Economic Costs of the 2009 Floods in the Fiji Sugar Belt and Policy Implications

Padma Narsey Lal, Rashmi Rita and Neehal Khatri

IUCN Oceania

Fiji Land Information System

Tukutuku ni Vanua

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Executive Summary

The January 2009 floods in Fiji were reported as the worst in the history of the country since the 1931 floods. Many parts of the country were affected by a number of consecutive flood events that spread over several days. The floods affected areas from Western Viti Levu where the impact was greatest, to the Northern and Central Divisions of Fiji. With excessive rainfall experienced for over a week most of the low lying areas in the country were under water for days and in places experienced flood levels of up to 3-5 metres.

This study was financed by the European Commission under its National Adaptation Strategy Technical Assistance to Fiji, Accompanying Measures Support Program (AMSP) 2006. The project was jointly implemented by the Regional Oceania Office of the International Union for the Conservation of Nature (IUCN) in Fiji, and the Fiji Land Information System of the Department of Lands, Government of Fiji. Activities were implemented in collaboration with Fiji Sugar Commission's constituencies, the Fiji Sugar Corporation (FSC), Sugar Research Institute of Fiji (SRIF) and Fiji Sugar Cane Growers Council (SCGC).

The key objectives of this study are to:

- Assess the economic costs of the recent floods on the sugarcane farmers – sugar cane production and household livelihood and cane access roads and farm drainage infrastructure; and
- Identify policy options for minimising flood related disaster risk in the sugar belt of Fiji.

Methodology

The United Nation's Economic Commission for Latin America and the Caribbean (ECLAC) disaster assessment methodology (ECLAC 2003), combined with a 'with and without' cost analysis, was used to assess the economic costs of the 2009 floods. Multiple sources of data was used, including a survey of a stratified sample of flood-affected farms selected using SUGAR-GIS.

Results

Flooding, or waterlogging of low lying areas and overflowing of rivers and creeks is generally associated with excessive rainfall beyond the regulatory capacity of landscape ecosystems. Flooding may also be associated with intrusion of sea water through storm surges and water inundation due to high tides, or breaks in coastal physical infrastructures, such as bund walls. Causes of flooding are wide and varied, including human induced changes in the catchment that increases rainfall-runoff as well as climate change and climate variability. Direct and indirect effects of floods in Fiji may be localized to low-lying areas or may be felt throughout the economy.

The total economic cost of the January floods in the sugar belt through damage to infrastructure and losses to growers and millers is estimated to be about $24 million. Additionally humanitarian costs of about $5 million were incurred. This assessment is based on a detailed 'with and without' floods impact assessment, including a field-survey based analysis, revealing key effects of the 2009 floods to include:

- Sugar cane and non-cane farms - loss in production[1], additional 'flood-related on-farm' costs;
- Sugarcane farm households – costs of house and/or possessions repair/replacement, health costs, lost wage and cleanup costs;
- Infrastructure – additional maintenance and repair costs of cane access roads, tramlines, drainage scheme drains & canals, infield drains);
- Mill repairs and loss in corresponding earnings due to decline in cane output; and
- Disaster humanitarian assistance.

1 It is noted that in some cases, particularly *bila* land, flooding actually may have an enriching effect on crop yields. These though are difficult to judge, as it depends on what type of soil came down with the floods. If it is top soil, then this may increase yield, but if it is sand that is brought down by flood waters, then cost of production may actually increase.

Growers' Farms and Household Costs
Growers' direct and indirect costs are estimated to be $13.4 million, or over half (56%) of the total flood-related costs. Grower costs include losses in cane output, non-cane and other farm losses, and direct and indirect household[2].

The impact of flood on the sugar belt though was not homogeneous. In total only 15 percent of 14,503 active sugarcane growers recorded at the end of 2008 cane season were affected by the floods, across 34 out of 39 sugar sectors. Four sectors, Lautoka, Koronubu, Saweni and Qeleloa, had over 35 percent of the farms affected by the floods. More than half the sectors had less than 10 % of the farms waterlogged/ 'flooded', with majority of the sectors having only small proportions of affected farms.

The industry is expected to see a loss in cane output by about 131,409 tonnes, valued at about $8.0 million, estimated using post devaluation cane price of $61.17/tonne. The largest loss in cane output is expected in Rarawai and Lautoka mill areas, accounting for 86 % of the losses, or $6.9 million. This is not surprising since Rarawai and Lautoka mill areas had the largest number of flood-affected farms and sectors.

