Pacific Small Islands Developing States (SIDS) this approach, linking upper, middle, and lower catchment management approaches with receiving coastal water and reef management

10 Note that ICZM is used in this project document rather than Integrated Coastal Management (ICM). This is to avoid confusion between Integrated Catchment Management – a common acronym used in watershed and catchment management projects. ICZM is also a globally used term concerned with coastal zone management issues. See OECD, (1997). *Integrated Coastal Zone Management: Review of Progress in Selected OECD Countries,* OECD, Paris, and Sorensen, J., (1993). The International Proliferation of Integrated Coastal Zone Management Efforts. *Ocean and Coastal Management,* 21(1-3): 45-80.

is called *Ridge to Reef*. Groundwater is often a critical resource in SIDS, including surface/groundwater exchanges, and land-groundwater interactions are equally important. But, aquifers and catchments do not necessarily geographically coincide, and therefore management of water resources within an IWRM approach becomes more complicated and challenging.

A catchment is a dynamic system which varies both with space and time. There is a need to not only manage the flows of water, but also variations in the quality of the water, erosion/deposition of soil and other matter, and the results of these changes on the receiving coastal waters and coral reefs. Flood management within an IWRM framework therefore requires integration across three dimensions:

1. The physical catchment;
2. Between land and water management, and
3. Across the different uses and functions of water.

However, this causes institutional problems. Catchments are arbitrary units varying greatly in size and whose boundaries do not coincide with traditional cultural, religious, political, ethnic, and often institutional boundaries. This makes planning within an IWRM framework difficult and challenging.

There is also a need to understand floods better. Floods are a natural process and rivers need space to move. Floodplains are natural elements within catchments, but in order to understand and manage rivers and floods better hydrological data and information is required to allow managers and policy makers to take into account cyclical variations, trends, and unexplained variations. A trend change could be due to climate variability, but could also be due to changes in land use, and river diversions etc.

Managing this variability means that all floods have to be 'managed' – and not just some floods, i.e.: those with a certain probability of return period and magnitude. Design standards of protection will only offer protection based on the time of design and construction. Trend changes upstream and downstream of design interventions (infrastructure) which alter river flows and changing land use practices can negate the protection offered by infrastructure. Furthermore, infrastructure can only offer the support it was designed for if it is adequately maintained and functioning.

The purpose of catchment management is to make the best use of the catchment as a whole, rather than to minimize flood losses. Catchment management is therefore multi-objective and has multiple constraints. Within an IWRM framework, catchment management has to incorporate socio-economic benefits, equitable use and ecological integrity through identifying what development should be allowed within the catchment, it's location and the impact of that development on the catchment and the people within it.

Integrated flood management consists of the following elements:

- *A participatory approach*

All users, planners, policy makers at all levels need to be included in making decisions concerning flood management and the wider catchment. This should be in an open, transparent, inclusive and communicative environment. Decentralisation is a key concept and a principle of IWRM and decisions should be taken at the lowest appropriate level following full public consultation (the principle of *subsidiarity*). An appropriate combination of both 'bottom-up' and 'top-down' approaches to ensure that all viewpoints and mechanisms are considered is a key element to the modern management of floods.

- *Integrating Land and Water Management*

Improved coordination and cross-sectoral working on land and water management authorities needs to take place to ensure that land use planning and water management are combined in one approach. The three main elements of river basin management (water quality, quantity, and the processes of erosion, deposition and accretion) should all be linked in land and water management plans. The effects of land use changes on the different elements of the hydrological cycle need to be taken into consideration.

- *Managing the entire Water Cycle*

Flood management approaches need to link with drought management approaches through maximising the use of flood water (where required) and by maximising the positive aspects of flooding to mitigate the negative aspects of drought and low flow periods.

- *Adopting a Portfolio of Strategies*

There is no one single solution to managing and coping with floods. A range of options needs to be considered, tailored to the specific situation but able to cope with changing conditions. A layered range of structural and non-structural measures must be evaluated, adopted and implemented and the pros and cons of all measures needs to be understood.

- *Adopting Integrated Hazard Management Approaches*

Flood management needs to be integrated into wider risk management strategies, especially where existing hazard planning and management and warning systems exist. Existing early warning systems need to be evaluated and adjusted/strengthened as necessary.

ii). Objectives and Activities:

Based on this background, the **Objective** of the project is to improve flood preparedness and integrate land and water management planning within the Nadi Basin using an integrated flood management approach.

This project can not work in isolation and will interlink with other activities in the Nadi Basin and Fiji wide working on flood and risk reduction issues. This proposal has been structured to highlight a range of

issues which need to be tackled. Some of the activities raised are beyond this particular GEF funded project, although this project will utilise the financial support from GEF as seed funding to encourage the Government of Fiji to seek additional funding from other donors, will raise awareness, and will work to mainstream integrated flood management approaches into normal everyday Government working practice.

The six components that will need to be addressed are outlined in the following section based on the bio-geophysical processes that generate floods, convey the waters down stream, interact with/effect in-stream ecosystem services and effect the coastal receiving waters.

Nadi Flood Processes and Possible IWRM Actions/Mitigation

Flood hazards are the outcome of many interacting bio-physical processes which are, in turn, modified by anthropogenic-based issues (e.g., building infrastructure/land-use/human behaviours). Of critical importance is to not only think of ameliorating current problems, but preparedness for the projected increase in severity of cyclone activity under future climate change and the projected exponential growth

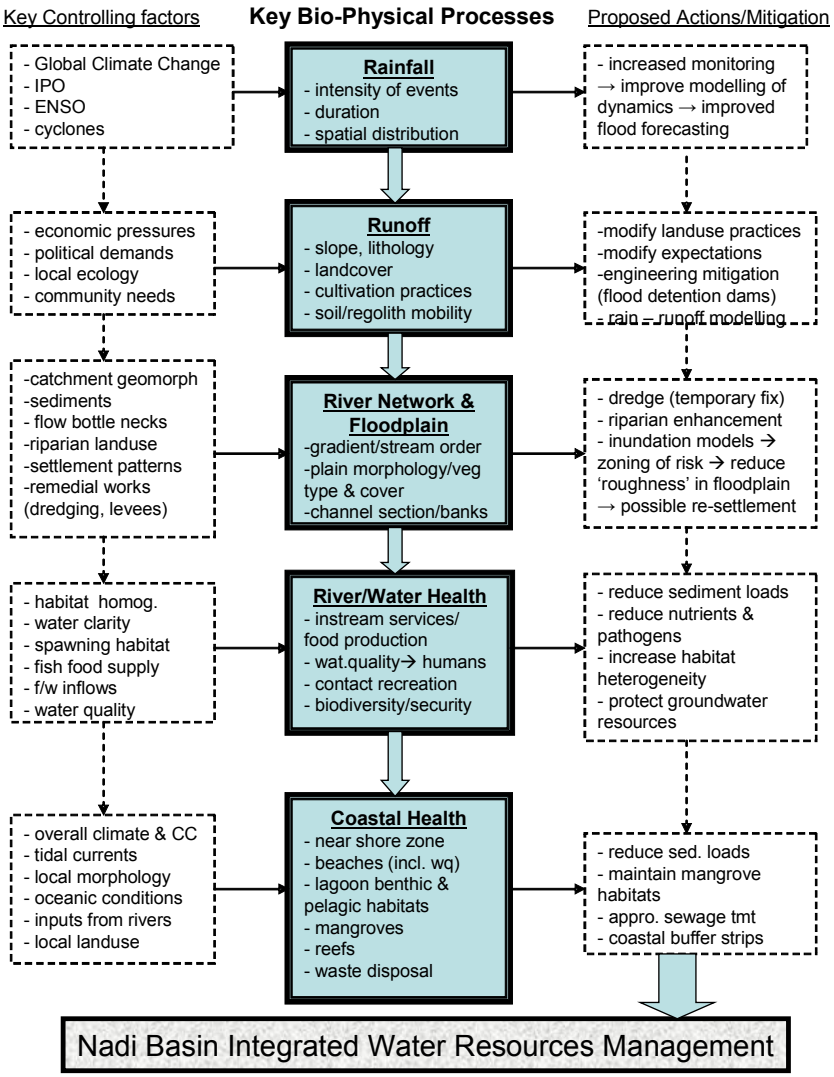

Fig. 3: Summary of key flood processes and some possible actions/mitigation in the Nadi basin. Note, not every 'Proposed Action/Mitigation' in the right hand column is appropriate for this IWRM demonstration project. Therefore only a subset of these is discussed below.

In brief, the primary Components which are required to enable an integrated flood management approach, and specific projects to allow remedial actions, are as follows:

1. *Rainfall:* Year – year temporal variability in the frequency and intensity of major rain events in the Pacific (and particularly the Nadi catchment) is very high. These are linked with broadscale climate variations such as IPO and ENSO events, and increasing climate unpredictability is also predicted to have major effects on this variability (particularly the occurrence of more frequent, very intense rainfall events). Large inter- and intra-catchment variability in the intensity and duration of events also occur depending on the direction of the weather systems and local topography. A key step in community response/mitigation of high intensity rainfall events is to develop better prediction tools of when and where an intense rain flood will occur.

   Early flood warnings (up to days out, vs. – later warnings based on upstream river flows, see below) can be given using models based on likely incoming, and current, precipitation. It is also important to know the intensity of these events and where in the catchment the high intensity events will occur. For the Nadi catchment, observation of recent events by the Fiji MetService have indicated that the largest proportion of the rain fell in the middle catchment, in the area where the clouds first start rising to cross the highlands at the back of the catchment. This also happens to be the area of most intense agricultural development and thus potential sediment source areas (see below). Anecdotal evidence suggests that data recording of river water levels around Nadi town is intermittent due to frequent equipment breakdown and insufficient recording equipment[11].