House and Household Losses
Of the total grower cost of $13.4 million, direct and indirect losses to house and household due to loss in possessions, household repairs, human health costs, and cleanup costs was about $2.5 million. Loss to homes and household possessions were also relatively low (compared to the urban dwellers), largely because only a small proportion of homes are located in flood-prone areas. Majority of farmers have their home sites on relatively higher grounds even if their farms are not. Other effects, such as loss in off-farm income and health costs were also small.

Miller Costs
Costs to the miller accounted for 31% of the total losses in the sugar belt, or approximately $7.5 million. This included corresponding loss in FSC's revenue due to the loss in cane output, tramline damage costs, and the damage to the mills. The miller's share of the loss in cane output is about $3.4 million, together with the cost of extra maintenance of the tramlines ('with and without' flood costs), estimated to be about $1.57 million. Only Rarawai mill was directly affected by the floods, with an estimated cost of $2.43 million.

Infrastructure Costs
All aspects of the sugar industry infrastructure, cane access roads and tramlines, were badly affected by the floods. The floods also damaged many drainage schemes in the mangrove reclaimed areas due to breaks in the seawalls, scouring of drains, washing away of culvert crossings, flood gates, and flap gates. The total costs of additional maintenance work required on the cane access roads and tramlines and associated bridges are estimated to be $2.4 million, as compared with the earlier FSC estimate of $4 million. There are also additional infrastructure costs associated with damage to the drainage schemes in lying coastal areas valued at $2.4 million. Thus the total infrastructure cost was estimated to be about $ 4.8 million.

Humanitarian Costs
The cost of humanitarian assistance in the west and the north, including the cane belt areas, is estimated to be $4.7 million. This assistance was provided by many different domestic and international organizations in various forms, including disaster emergency boxes, food aid, school lunches, bus fares and medical kits. There was also $3.57 million in-kind assistance provided by the development partners directly to other humanitarian groups such as Red Cross and the United Nations Chidren's Fund (UNICEF). In addition there was $2.01 million collected under the Prime Minister's Disaster Relief Fund. There were also many commercial houses that either provided in cash or in-kind assistance directly or indirectly through other relief organizations, which are not captured in the above estimates.

Discussion

The 2009 floods caused widespread damage, affecting lives and livelihoods of many people in the sugar industry, as well as elsewhere in the country. The impacts of floods depend not only on the intensity of precipitation, the rainfall-runoff patterns and the resulting floods, but also on the ability of the excessive water, to be flushed out of the system and the speed with which the flood waters can recede. Sugarcane, being a hardy crop did not sustain much damage during the 2009 floods perhaps because the flooding

2 Value of washed away land is not included.

occurred at the end of summer, flood water did not remain stagnant for long, and the peak flood level was relatively low compared to the height of the cane. Other non-cane crops in the low lying areas, which are more sensitive to floods, though were totally lost; farms that had non-cane crops on higher grounds did not report any losses to their non-cane crops. Loss to homes and household possessions were also relatively low (compared to the urban dweller) because farmers usually have low household incomes, and thus fewer valuables. Perhaps more importantly only a small proportion of homes are located in flood-prone areas, and were thus affected. Majority of farmers have their home sites on relatively higher grounds even if their farms are not.
Loss of income to the miller came largely from the flood waters in the Rarawai mill, as well as the loss in their share of loss in cane output plus direct damage to the tramline infrastructure, which is the miller's responsibility. For other infrastructure, the costs will be borne by the growers, the government, and the miller.

Some of the damages could have been avoided had the infrastructure been maintained and more targeted disaster response and rehabilitation management had been adopted. The generally poor state of all infrastructure, main and infield drains, tramline drain and drainage schemes, as well as cane access roads and tramlines, contributed to effects of the flood.

Disasters, including floods, are known to have negative effects on national economic conditions, particularly in those countries heavily reliant on the primary sector. However, the difference is that while Fiji has had similar, if not higher, disaster related economic costs on the sugarcane farming sector in the past, the January 2009 floods could not have come at a worse time than when it did for the industry and the sugar belt.

The industry has been struggling to reform its operations, despite several attempts in the last decade. All sectors of the industry, farm production, harvest and transport, and the milling and processing sectors have been declining since at least the 1987 political coups (see (Lal 2008)). The floods will have direct impact on the cash flow in the industry, as well as affect basic livelihoods and household welfares of those farms worst affected.

The flood outcomes will be further aggravated by the contraction in the national economy by almost 4.7 % in 2008, and the potential loss of majority of the Euro 124 million (or approximately FJD 300 million) allocated to Fiji under the National Adaptation Strategy[3]. Secondly, in October 2009, Fiji will be losing its last set of price 'subsidies' from the European Union (EU), and thus its cash flow is expected to decrease considerably, even if the dollar has been devalued. Such economic woes will have flow-on effects throughout the country and many of the regional towns in the Western and Northern Divisions where cane is the lifeline, may become ghost towns.

It is worth noting that the economic cost estimates arrived in this study are lower than the $27 million figure provided by the industry stakeholders. The FSC estimated an economic cost of $27 million to the sugar industry including an estimated $10.9 million for the sugarcane crops (before devaluation, which changed the mill gate price of cane). At the same time, the SRIF has given an estimate of $22.6 million required to rehabilitate the affected crops/farms. These impacts on the sugar industry/belt did not include the cost of the floods on the drainage infrastructure, including in the main drainage schemes servicing the sugar farms, or the costs to the drainage schemes.

The lower cost estimates are noted despite the IUCN/Fiji Land Information System (FLIS) study using the higher forecast price following devaluation and including many other costs in this study not considered by the industry. Such additional costs considered in the study include costs of house and household level damages, drainage schemes costs and humanitarian costs. It should also be noted that many of the subcategories of costs estimated in this study are less than those earlier provided by the industry stakeholders. This may be as a result of differences in the assessment methodology used, and perhaps lack of capacity in the industry to undertake appropriate 'with and without' disaster impact assessment.

Poverty Effects of the Floods
Using the Food Poverty Line (FPL) and Basic Needs Poverty Line (BNPL) of Narsey (2008), adjusted to 2008 equivalent value using the Consumer Price Index (CPI), it is observed that due to the 2009 floods about 42 percent of flood-affected farms are expected to struggle to provide even their family's basic food

3 The funds are expected to be released when the Interim Government takes firm steps to return the country to a democratically elected government

needs. This is in comparison with 19 percent of farmers that are expected to fall below the FPL had the floods not affected their crops, off-farm income, and other indirect costs. In terms of basic needs poverty measure, 77% of the flood affected sugarcane families will fall below poverty line, as compared with 54% the families, had they not suffered from flooding. Labasa and Ba mill areas families were worst affected. Such projections are particularly of concern as the 'with and without' analysis in this project took into account off-farm income earned by members of the sugarcane household poverty analysis, and excludes all costs not associated with income generating activities. The analysis also did not include considerations of any debt which the farmers have.

It is thus not surprising that many sugarcane farmers, and others in the flood affected areas, were forced to make some difficult choices immediately following the floods. Many families had to choose whether, for example, to send their kids to school or to meet their basic food requirements. Had it not been for the humanitarian assistance provided by many national and international organizations, it is likely that many children would have dropped out of schools this year.

Policy Recommendations

Flood related disaster risk reduction and disaster risk management strategies cannot be treated in isolation. Flood related disaster management is part and parcel of the institutional improvements needed to tackle all hazards. Disaster risk reduction and disaster management of all hazards must become everyone's business.

In this report only immediate policy issues related to disaster risk reduction and disaster management that need to be tackled specifically in relation to the flooding in the sugar belt are highlighted[4]. Two categories of recommendations are relevant in this context of flooding in the sugar belt area - those that need to be addressed by the Government of Fiji within its disaster risk management context, and those that are of direct relevance to the Fiji sugar industry.

1. National level

As noted earlier, the probability of flooding is increased with changes in landscape for agriculture and urban development. Such developments affect the regulatory ecosystem services provided by natural systems, including the level of rainfall-runoff, and the amount of water that is not flushed out of the natural waterways.