   Recent work in the Navua River Basin has included the installation of a flood warning system, potentially providing residents of Navua town with up to three hours warning following intense rainfall upstream. Through automatic field stations placed at strategic points, and real-time radio transmissions to the Fiji Hydrology Department in Suva forecasts are made as to the likeliness of

11 Funding from the French Government for hydrological equipment through Meteo France is currently on hold due to procurement and technical specification problems. This project will help to move the situation forward and where necessary look to alternative options.

flooding. The key element in this process is getting the information to communities in a quick and appropriate format, and helping them respond to the information.

Recommended work streams and suggested priorities for the IWRM programme are:

Activity	Funding
A. Install, at medium – fine spatial resolution, meteorological recording network with telemetered real-time data feeds[12]. This would also require the appropriate base station computer infrastructure, database and data analysis systems. The actual nature of the warning will be determined during the project and is dependent on the support from the Fiji Government in recognising the importance of flood warning, and the realistic ability to provide warning in the Nadi Basin. Short travel times in the smaller rivers directly behind Nadi Town may result in the use of the main Nadi River as an indicator of flooding likely from smaller and potentially more destructive tributaries.	Nominated implementing agency: Fiji MetService **Priority 1 IWRM funding**
B. Develop a model to enable time-dependent precipitation to be predicted at various points in the catchment based on outputs from weather radar (and possibly the British MetService Unified Global Weather model) to develop an operational rainfall forecasting system (which takes into account antecedent conditions).	Nominated implementing agency: Fiji MetService **Priority 2 – other funding**

2. *Runoff:* the rate and quantity of water that runs off the land into the channel network varies greatly depending on local catchment slope, lithology, landcover and land tenure/cultivation practices. While slope and lithology are usually fixed entities of the landscape, land cover and tenure/cultivation practices are variables controlled by human activities (which reflect socio-economic expectations and pressures). At the extremes, totally forested catchments act as significant buffers, delaying the passage of water to the channel network and thus dispersing (often reducing) the flood peaks. Conversely, completely paved or hard areas facilitate very rapid runoff, so that streams draining urban areas are characteristically very 'flashy'.

Some methods of cultivation can also enhance runoff, and exacerbate flood effects by encouraging soil erosion (e.g., down-slope furrowing) which then deposits in low gradient areas and may potentially reduce water conveyance in the channel network. Indeed, land erosion and generation of sediments is a major secondary problem of flood generation in the Nadi basin, with

12 The most cost-efficient method would be to contract a consultant to assess, procure, install and train staff in equipment use.

many project developments likely to enhance runoff rates and soil erosion in the future. While knowing more about the spatio-temporal patterns of rainfall is important for forecasting events, *targeted* upgrading of landuse practices and landcover (e.g., in zones of 'quickflow' and riparian zones of low order tributaries) can be an effective tool for reducing runoff and soil erosion during high intensity rain events. It is important to note that reducing environmental impacts through good agricultural practices is usually less expensive than investing in technology for point source control.

An additional tool that has been used in North America and Europe is small flood detention dams on key low-order tributaries for trapping bed load sediment in the upper catchment and to slow down flood waters to manage high flow periods more effectively. These are then cleared and the sediments/lost soils are periodically dug out and redistributed back on the land for cultivation. The Fiji Department of Land & Water Management has recently built one of these detention dams (which will also be used to supply irrigation water) and considers that a further 15 – 20 are needed in the Nadi basin[13]. However, their effectiveness in the bio-geophysical setting of the area is as yet untested[14]. It is also important to build understanding within the community (and related industries such as sugar cane) regarding the effects of their tillage/landcover practices as much of the required 'fixes' in these circumstances requires a permanent commitment by rural communities/industry to change behaviours[15]. Policing such issues is difficult. The basis of targeting such areas for changed practices needs to be informed by the spatial network of weather stations and detailed rainfall – runoff modelling that incorporates as key issues slope, lithology and landcover.

In considering the seasonal impact on water flows, planning of upstream water developments (such as retention dams) should specifically take into account possible ecological consequences of the changes in flooding, including loss of habitat, changes in sediment inflows to lower areas, and changes in water oxygen levels, etc. Furthermore, and perhaps most importantly in areas prone to flooding on a regular basis, the cumulative effect of upstream infrastructure development needs to be considered.

Note: funding for flood detention dams has already been secured by LWRM from the Fiji Government.

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13 See the study: Nadi Micro Catchment Project Study, September 2004. Ministry of Agriculture, Sugar and Land Rettlement, Land and Water Resource Management Division.

14 It is not clear if further retention dams will be constructed. The initial dam was bypassed by the river during a high flow event. It is also not clear what agricultural extension services are available during the transition period for farmers to change their traditional sugar cane practices to a new technology (drip irrigation) and the suitability of the area to growing high value vegetables where water flows have high sediment loads and some form of pumping will be required. There is a need to understand what possible crops could be grown in the future and different cropping scenarios to be developed as an entry point for farmer and wider community consultation.

15 Annual high and intense rainfall events coincide with bare soil periods in the areas used for sugar cane. Ways to manage this issue include possible double cropping, with lower crop cover at these periods, changing land rotation and ploughing practices, and the construction of natural sediment traps using ditches and certain vegetation banks/traps.

Recommended work streams and suggested priorities for the IWRM programme are:

Activity	Funding
A. Develop and calibrate a rainfall – runoff model that will use both the flow and rainfall stations to give spatially explicit predictions of the main flood flow contributing areas in the Nadi catchment. Training would be given in running the model. Run different land cover scenarios to quantitatively determine the likely benefits of possible changes in landuse practices. Determine soil/sediment losses under different landuse/rainfall scenarios.	Nominated implementing agency - Land & Water Resources Management Dept **Priority 1 IWRM funding**
B. Develop a 'best practice' cultivation guideline that is customised to the climate/landscapes for different areas of the Nadi basin and based on the results of the above rainfall – runoff modelling. Links need to be made with the GEF funded PACC Project focussing on the Navua and Tailevu catchment areas to extend present drainage activities, reviewing existing drainage/flood structure designs and reviewing any future design criteria in view of climate change (esp. rainfall patterns). This also includes alignment of project interventions to existing initiatives such as the Flat Land Development programme. Links also need to be made to the GEF funded Sustainable Land Management Project	Nominated implementing agency - Land & Water Resources Management Dept, in collaboration with industry such as SCGs **Priority 2 – other funding**
C. Community engagement and capacity building to educate on the problems of the Nadi basin and best practice guidelines for cultivation and their benefits (a key message could be that if the Nadi town and linked tourist area are flood-bound for weeks, then the market for their produce will also suffer: i.e., urban – rural areas are inextricably linked). Use this project as a key 'engagement point' for the community in the IWRM process.	Nominated implementing agency – USP, NGOs, Land & Water Resources Management **Priority 1 IWRM funding**
D. Monitoring to test the efficiency of sediment and water trapping in the flood detention dams and review design criteria using the climate monitoring data and rainfall – runoff	Nominated implementing agency - Land & Water Resources Management

modelling as controlling factors to then enhance dam design/operation for other problem catchments in the Pacific/SIDS regions.	Dept **Priority 1 IWRM funding**

3. *River Network and Floodplain:* A range of natural and human influenced factors effect or control the ability of the channel and floodplain to convey flood flows. Whether bank overtopping occurs during high intensity rain events is largely linked to channel geometry, 'roughness elements' such as weirs, boulders and vegetation, and local channel slope. All these factors can insert 'bottlenecks' for flow conveyance in the channel network and are subject to human alteration. Most often, vegetation is removed from the flood plain as part of land-use development, but this is accompanied by channel narrowing (due to a range of processes including artificial bank stabilisation to maximise productive areas) and development of infrastructure (including buildings, raised road corridors, cropping etc) that interfere with water conveyance once water flows out of the channel and onto the flood fairway. Sedimentation in the Nadi river channel has greatly lowered the local channel gradient in the area immediately downstream of the town and created a very shallow bar at the outlet of the river on the coast.

These bottlenecks are thought to have greatly exacerbated recent flooding in Nadi so a two stage programme for sediment dredging by the Land & Water Management Dept has been funded by the Fiji Government, starting 2007. However, this will only stop bank overtopping for medium level floods, not high level events (the existing channel will only accommodate 350 m^3/s, whereas flood flows can peak at > 1,800 m^3/s[16]) so will only be a 'partial fix'. Also, unless the downstream sediment flux is mitigated, further dredging will be required in the medium term future and is therefore not a recommended sustainable medium to long term option. Where the river banks are already been 'lost' to erosion even at low flow periods, especially within Nadi Town, there is a need to stabilise and protect key infrastructure and living areas[17].

16 JICA Watershed Management and Flood Control Study of the Nadi River (1998).

17 Based on findings from earlier studies across Fiji, including the Vulnerability and Adaptation Assessment Report for Buretu Village, Tailevu in the Rewa Delta (L. Limalevu, Draft Discussion Paper, 01.08.07).