Recommendation 1: *Invest in improving the health of natural ecosystem for flood mitigation through integrated river catchment management, including sustainable management of upstream forestry, good farm husbandry, and management remnant natural freshwater wetlands.*

Disaster risk reduction produces higher benefits, particularly for the poor, than disaster management. For every dollar invested in disaster risk reduction, between two and four dollars are returned in terms of avoided or reduced disaster impacts. Poor people are more sensitive to disasters because they often live in hazard-prone areas, live in poor conditions, and have limited capacity to respond to, recover from disasters. Disaster events also increase the poverty level, thus increasing the vulnerability of people who live below or near the poverty line.

Recommendation 2: *Adopt a pro-poor development strategy that targets poor communities living in areas prone to natural hazards.*

In the past, the Fiji Government, together with the sugar industry regularly invested in drainage and flood protection infrastructure, but the level of investment has decreased in recent years, particularly following the 1987 political coup. Poor maintenance of the drainage infrastructure affects not only the sugar cane farmers and the industry but also causes externality costs on the urban and peri-urban residents downstream.

4 A more comprehensive policy recommendation regarding disaster risk reduction and disaster rim management is included in the Annex 2 of this report, adapted from Lal et al 2009.

Recommendation 3: *Investigate appropriate insurance and other financing schemes for risk reduction and disaster management for the sugar belt.*

The Government needs to seriously consider establishing a disaster risk financing scheme that takes the responsibility of maintaining all drainage infrastructures in the sugar belt area. Poor maintenance of the drainage infrastructure affects not only the sugar cane farmers and the industry but also causes externality costs on the urban and peri-urban residents downstream.

Recommendation 4*: Increase investment in the maintenance of physical infrastructures including drainage canals, drains and infield farm drains to reduce probability of flooding.*

Unplanned and ad hoc peri-urban development also increases rainfall-runoff, increasing the probability of flooding beyond the natural systems regulatory capacity. Developments in hazard-prone areas also increase sensitivity of humans to flooding. Such impacts can be avoided through appropriate regulation of developments.

Recommendation 5: *Integrate disaster risk reduction considerations in all development initiatives, including:*

- *Integrate (in other words, 'mainstream') disaster risk considerations in national development planning and budgeting processes at national, provincial, district, and village/settlement levels and in development design*
- *Revise infrastructure development planning, maintenance, and funding to reflect requirements for hazard and risk assessments*
- *Revise development approval processes and guidelines to require hazard and risk assessments of development initiatives, particularly in hazard-prone areas-*
- *Develop and enforce proper land-use planning and development as a flood mitigation strategy*

Recommendation 6: *Integrate disaster risk reduction considerations in all infrastructure construction and maintenance initiatives and resource allocations that reflect considerations of disaster risk reduction, particularly in flood-prone areas.*

2. Industry Level

Sugar industry covers a wide area and thus has a significant impact on the dynamics of rainfall-runoff in the sugar belt and associated riverine systems.

Recommendation 7: *Establish a Fiji sugar industry disaster response strategy in partnership with the National Disaster Management Office and the Divisional Commissioners, including coordination for post disaster rapid assessment, disaster relief efforts, and post disaster rehabilitation.*

Recommendation 8: *To minimize the risk of regular floods the industry, as a minimum, needs to "go back to the future" and:*

- *Ensure farmers adopt appropriate farm management practices that minimise- farm level soil erosion, including the banning of agricultural development on slopes greater than 8^0 under the Soil Conservation Act;*
- *Re-establish maintenance of key infrastructure, main and arterial drains, and infield drains, as well as tramline drains and cane access road drains if the risk of regular flooding is to be minimized;*
- *Re-establish the old Colonial Sugar Refinery (CSR) drains, and reintroduce annual drainage gang system for maintaining key drain infrastructure; and*
- *Re-establish regular (annual) maintenance of drainage scheme infrastructure, including seawalls, bridges, and culverts.*

3) Information System

Good information is critical for disaster risk reduction and disaster management efforts. Fiji has limited quality data on flood and climate related hazards, flood-prone areas and disaster impacts, including coverage of disaster events and their effects on household welfare, sectoral activities, and national economy. For the sugar belt, a SUGAR-GIS information system is already available, that integrates various layers of information including, sugarcane farms, land owners and land tenure, mill catchment areas, rivers and streams as well as cadastral maps. This can be extended to key infrastructure, such as cane access roads, tramlines, and drainage schemes. Using flood inundation models for each river system, the database can be extended to create flood hazard maps, as well as flood impact areas to support future decision-making.