Fig. 4: ***Left:*** **Typical upper catchment behind Nadi Town. Clear tributaries approaching the major sugar cane growing areas.**

Right: **Reconstruction of gabion supports and river bank surrounding the small check dam designed to reduce high flow periods and back-up water for drip irrigation behind Nadi Town.**

Recommended work streams and suggested priorities for the IWRM programme are:

Activity	Funding
A. Survey/characterise/classify riparian and floodplain vegetation and infrastructure cover in the catchment to assess its role in: a) flow and sediment mitigation from the land into the channel; b) reducing flood flow conveyance on the flood plain. A related element would be to analyse channel hydraulic geometry to determine how to further improve flood conveyance in the channel (e.g., bank widening in certain critical areas). These data would be integrated into a GIS-based management plan for riparian zones and channel geometry (with specific recommendations for ameliorative actions) to complement the other flood mitigation/management projects.	Nominated implementing agency - Land & Water Resources Management Dept of MAFF **Priority 1 – IWRM funded**
B. River flow-based flood warning system. This would be based on a network of telemetered flow and rainfall recording sites in the catchment (installed as part of Project 1a). It will be critical to strategically locate sites both in relation to potential areas runoff generation and to link with weather station network (incl. rainfall intensity gauges). Such systems have been designed for the Navua and Rewa catchments and will be installed in the next 2 years. The work involved in this project would be to provide a flood advisory methodology based on defined flood impact levels, together with	Nominated implementing agency - Fiji Met Service, Public Works Department, Disaster Management Response Unit **Priority 1 – IWRM funded**

documentation of local procedures in conjunction with the operators, training workshops, commissioning and reporting. The design and implementation of a system for the Nadi catchment will leverage developing experience in these neighbouring catchments.	
C. Survey current sediment fluxes and map/assess their source areas and potential for mitigation on a catchment-wide basis (including bank erosion). Upper catchment forestry areas would be included. Determine sedimentation rates in the channel of the lower catchment and predict frequency that channel mitigation dredging will be required until upper catchment erosion mitigation and bank stabilisation becomes effective.	Nominated implementing agency - Land & Water Resources Management Dept., USP. **Priority 2 – other funding** *Note: this project needs to be carried out prior to 2b, above.*
D. Inundation modelling/assessment for the floodplain. This would need to be based on a LiDAR[18] survey, a detailed digital elevation model, and a ground verification/analysis of critical floodplain assets/infrastructure in relation to water levels for various flood scenarios. This assessment would develop recommendations for future planning policy controlling floodplain development, including how best to deal with current developments to mitigate flood levels. The model would also be used to assess alternative downstream development scenarios, based on current and future changes to flows in the upper catchment and working with relevant institutions and partners to develop technical guidelines for the design and location of structures, buildings and infrastructure to permit passage of flood waters.	Nominated implementing agency - Land & Water Resources Management Dept **Priority 2 – other funding**

4. *River/Water Health:* Processes controlling flood generation and conveyance, and mitigation actions do not operate in isolation of river/water health and in-stream ecosystem services. Consultation with stakeholders and informal observations have identified a decline in river health, ecosystem services and use of the river as an integral component of village life. Loss of morphological heterogeneity (e.g., pools, riffles etc) and degradation of water quality (part. sediments and microbial contamination) are key factors contributing to this. Once, fish and crustaceans were harvested from the river and there was likely a diverse bottom dwelling invertebrate community. As part of the flood mitigation plans (part. sediment reduction, flood

18 LiDAR (Light Detection And Ranging) is an active sensor, similar to radar, that transmits laser pulses to a target and records the time it takes for the pulse to return to the sensor receiver. This technology is currently being used for high-resolution topographic mapping by mounting a LiDAR sensor, integrated with Global Positioning System (GPS) and inertial measurement unit (IMU) technology, to the bottom of aircraft and measuring the pulse return rate to determine very accurate surface elevations.

detention dams, channel dredging, riparian management/enhancement) it will be important to optimise benefits for the in-stream environment.

Key locations for this assessment and future monitoring will be in the low order tributaries (Orders 1 – 3) where the land (part. riparian) – water connectivity is at its highest, habitat heterogeneity is highest, and to prevent contaminated water flowing into the high order channel of the lowland area. While quantitative assessments of the value of riparian enhancement and flow/sediment detention dams should be carried out as part of performance assessment measures of the wider IWRM programme, this area also lends itself to some community capacity building in stream health monitoring using the newly developed Pacific SHMAK.

Recommended work streams and suggested priorities for the IWRM programme are:

Activity	**Funding**
A. In association with Project 3a, described above, define riparian management guidelines to maximise physical and water quality benefits for in-stream communities in the low order tributaries of the Nadi catchment.	Nominated implementing agency - Land & Water Resources Management Dept, in collaboration with Min for Environment. **Priority 1 – other funding**
B. Design and implement a water quality and biological monitoring programme to specifically measure the benefits for changes in land and riparian management in the Nadi basin. This should incorporate a capacity building component to enable a progressive transfer of monitoring responsibilities to the local communities and other stakeholders. A central database of quality assured results would need to be established.	Nominated implementing agency - Land & Water Resources Management in collaboration with Dept. for Environment, Mamanuca Environment Society. **Priority 2 – other funding**

5. *Coastal Health:* The coastal receiving waters appear to have been heavily impacted by flood generated sediments (and probably nutrients and pathogens), with implications for ecosystems, ecosystem services and the tourism industry. The largest mass-flux of these pollutants is usually during high rain events. Indeed, turbid water from the Nadi River often extends along much of the coast around Nadi Bay where there is extensive tourist resort development and a prawn fishery that is exploited by local villages (to supply the resorts). There are already major concerns amongst villagers that the proposed channel dredging, and re-suspension of silts will have major impacts on the prawn fishery. For example, stakeholders have reported that it can take up to a month for the prawns to return after flood events in the catchment. Further, the

effects of these turbid inflows on Nadi Bay and reef communities are largely unknown, as well as on bathing water pathogen levels (in relation to standards). Additionally, mangrove communities in the lagoon area are under pressure from development and to improve the conveyance of flood flows from the river. However, these mangroves are likely to be an important rearing habitat for many organisms, but particularly prawns and fish.

The local tourist industry has grouped together to form the Mamanuca Environment Society[19] (MES) to promote better coastal and coral reef management practices, thereby protecting the sustainability of the industry. Their activities are funded through a bed-night levy on tourists and current MES activities will strongly complement the IWRM Nadi programme. MES studies have highlighted that high nutrient loading in many recreational waters has caused blooms of algae/seaweed to crowd the once clean beachfronts of many resorts. MES has also raised concerns over the amount of fertilisers from agricultural areas entering the coastal receiving waters.

Recommended work streams and suggested priorities for the IWRM programme are:

Activity	**Funding**
A. Mangrove mapping and ecological assessment analysis. Knowing more about the ecological role of the mangroves at the outlet of the Nadi River will provide key information to determine future management strategies for the lagoon area in relation to flood conveyance. For example, if this area is a key nursery for coastal biota (e.g., black prawns) then this will need to be accommodated within plans for flood channel management.	Nominated implementing agency = ??? **Priority 1 – other funding**
B. Assessment of temporal/spatial variability of coastal water quality. Spatial and temporal variability in suspended sediments, nutrients and microbial contamination from the Nadi River, particularly during flood flows, needs to be assessed and the effects of different outflow rates from the Nadi River determined. This assessment should then form the basis for the design and implementation of a longer-term monitoring programme to define the effects/benefits of flood flow mitigation further up the catchment (Project 5.C).	Nominated implementing agency = ??? **Priority #1 – other funding**
C. Coastal water quality monitoring programme. Monitor sediment concentrations, nutrients and pathogens at strategically located sites for a prolonged period to determine the effects/benefits of the catchment	Nominated implementing agency = ???

[19] The Mamanuca Environment Society was established by the Mamanuca Fiji Hoteliers Association in 2002. It is a fully independent organisation funded by hotel membership, and grants from local and international stakeholders.

flood mitigation activities.	**Priority #2 – other funding**

6. *Nadi IWRM – Basin Flood Management Plan:* outputs from the above work streams will be critical to informing the development of an integrated flood management plan, which will need to be prepared as a pan-stakeholder project. It will be essential that all relevant implementing agencies and community groups are included in this plan, and its implementation, so community and stakeholder consultation will be a key element. A Nadi Basin Catchment Committee would need to be established (Nadi BCC). While such committees are widely established in New Zealand and Australia, this would be a unique body in the Pacific Region and the experience of setting this up/running the committee would be beneficial to the whole Pacific Region. This committee would include a wide-ranging group of stakeholders.

   It is envisaged that plan development would need to start after approximately 2 years of the IWRM programme and be iterated to include community input and the results of the on-going studies as they become available. This process will probably also identify areas where further studies are required to enhance current project activities and to support other activities going on in the Basin.

   The preparations of this plan will also benefit from outcomes of the EU Programme for Water Governance project completed in 2007 and the EU Water Facility funded IWRM National Planning Programme which started in December 2007. The Basin Flood Management Plan would become a cross-sectoral reference point to guide future catchment management in relation to risks associated with flooding, urban and rural, including agricultural development and planning.

   At present Government departments are defined by their legislative duties, and not necessarily by their policy delivery requirements as specified in their institutional mandates. Furthermore, many departments are consumed with performing basic legislative tasks, leaving them unable to proactively pursue other problems, especially the development of policies[20]. Where data is collected across a range of institutions it becomes difficult to determine progress, especially where information is stored and not shared across institutions. By Developing a Nadi Basin Catchment Committee there will be a stronger role and focus for local and municipal institutions to become involved in planning approaches and options, empowering local government to engage with communities, customary landowners and the private sector.

   The Basin Flood Management Plan would be developed based on five principles:

20 Lane, M.B., (2005) *The Governance of Coastal Resources in Fiji – an Analysis of the Strategic Issues, Report to IWP*. Geographical and Environmental Studies, The University of Adelaide.

- *Principle 1. Establishing partnerships* – supporting national, provincial and municipal state institutions to work together to achieve a basin wide objective. This will include modernising existing working practices to include much wider stakeholder consultation and engagement using new approaches to ensure that all stakeholders are learning together, decision making is improved, partnerships are developed, and collaborative working is developed through working with the lives of the people who live within the floodplain areas and the wider basin.
- *Principle 2.* Getting and sharing *better information* – amongst institutions so that the Nadi Basin Catchment Committee can make multi-sectoral decisions based on current and real-time information for the development and protection of the basin.
- *Principle 3. Strengthening capacities* – through multi-sectoral and multi-institutional working the project as a whole will improve national and local capacity to deal with flood and water management issues through integrating previously silo based institutions through representation on the Basin Catchment Council. Within an IWRM approach, decisions should be taken at the lowest appropriate level following full public consultation (the principle of *subsidiarity*). In the case of the Nadi Basin, by the people and the institutions directly responsible for living, coping, and managing the water resources and associated floods within the Nadi Basin. An appropriate combination of both 'bottom-up' and 'top-down' approaches to ensure that all viewpoints and mechanisms are considered is a key element to the modern management of floods.
- *Principle 4. Developing innovative economic and environmental tools and financing* – especially in relation to the use of the environment in coping with floods, and the potential damage of flooding on both the natural and built environments. For example, Environmental Impact Assessment (EIA's) are often geographically focused and are therefore limited in terms of technical content and processes. They tend to focus on the geographical area of the project, which provides at best a partial estimate of their impact, and on the short term biological and physical changes to water flows and fisheries, etc. Furthermore, they do not systematically address socio-economic issues and lack a comprehensive mechanism for the consultation of stakeholders such as local communities, provincial authorities and NGOs. EIAs often fail to address the cumulative impact of large scale infrastructure projects which involves more than simply adding-up their individual impacts. To understand how ecosystem services can help address these and other challenges it is useful to list current and expected water management problems. It is also important to know the geographical location and distribution of the various hydrological units in a basin. Here a land use inventory or map that identifies water bodies, forested areas, wetland and grassland areas, pastures, urban areas and

other forms of land use is very helpful, especially when working with communities to designate areas that need to be flood free or protected.

- *Principle 5.* Using, supporting and strengthening *national legislation and policies* – through review and support provided by the EU funded National IWRM Planning Programme to support institutions in, where necessary, policy review and revision, and legislative support.

Activity	Funding
A. Establish the Nadi Basin Catchment Committee (Nadi BCC) – developed initially as a flexible partnership based on extensive consultation within the Basin, 'inviting' external stakeholders 'into the basin' to witness the process, the Nadi BCC could be developed into an effective decision-making entity able to work across traditional institutional boundaries and with a wide variety of stakeholders. Initially supported by the project, the Nadi BCC would look to secure financial support through national funds and other mechanisms over the next five years. By the end of the project a Short Term (5yr), Medium Term (10yr) and Long Term (15yr) plan fro the development and sustainability of the Nadi BCC will be developed. **The Nadi Basin CC will be a sub-committee of the National Water Committee.**	Nominated implementing agency = ?? Land & Water Resources Management, Dept of MAFF and Min of Provincial Development **Priority #1 – IWRM funded**
B. Nadi Basin Flood Management Plan – flood management plan preparation: which will take into account outputs from the Demonstration Project work streams, current basin plans, and stakeholder input and cover both upper catchment and flood plain management issues (including infrastructure needs and using the natural environment for flood management/control). Initial work will include an assessment of present and future flood risks, as a function of the magnitude of the hazard, the degree of exposure to hazard, and the vulnerability of society against damage due to the hazard. The plan will be a working documents revised on an annual basis to ensure that annual experience of living and coping with flooding is learnt from.	Nominated implementing agency = ?? Land & Water Resources Management, Dept of MAFF and Min of Provincial Development **Priority #1 – IWRM funded**

In developing a Basin Flood Management Plan the following issues would need to be considered:

- *Leaving space for the river* – creating areas where minimal, low-value cultivation can take place, but which is designated part of the natural floodplain. However, floodplains contain fertile soils and the use of fertile areas as flood refuge areas may require some form of compensation/subsidy to farmers/landowners.

- *Creation of wetland areas* – depending on water quality and replenishment, constructed wetlands are valuable areas for fresh and marine water animals, etc. They also slow down flood waters which reduces the power of fast flowing water. However, in the case of Nadi Town, due to the back-up effect downstream of the town flood waters need to be discharged to sea as quickly as possible. Wetlands also take up space – space which may require resettlement and removes valuable development land from the coastline.

- *Using economic tools* – understanding the economic impact and longer term effects of decisions will help decision makers, including the Catchment Council, through engagement with stakeholders to make informed decisions. Formal land-use policies are often not the most appropriate way to manage flooding issues and control flood prevention. This is because land-use is connected to employment, control, power and economic development. Flexible approaches often produce better results in areas where multiple pressures are put on land. Subsidies and compensation may be options to control land development in floodplain and higher-risk areas, but alternatively incentive schemes to prevent development in certain areas may be more suitable alternative approaches – shifting development to other lower risk and less fragile parts of the basin and balancing this with economic development.

- *Adjustment and enforcement of building codes* – raising buildings reduces some of the flood damage costs, depending on the flood size. However, where flood waters reach and exceed a certain velocity the construction work needs to be of a high standard and technical design. One option would be to develop a national fund for the poorer communities to cope with this additional construction cost. Rougher building materials will slow down flood waters.

- *Nadi Town Drainage* – Nadi Town Council are well aware of the urban drainage issues. There is an urgent need to assist the Town Council in assessing the status of urban drains and to identify where the problems occur, including working with LAWRM, the Drainage Boards, and the Fiji Sugar Corporation to identify where agricultural drains cause the back-up of water back into urban areas. As part of the development of the Basin Flood Management Plan specific attention needs to be paid to urban areas. This includes an assessment of future development (concreted areas), access roads, paved areas, etc, and the need to consider alternative construction materials and approaches to cope with future flood events. This could include using roads as transfer channels for flood waters (using high kerbs and improved surface drains – provided they are well maintained), setting building back from lower road areas, permeable materials for car parks, etc.

- *Community Engagement and the Catchment Council* – under the principle of subsidiarity, there is an urgent in Fiji to decentralize approaches to the lowest decision making bodies. In the case of the Nadi Basin, a wide variety of stakeholders need to be included. The Basin Catchment Committee can provide the support for communities through consultation and consideration of their needs. The

Catchment Committee needs to be a sturdy organisation, populated with dynamic individuals from across sectors with a wide range of disciplinary experience (gender balanced), able to inform and guide government and other stakeholders and develop wider strategy development for the Nadi Basin. Short to medium term the Committee would need to establish a comprehensive mandate and powers (either as an entity in itself, or through member parent organisations) to enforce decisions. The Catchment Council may need to be the host of multi-sectoral datasets, initially providing baseline information on water use, flood areas, flood damage, infrastructure and other major assets, socio-economic information to determine poorer communities requiring assistance during floods and in re-building efforts, ecological information etc. This information is required to help monitor the effectiveness of the measures, and the Catchment Council itself over time. The Council can also demonstrate to Government the methods and approaches used to engage communities in a dynamic and complex basin, and will work to improve engagement approaches for wider use across Fiji, supporting and working with other Government departments in these areas, empowering local government to engage with local communities and customary landowners.

- *Other Issues to Consider* – a 'no regrets' approach to flooding needs to be adopted – ensuring that additional 'stress' (environmental, social and economic) is not put on the Basin. Measures need to be adopted which increase awareness and understanding of flood risk, measuring and recording flood levels for communities to see and understand the danger of floods. As part of any flood warning system flood preparedness guidelines need to be prepared.

All projects would involve working with the relevant stakeholder organisations. This Demonstration Project will also show how the management of floods can be improved with benefits for most of the Nadi basin inhabitants, commercial enterprises and ecosystem services. Lessons learnt will be shared and developed with other Pacific SIDS and demonstrate a more holistic catchment management approach.

Summary of proposed Projects/Components

Activities proposed under the IWRM Demonstration Project proposal are summarised in Table 3. Note that not all activities will be funded by GEF due to limitations with the budget. Co-funding will be sought throughout the project to support the other activities and the project will seek to source alternative funding from national government, regional government agencies, donors, and the private sector. The total budget for the selected activities under each component is US$500,000. The cost of the additional activities identified is estimated to be approximately US$590,000.

Table 3: Summary of Project Component, Activities, and Funding Sources

Project Component	Project Main Activities	IWRM Programme	Funding Source

		Priority	
1. Rainfall	**A. Upgrade hydro-climate monitoring network**	**1**	**GEF**
	B. Operational rainfall event forecasting	2	Other
2. Runoff	**A. Rainfall – runoff prediction model**	**1**	**GEF**
	B. Best-practice cultivation guide	2	Other
	C. Capacity building – land management	3	**GEF**
	D. Monitoring existing and new infrastructure (including retention dams)	4	**GEF**
3. River Network & Floodplain	**A. Riparian & floodplain vegetation mapping**	**1**	**GEF**
	B. Flood warning system	**1**	**GEF**
	C. Sediment flux assessment	2	Other
	D. Floodplain inundation modelling	2	Other
4. River/water health	A. Riparian management guidelines	1	Other
	B. Water quality & biological monitoring programme	2	Other
5. Coastal health	A. Mangrove mapping & ecological assessment	1	Other
	B. Water quality variability	1	Other
	C. Water quality & biological surveillance	2	Other
6. Nadi Basin Flood Management Plan	**A. Establish and support the Nadi Basin Catchment Committee**	**1**	**GEF**
	B. Develop first Nadi Basin Flood Management Plan	**1**	**GEF**

iii). End of Project Landscape:

At the end of the project, measures will be in place to greatly reduce the risk of floods and flood damage to the lower Nadi River floodplain, reduce sediment and pollution fluxes and enhance protection of human life through timely warning systems and capacity building. Control and management of the water resource in the basin will be linked and integrated to reduce flood risk while attaining more efficient use of land and water. Domination of the landscape by monoculture will have been reduced, and the ecosystem functions of the valley will have been enhanced through development of more appropriate and sustainable land usage practices.

In particular, the following primary indicators should be apparent:

- Agricultural practices will have altered resulting in reduced runoff and sediment pollution from agricultural areas within the Nadi Basin;

- Riparian zones along riverine corridors will meet criteria for filtering sheet-flow runoff and be well managed according to riparian best-practice guidelines. In particular, 1st Order channels will remain permanently vegetated;
- Unpaved roading runoff is routed through sediment detention ponds/wetlands;
- The channel carrying capacity for flood waters will have been improved to allow at least annual flood flows without bank over-topping;
- An effective flood warning system will be operating;
- Planning frameworks will be in place to better manage infrastructure, commercial and residential development on the flood plain;
- Effective monitoring and compliance will be in place ensure landuse and riparian management policies are actively maintained;
- A draft Nadi Basin Flood Management Plan will have been adopted by the Nadi Town Council and Department of Land & Water Resources Management and other stakeholders focusing on sustainable development of the land area integrated with long-term protection and conservation of the water resource. The plan will be advocated by a newly established and functioning Nadi Basin Catchment Committee

Flood risk is the product of many interacting, often complex, bio-physical and human issues. The regional environmental benefits from developing such a model would be in its ability to define an approach to assessing the critical paths for reducing flood magnitude and human/infrastructure risk. It is usually difficult to clearly identify cause and effect, then respond with effective mitigation, for such issues. Helping define the critical steps enhancing flood risk and defining what might be done about it will be particularly relevant for Pacific Island States in the future as they are expected to be the most vulnerable nations in the world to climate change related intensification of extreme/cyclonic weather events[21].

Guidance for regional scale adaptation is now critical as when these events occur humanitarian relief is extremely difficult to deliver. The adoption of effective models for watershed protection and sustainable land management will also result in a marked regional improvement in coastal and watershed environmental quality, supported by communities and stakeholders who recognise improvements within their own quality of life as a result of these initiatives. It is intended that lessons and best practices from this model and from the demonstration approach as a whole could be transferred globally to other SIDS (and non-SIDS) situations as relevant.

Project Outputs:

21 Intergovernmental Panel for Climate Change Fourth Assessment Report (AR4)

i) Better forecasting potentials and effective response measures introduced for the Nadi Catchment through availability of quality real-time precipitation data.

ii) Improved spatially explicit predictions of rainfall run-off for different bio-physical and socio-economic scenarios in place for the Nadi Catchment through availability of site specific rainfall-runoff model.

iii) Better flood channel conveyance processes put in place for the Nadi Catchment through the clear understanding of natural and human factors that contribute to sediment flow.

iv) Riparian management guideline available that would contribute to improvement of physical and water quality benefits for instream communities in the low order tributaries of the Nadi Catchment.

v) Better and appropriate management strategies in place for the Nadi Catchment through the better understanding of coastal water quality management.

vi) A comprehensive and realistic flood management plan for the Nadi Catchment in place that takes into consideration upper catchment and flood plain management issues.

H. Project Management Structure and Accountability:

The lead agency responsibility will be shared between the Mineral Resources Department which hosts the GEF IWRM Focal Point and is the Government Agency responsible for Water Resources Policy and the Land and Water Resources Management Unit of the Ministry of Agriculture, Sugar and Land Resettlement. The project will be overseen by the National Water Committee and will be managed locally through a Nadi Basin based Steering Committee. This will include the Mineral Resources Department, Land and Water Resources Management Division, Department of Environment, Fiji Meteorological Service, Hydrology Division of Public Works Department, Water Supply Department, Town & Country Planning Department, Department of Lands and Surveys, Disaster Management Council, Land Transport Authority, Native Land Trust Board, Nadi Municipal Council, Fiji Water Authority, Ministry of Health and Social Welfare, Fiji Visitors Bureau, Department of Tourism and relevant private sector operators. The local committee and associated governance framework is intended to provide a model for flood management elsewhere in Fiji and possibly for other PICs - the aim being for the Nadi Basin Steering Committee to become the Nadi Basin Catchment Committee to avoid overly bureaucratic procedures and use existing working mechanisms.

In addition, at the local level (Nadi valley) non-government stakeholders in the key sectors will participate in the committee or through liaison arrangements, such as the Fiji Hotels Association, beneficiaries in transport, land ownership, agriculture and fisheries. NGO participation is critical for evaluation of issues relating to environment, social issues and to assist with public consultation and education.

Current global natural resource management approaches suggest that in order to maximise benefits and improve sustainability an integrated approach needs to be adopted in designing common property resource projects. This includes ensuring the following is included:

- Participation of the concerned communities in planning, design, implementation, and monitoring of a project;
- Awareness raising and capacity building initiative for the concerned communities; awareness of the need for protection and conservation of natural resources; and
- Creation of self-reliance among the members of the participating community, including valuing their environment for flood protection.

Given the complex nature of the project 2 full time staff will be required for delivery of this project:

1. *Project Manager* – a senior position (15yrs plus experience) requiring flood management knowledge, ideally educated in an engineering or a related based discipline, with sound knowledge of relevant stakeholder organisations and the relevant Fiji water polices and processes. A detailed Terms of Reference will be prepared and agreed to by the National Water Committee at project start.
2. *Project Adviser* – an advisory position (5-10 yrs experience) with experience and qualifications in an environmental and/or social subject. A detailed Terms of Reference will be prepared and agreed to by the National Water Committee at project start.

Both positions require dynamic individuals with good participatory and facilitation skills who are ready to articulate change with the institutions working within the Basin and need to be able to help the institutions go through this change process. Both positions ideally need to have experience of working with donor organisations. Project staff will be based in Nadi Town and together will form the Project Management Unit.

Three key tasks of the PMU will be:

1. To secure funds through the national budget, NGO's, private sector, and other donor programmes over the five year period (from project start) to fund the other components of this project which GEF is unable to support;
2. To assist the Fiji Met. Service to move the current situation forward regarding financing for equipment from Meteo France, and;
3. To look at different options to support, finance and improve the role of the Nadi Basin Catchment Committee to ensure it remains a viable management unit for the Nadi Basin.

Project Implementation – Both the above positions will be responsible for both managing the project and reporting to relevant agencies, but also actual project implementation. It is envisaged that during the first six months of the project a full project logframe will be developed in consultation with all stakeholders prior to the start of on-the-ground activities.

The Project Management Structure is presented in Figure 5 below. The Project Management Unit (PMU) will be advised by the National IWRM Focal Point and the National Water Committee (the National IWRM Focal Point is also a key member of the National Water Committee). A Technical Advisory Group will also support the PMU.

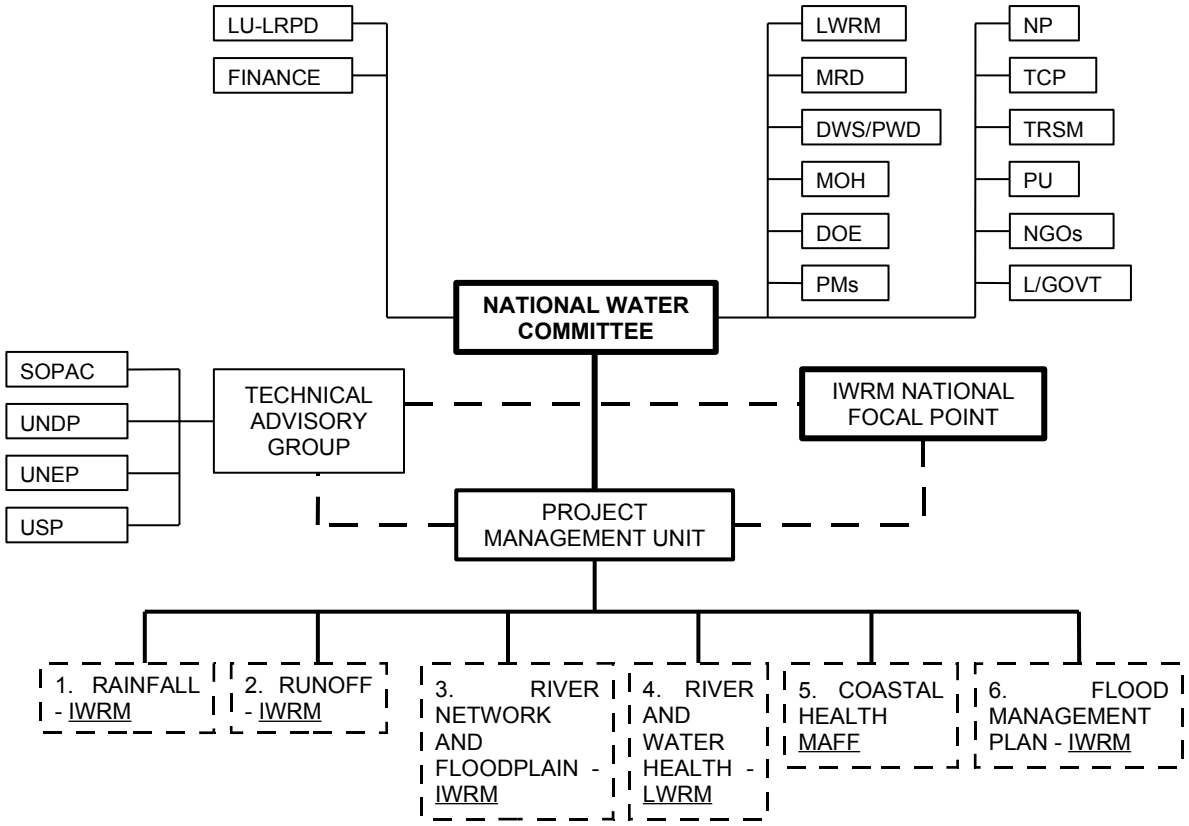


Figure 5.: Project Management Structure

I. Stakeholders and Beneficiaries:

As noted earlier, there will be many agencies (central/local government and commercial) that are critical beneficiaries of this work, with many being involved to ensure an integrated, multi-sectoral approach to developing the workplan and its implementation.

They include:

- NGO's
- Airports Fiji Ltd
- Central Board of Health
- Commercial retail interests in Nadi Town
- Other Private Sector
- Dept of Environment
- Dept of Tourism
- Dept of Water & Sewage
- Fiji Islands Visitors Bureau
- Fiji Sugar Cane Growers Association
- Lands & Minerals Dept
- Local villages & Farmer Groups
- Land & Water Resources Management
- Mamanuca Environment Society
- Min Agriculture, Fisheries & Forestry
- Fiji Water Authority
- Secretariat of the Pacific Community
- Min of Provincial Development
- Min. of Tourism
- Mineral Resources Dept
- Nadi Town Council
- Native Land Trust Board
- Police Operations
- Provincial Development & National Disaster Management Office
- Public Works Dept (Hydrology)
- Town & Country Planning Dept
- Transport, Works & Energy Dept
- DISMAC[22]
- Min. Health & Social Welfare
- Church Groups
- Rotary Club and other Private sector groups
- Live and Learn Environmental Education
- District Office

[22] As part of wider restructuring within the Fiji Government Disaster Risk Management and the National Disaster Management Office is now located with the Ministry of Provincial Development. The move is part of a wider initiative to decentralise and mainstream provincial development in order to engage with communities in the development planning and decision-making process.

The majority of these groups have already been consulted and are committed to achieving the Objectives of the Nadi Basin Flood Management programme. The Ministry of Tourism are particularly concerned about the current flooding problems and strongly advocates for a solution as the international airport can be cut-off for days to weeks during the flood events which creates massive disruption to the tourist industry and associated supply chains.

J. Long-term Sustainability Strategy:

Long-term sustainability must be a key thread of the Nadi Basin Flood Management Plan. Achieving this goal will require:

- Amendments to land-use designations in regional plans and planning frameworks;
- Development of locally based management guidelines for tillage practices and riparian retirement/management;
- Simple and robust technologies which do not require a high level of maintenance;
- Well developed warning systems with on-going resourced support from Government;
- On-going education for best management practices for land, and associated capacity building for mitigating flood effects before and during events.

It will be essential to get these commitments as part of the development of the Nadi Basin Flood Management Plan. Building effective partnerships must be a priority for the implementation process.

K. Replicability:

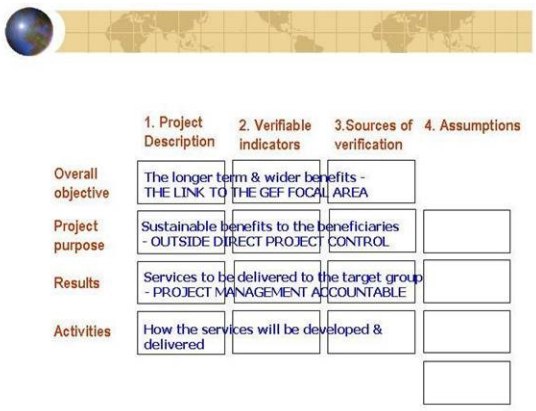
The concept of Integrated Flood Management should have immediate benefits to the population of the Nadi Basin. A coordinated approach is desperately needed, and through the proposed Basin Catchment Committee this project will help move the situation forward to make flood management a reality, rather than an annual disaster risk which society is forced to cope with.

The project approach is intended to become a model for other catchments experiencing flooding in Fiji and the Pacific. Fiji is expected to share experiences and lessons learned with Vanuatu, PNG, and Samoa within the Pacific, and with Trinidad & Tobago, St Lucia, and other relevant countries in the GEF IWCAM project.

L. Monitoring and Evaluation Process:

The project will support and strengthen existing initiatives and seeks to determine baseline information on ecological, hydrological and socio-economic background and parameters in order to define some initial baselines. This will then be linked to the physical and economic changes caused by this project, and the

other initiatives working in the basin in an attempt to provide information for decision-making purposes. Community involvement is critical to the success of the project, and through active involvement serves to provide an effective monitoring approach, feeding in information on what works, and what does not work over the lifetime of the project to allow best practice to be identified, and a range of different approaches to be indentified of use to Viti Levu, Vanua Levu, and other SIDS in general.



For this project to be successful it must monitor change over time against a base line set of evidence. As a result of linkages made with existing on-going initiatives some baseline data is already available. Other data will be captured at the beginning of the project (Year 1).

Project activities will be refined during the first six months of the project in close consultation with stakeholders. One approach is to ensure that the project includes communities and wider stakeholders as part of a participatory monitoring and evaluation plan. Community level approaches, and the impacts of these need to be understood to ensure that the project learns the lessons and shares these up to National level.

Communities will be asked to report (using appropriate mediums) on project process – to ensure ownership of their own actions and understanding of cause and effect. Often, unless the actual impact of negative actions can be seen it is difficult to convey the 'right' message to people. Using technology support such as RS and GIS images, photo and video media this project will highlight different impacts on the environment, along the ridge to reef transect.

An annual meeting, in which communities will be encouraged to present their own findings, will be arranged. Standard reporting will follow by the Project Manager. Table 4 contains an initial Monitoring and Evaluation Framework to be refined during the first six months of the project.

Table 4: Monitoring and Evaluation Framework

Title:	Environmental and Socio-Economic Protection in Fiji: Integrated Flood Management in the Nadi River Basin		
Objective:	To improve flood preparedness and integrate land and water management planning within the Nadi Basin using an integrated flood management approach		
Purpose:	Improved catchment resilience to flood impacts and better flood preparedness and management within the Nadi Basin using Integrated Flood Management approaches		
Components	**Activities**	**Baseline Indicators ***	**Target Indicators**
1. Rainfall	**A. Upgrade hydro-climate monitoring network:** (i) Assessment & identify equipment needs (ii) Equipment sourcing and procurement (iii) Installation & training (incl. fault diagnosis and repair training)	• Current datasets and records • Monitoring equipment in place and functioning • Repairs and maintenance reporting & budget in place	• Basin wide hydro-climate monitoring system established by project year 3 • By project year 5 95% complete data recovery & analysis • By year 5 funds allocated to hydrological systems, maintenance, transport and reporting • XX trained technicians in place by project year 3
	B. Operational rainfall event forecasting:	***Not funded by GEF***	

2. Runoff	**A. Rainfall – runoff prediction model** (i) Data source and capture (ii) Model development and integration (iii) Training	• Current datasets and records • Monitoring equipment in place and functioning • Data analysis and assessment status • Communication and awareness raising programme	• By project year 3 fully functioning rainfall – runoff prediction model in place • XX trained staff in model development, use and analysis, with ongoing training provided • Communication programme in place by project year 3 between agencies responsible
	B. Best-practice cultivation guide	***Not funded by GEF***	
	C. Capacity building – land management (i) Stakeholder engagement and consultation – awareness raising to the issues (ii) Stakeholder workshops (iii) Guidelines development and drafting (iv) Stakeholder workshops and consultation on draft (v) Using local farms to pilot approaches	• Links to community and farmer groups • Existing cultivation approaches and guidelines • Agricultural extension services & support programmes • Current monitoring of land management practices	• Stakeholder workshops conducted on a regular basis • Cultivation guidelines published and distributed based on stakeholder consultation • Pilot approaches on at least 4 farms by year 3 of project across Nadi Basin • Stakeholder workshops on the farms to monitor impact of new techniques
	D. Monitoring existing and new infrastructure (including retention dams) (i) Infrastructure and current plan assessment (ii) Recommendations for future activities (including possible need for retro-fitting) (iii) Asset maintenance plan development	• Operation & Maintenance schedule • Asset mgmt plan and budgeting (capital repair funds etc) • Alternative agriculture and irrigation plan • Agricultural extension services & support programmes	• Operation & maintenance schedule, resources and budget in place by yr 2 of the project • Alternative agricultural practices approach (with full stakeholder consultation) presented by end yr 1 of project

3. River Network and Floodplain	**A. Riparian & floodplain vegetation mapping** (i) Participatory infrastructure, ecological and channel geometry survey (ii) Develop GIS mapping for riparian zones	• Existing land use and planning maps, GIS/RS and other databases (FLIS, etc) • Existing river survey information • Community monitoring and village activities • Private Sector and Town Council involvement	• Surveys conducted by end yr 2 of project • GIS in place for *(i)* initially Nadi River, then *(ii)* wider basin • Institutional home, budget, mandate for use and responsibilities assigned to GIS system by end yr 3 • Staff trained in GIS use & analysis
	B. Flood warning system (i) Socio-economic assessment on benefits of flood warning system (ii) Communication and awareness strategy developed with communities, including determination of best flood warning approach for the Nadi Basin based on options from socio-economic assessment (iii) Flood preparedness and response plans developed (iv) Determine most appropriate institutional setting (v) Construct warning system (depending on methods construction may include tele-communications, siren warnings, etc)	• Existing flood warning system and approaches • Existing communication approaches and flooding indicators • Existing institutional coordination and approaches prior, during and after flood events • Current clean-up and restructuring approaches and funds available	• Socio-economic survey conducted by end year 2 • Communication and awareness strategy in place by year 2.5 • Flood response and preparedness plans in place by end yr 3 • Feasibility and scoping of flood warning system by end yr 3 • Flood warning system in place by end yr 4
	C. Sediment flux assessment	***Not funded by GEF***	
	D. Floodplain inundation modelling	***Not funded by GEF***	

4. River/Water Health	**A. Riparian management guidelines**	***Not funded by GEF***
	B. Water quality & biological surveillance	***Not funded by GEF***
5. Coastal Health	**A. Mangrove mapping & ecological assessment**	***Not funded by GEF***
	B. Water quality variability	***Not funded by GEF***
	C. Water quality & biological surveillance	***Not funded by GEF***

6. Nadi IWRM Basin Flood Management Plan	**A. Establish and support the Nadi Basin Catchment Committee** (i) Awareness raising (ii) Stakeholder consultation (iii) Drafting of ToR for the Nadi Basin Catchment Committee and members (iv) Map institutional set up and location of Nadi BCC (v) Establish Nadi Basin BCC (vi) Determine reporting and awareness activities (v) Basin tours for BCC. Facilitated workshops with BCC to produce problem and objective trees (vi) Identify options for sustainable financing (and institutional home) of Nadi BCC, GIS Mgmt Plan, and other Project Outputs. (vii) Develop 5, 10, and 15yr Nadi BCC duties – linked to Basin Flood Mgmt Plan	• Current institutional make-up and approach • Current planning and development approaches • Current regulation and enforcement of planning rules • Current approach for dealing with flooding and river basin management • Community stakeholder and participation approaches • Financing for water and environmental protection and flooding • Cross sectoral integration mechanisms • Information and communication systems	• Institutional and responsibility mapping (together with stakeholder analysis) by end month 4 • Concept report on Nadi Basin Catchment Council including draft Council ToR by end month 6 • Institutions and members of Nadi BCC indentified, reporting schedule agreed, mandata of BCC agreed by month 9 • First draft annual budget for Nadi BCC drafted by end yr 1 (and per year thereafter) • Funding source for Nadi BCC indentified by end yr 3
	B. Develop first Nadi Basin Flood Management Plan (i) Draft Contents of Basin Flood Mgmt Plan (including vision, strategy etc, building on previous IWRM goals identified) (ii) Open Contents through BCC to wider stakeholder consultation (iii) Draft Basin Flood Mgmt Plan	• Existing flood management approaches and plans	• Contents of Basin Flood Mgmt Plan drafted and presented by end yr 2 • Institutional responsibilities identified and financial allocations in place for plan implementation • Final Plan drafted by end yr 4 of project

7. Project Management & Design	**A. Establish Project Management Unit** (i) Recruit Project Manager and Project Assistant (ii) Establish Project Management Unit office^ (iii) Identify and clarify stakeholders (iv) Re-visit project design with stakeholders and refine design and approach where necessary (v) Source additional funding		• PMU recruited and full functioning by month 2 of project • Detailed stakeholder analysis conducted by month 4 of project • Revision of project design with stakeholders by month 6 of project • Additional funds sourced by end yr 1, 2, 3, 4, & 5 of project

Notes: * Baseline information needs to be collected during the first six months of the project as the design is refined. The current information in the Baseline Indicator column above specific the type of information required and suggests possible sources and types of baseline information/indicators which need to be developed for monitoring purposes. ^ The PMU office could be conveniently located within the District Office.

M. Co-Funding:

To be completed

i) Integrated Water Resources Management in Fiji (EU) = US$XXX

Activities:

- The EU IWRM programme is intended to include funding for institutional and legal aspects relevant to the project, namely the development of agency mandates and law and regulations for the implementation and enforcement of the floodplain plan.

ii) Flood Warning System for the Navua River, Fiji – (EU) = US$$XXX

Activities:

iii) Coral Reef Initiative for the South Pacific (CRISP) – FranceActivities

iv) Hydrology for the Environment, Life and Policy (HELP) – (UNESCO) = US$XXX

Activities:

v) Land and Water Resources Management Unit (LWRM) = US$XXX

Activities:

vi) Live and Learn Environmental Education Governing Waters Project (EU) = US$XX

Activities

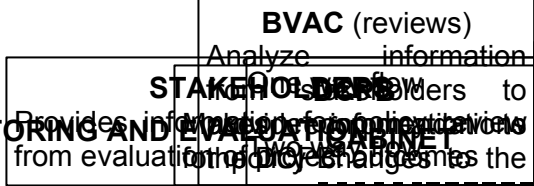
vii) *Sustainable Land Use Options in the Sugar Cane Belt, Fiji – NZAid = US$188,000*

Activities:

viii) *Fiji Stream Health Monitoring and Assessment Kit Development – NZ Aid = US$190,000*

Activities:

- Development of a protocol for village communities to sample stream biota
- Link levels physical and riparian habitat degradation with the composition of bottom-dwelling biota



- Develop a pollution tolerance rating for common stream invertebrates
- Train villagers, and school/university students in the application of the methodology
- Carry out broad surveys of stream health in Fiji in undeveloped, moderately developed and highly developed reaches to validate the methodology.

ix) Hydrology for the Environment = US$XXX

Activities:

x) Hydrological Cycle Observing System (HYCOS) = US$XXX

Activities:

Total: US$XXX

ANNEX A1: BUDGET DETAILS

Component	Budget Item	USD GEF	USD In-kind	USD Co-funding Funds	USD Donor	Total
Project Management & Design	**A. Establish Project Management Unit**					
	(i) Recruit Project Manager and Project Assistant		5,000		GoF	5,000
	(ii) Establish Project Management Unit office (Office rental, communications, utilities and stationery etc)	1,500	20,000		GoF	21,500
	(iii) Identify and clarify stakeholders	2,000				2,000
	(iv) Re-visit project design with stakeholders and refine design and approach where necessary	3,000	4,000			7,000
	(v) Equipment (2 x laptops, 1 x digital camera, 1 x printer, 1 x GPS)	5,700				5,700
	(vi) Salaries for Project Management (1 x Project Manager and 1 x Project Adviser)	50,000				50,000
Subtotal:		*62,200*	*29,000*	*0*		*91,200*
1. Rainfall	**A. Upgrade hydro-climate monitoring network:**					
	(i) Assessment & identify equipment needs	7,500				7,500
	(ii) Equipment sourcing and procurement	60,000				60,000
	(iii) Installation & training (incl. fault diagnosis and repair training)	60,000				60,000
Subtotal 1:		*127,500*	*0*	*0*		*127,500*
2. Run-off	**A. Rainfall – runoff prediction model**					
	(i) Data source and capture	10,000				10,000
	(ii) Model development and integration	14,000				14,000
	(iii) Training	10,000				10,000
	C. Capacity building – land management					
	(i) Stakeholder engagement and consultation – awareness raising to the issues	4,000				4,000
	(ii) Stakeholder workshops	6,000				6,000
	(iii) Guidelines development and drafting	5,000				5,000
	(iv) Stakeholder workshops and consultation on draft	8,000				8,000
	(v) Using local farms to pilot approaches	5,000				5,000
	D. Monitoring existing and new infrastructure (including retention dams)					
	(i) Infrastructure and current plan assessment	10,000				10,000
	(ii) Recommendations for future activities (including possible need for retro-fitting)	8,500				8,500
	(iii) Asset maintenance plan development	5,000				5,000
Subtotal 2:		*85,500*	*0*	*0*		*85,500*
3. River Network and Floodplain	**A. Riparian & floodplain vegetation mapping**					
	(i) Infrastructure, ecological and channel geometry survey	10,000				10,000
	(ii) Develop GIS mapping for riparian zones	10,000				10,000
	B. Flood warning system					
	(i) Socio-economic assessment on benefits of flood warning system	15,000				15,000
	(ii) Communication and awareness strategy developed with communities, including determination of best flood warning approach for the Nadi Basin based on options from socio-economic assessment	9,800				9,800
	(iii) Flood preparedness and response plans developed	12,000				12,000
	(iv) Determine most appropriate institutional setting	3,000				3,000
	(v) Construct warning system (depending on methods construction may include tele-communications, siren warnings, etc)	115,000				115,000
Subtotal 3:		*174,800*	*0*	*0*		*174,800*
6. Nadi IWRM Basin Flood Management Plan	**A. Establish and support the Nadi Basin Catchment Committee**					
	(i) Awareness raising					30,000
	(ii) Stakeholder consultation					0
	(iii) Drafting of ToR for the Nadi Basin Catchment Committee and members					0
	(iv) Map institutional set up and location of Nadi BCC					0
	(v) Establish Nadi Basin BCC					0
	(vi) Determine reporting and awareness activities					0
	(v) Basin tours for BCC. Facilitated workshops with BCC to produce problem and objective trees					0
	(vi) Identify options for sustainable financing (and institutional home) of Nadi BCC, GIS Mgmt Plan, and other Project Outputs.					0
	(vii) Develop 5, 10, and 15yr Nadi BCC duties – linked to Basin Flood Mgmt Plan					0
	B. Develop first Nadi Basin Flood Management Plan	30,000				
	(i) Draft Contents of Basin Flood Mgmt Plan					20,000
	(ii) Open Plan Contents through BCC to wider stakeholder consultation					0
	(iii) Draft Basin Flood Mgmt Plan					0
	(iv) Implement Plan	20,000				0
Subtotal 6:		*50,000*	*0*	*0*		*50,000*
Total:		**500,000**	**29,000**	**0**		**529,000**

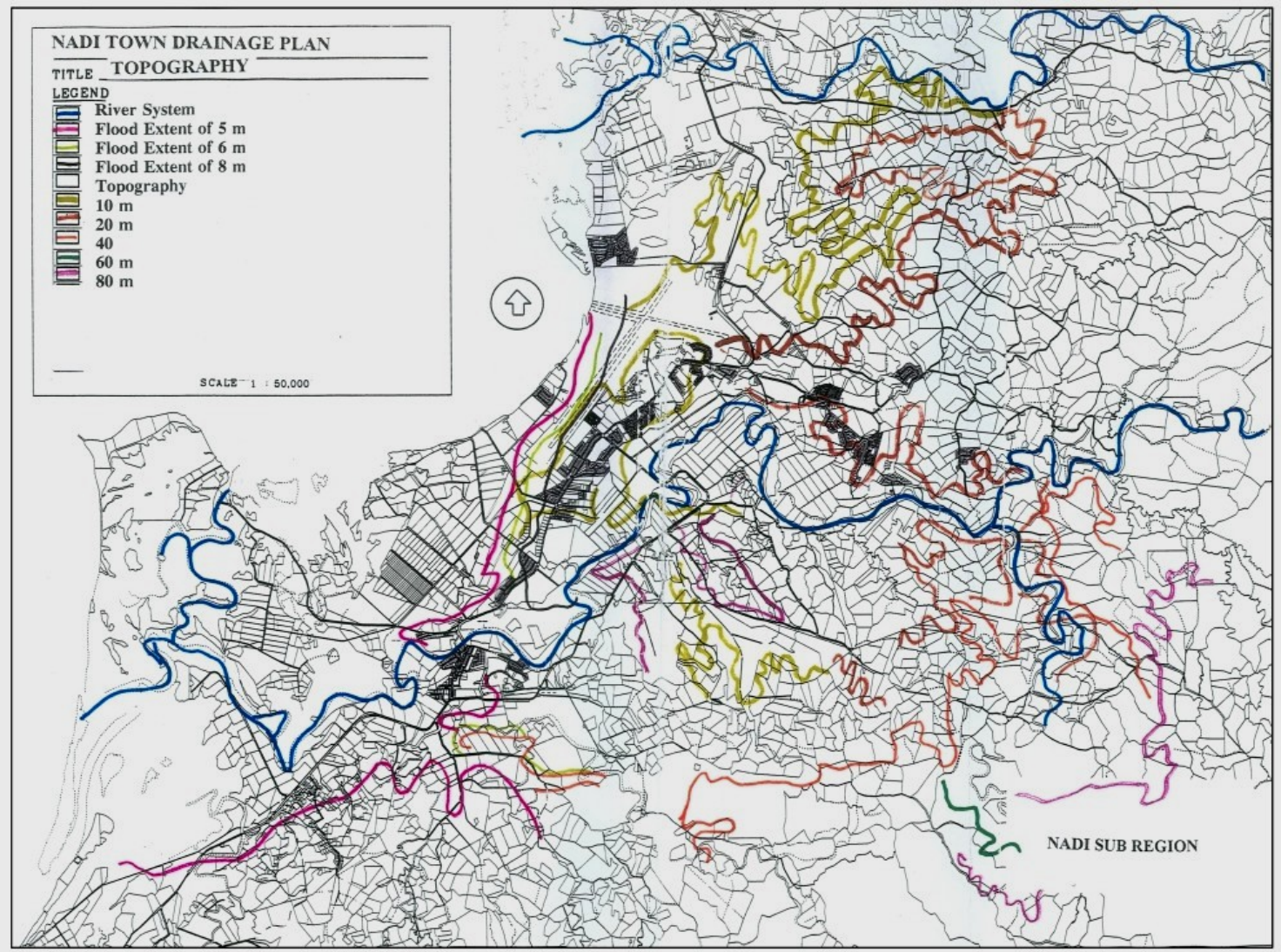
ANNEX A2: BUDGET SUMMARY

BUDGET LINE	US$	US$		US$
	GEF	OTHER		TOTAL
		In-Kind[1]	Funds[2]	
SALARIES	50,000			
EQUIPMENT	188,200			
MAINTENANCE	75,000			
REPORTING AND PA	6,500			
SUB-CONTRACTS:				
Model Development	24,000			
Capacity Building and Stakeholder Consultation	37,800			
Flood Warning System	68,500			
Nadi Basin Catchment council and Basin Flood Management Plan	50,000			
TOTAL	**500,000**			

ANNEX B: WORKPLAN

Components	Activities	YEAR 1				YEAR 2				YEAR 3				YEAR 4				YEAR 5			
		Qrt 1	Qrt 2	Qrt 3	Qrt 4	Qrt 1	Qrt 2	Qrt 3	Qrt 4	Qrt 1	Qrt 2	Qrt 3	Qrt 4	Qrt 1	Qrt 2	Qrt 3	Qrt 4	Qrt 1	Qrt 2	Qrt 3	Qrt 4
1. Rainfall	**A. Upgrade hydro-climate monitoring network:**																				
	(i) Assessment & identify equipment needs																				
	(ii) Equipment sourcing and procurement																				
	(iii) Installation & training (incl. fault diagnosis and repair training)																				
	B. Operational rainfall event forecasting:																				
2. Runoff	**A. Rainfall – runoff prediction model**																				
	(i) Data source and capture																				
	(ii) Model development and integration																				
	(iii) Training																				
	B. Best-practice cultivation guide																				
	C. Capacity building – land management																				
	(i) Stakeholder engagement and consultation – awareness raising to the issues																				
	(ii) Stakeholder workshops																				
	(iii) Guidelines development and drafting																				
	(iv) Stakeholder workshops and consultation on draft																				
	(v) Using local farms to pilot approaches																				
	D. Monitoring existing and new infrastructure (including retention dams)																				
	(i) Infrastructure and current plan assessment																				
	(ii) Recommendations for future activities (including possible need for retro-fitting)																				
	(iii) Asset maintenance plan development																				
3. River Network and Floodplain	**A. Riparian & floodplain vegetation mapping**																				
	(i) Infrastructure, ecological and channel geometry survey																				
	(ii) Develop GIS mapping for riparian zones																				
	B. Flood warning system																				
	(i) Socio-economic assessment on benefits of flood warning system																				
	(ii) Communication and awareness strategy developed with communities, including determination of best flood warning approach for the Nadi																				
	(iii) Flood preparedness and response plans developed																				
	(iv) Determine most appropriate institutional setting																				
	(v) Construct warning system (depending on methods construction may include tele-communications, siren warnings, etc)																				
	C. Sediment flux assessment																				
	D. Floodplain inundation modelling																				
4. River/Water Health	A. Riparian management guidelines																				
	B. Water quality & biological surveillance																				
5. Coastal Health	A. Mangrove mapping & ecological assessment																				
	B. Water quality variability																				
	C. Water quality & biological surveillance																				
6. Nadi IWRM Basin Flood Management Plan	**A. Establish and support the Nadi Basin Catchment Committee**																				
	(i) Awareness raising																				
	(ii) Stakeholder consultation																				
	(iii) Drafting of ToR for the Nadi Basin Catchment Committee and members																				
	(iv) Map institutional set up and location of Nadi BCC																				
	(v) Establish Nadi Basin BCC																				
	(vi) Determine reporting and awareness activities																				
	(v) Basin tours for BCC. Facilitated workshops with BCC to produce problem and objective trees																				
	(vi) Identify options for sustainable financing (and institutional home) of Nadi BCC, GIS Mgmt Plan, and other Project Outputs.																				
	(vii) Develop 5, 10, and 15yr Nadi BCC duties – linked to Basin Flood Mgmt Plan																				
	B. Develop first Nadi Basin Flood Management Plan																				
	(i) Draft Contents of Basin Flood Mgmt Plan																				
	(ii) Open Contents through BCC to wider stakeholder consultation																				
	(iii) Draft Basin Flood Mgmt Plan																				
	(iv) Implement Plan																				
7. Project Management & Design	**A. Establish Project Management Unit**																				
	(i) Recruit Project Manager and Project Assistant																				
	(ii) Establish Project Management Unit office																				
	(iii) Identify and clarify stakeholders																				
	(iv) Re-visit project design with stakeholders and refine design and approach where necessary																				

ANNEX C:


NADI TOWN DRAINAGE PLAN
TITLE TOPOGRAPHY
LEGEND
River System
Flood Extent of 5 m
Flood Extent of 6 m
Flood Extent of 8 m
Topography
10 m
20 m
40
60 m
80 m
SCALE 1 : 50,000
NADI SUB REGION

ANNEX D: CO-FIN LETTERS

To be attached