Recommendation 9: *Enhance its SUGAR-GIS information system and develop a flood hazard layer of information, together with a robust system for collecting and analysing disaster impact assessments to support disaster risk reduction and disaster management. As a minimum:*

- *Establish a robust sugar industry-based rapid assessment methodology that takes advantage of the field knowledge of FSC field and extension workers, and cane growers councillors;*
- *Develop a layer hazard related information system as part of the SUGAR-GIS information system, including maps of hazard and disaster-prone areas, the geographic distribution and socioeconomic characteristics of poor; and*
- *Using the Sugar-GIS based information system and the results of objective rapid disaster impact assessment, assist with targeted humanitarian assistance as well as post disaster rehabilitation in partnership with the Divisional Disaster Management Committee* (*DISMAC) office, relevant government ministries, humanitarian nongovernmental agencies, as well as development partners.*

Recommendation 10: *Improve the coverage and quality of data on floods and other climate related hazards, including flood maps, and on the impacts of floods and other disasters on human livelihood and wellbeing at household, sectoral, and national levels.*

- *Develop time series information on determinants of natural disasters to support the forecasting of disaster events*
- *Compile time series information on household income and expenditure, the human poverty index and human development index, and their key determinants to inform both development policies*
- *Link the enhanced SUGAR-GIS with the national Geographic Information Systems (GIS) based disaster information system, including maps of hazard and disaster-prone areas, the geographic distribution and socioeconomic characteristics of poor, disaster records and disaster impact assessments to help improve Disaster Risk Reduction (DRR) and Disaster Management (DM)*

Recommendation 11: *Strengthen capacity in appropriate 'with and without' disaster impact assessments.*

Recommendation 12: *Investigate appropriate insurance and other financing schemes for risk reduction and disaster management for the sugar belt.*

There are no financial mechanisms, including insurance schemes, available particularly to the farmers. Even where available, such as to the miller, they had recently opted not to insure their assets. The government needs to seriously consider establishing a disaster risk financing scheme for disaster risk reduction and disaster management. Recently, the World Bank had helped the Caribbean island countries to establish a Catastrophic Insurance Scheme. The experiences of the Caribbean island countries with the insurance scheme may have some relevance to Fiji (and other Pacific Island Countries (PICs).

Concluding Remarks

The severe rainfall pattern in January 2009 was considered to be a one-in-50 year event and the volume of water in the rivers and creeks were beyond their discharge capacity. However, the nature and duration of flooding of the low lying areas in the sugar belt is also a product of the changes in the regulatory services provided by the landscape due to increased agricultural developments, particularly on the steep lands and mangrove reclaimed lowlands. Some of the damage could have been avoided had the sugar industry and the government invested adequately in the maintaining of the natural health of the ecosystems, particularly by maintaining the drainage systems.

To minimise future flood-related costs, a multipronged disaster risk reduction and disaster management approach is required at all levels – national, industry and household levels. The government, the sugar industry in partnership with the National Disaster Management Office (NDMO) and other catchment-based stakeholders must invest in enhancing regulating ecosystem services provided by the natural landscape, as well as in the maintenance of the drainage systems. As a minimum, unless the industry 'goes back to the future' and invests in at least maintaining the key drainage infrastructures - including the old CSR drains, main drains and infield drains in the sugarcane farms, as well as the drainage schemes in the reclaimed mangrove and other coastal areas - such floods will continue, and will get worse with extreme weather events associated with climate change.

Disaster risk management in the sugar belt area though must also go beyond what the sugar industry should do. Economic wellbeing of rural households must also be improved to make them less sensitive to disaster events, and better cope with the residual risks they may face. Without adopting a multipronged approach to disaster risk reduction and disaster management, Fiji will continue to suffer the effects of flooding, particularly the poor, and regular floods would force more people in the sugar belt to fall below the basic needs poverty line.

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Preface

The January 2009 floods have been reported as the worst in the history of Fiji, since the 1931 floods. Many parts of the country were affected by floods that spread over several days – from Western Viti Levu where the impact was greatest, to the Northern and Central Divisions of Fiji. With excessive rainfall experienced for over a week most low lying areas in the country were under water for days and in places experienced flood levels of up to 3-5 metres.

Almost 12,000 people are reported to have become homeless, and many have lost all their possessions – foods, cooking utensils, clothing, livestock, and/or crops. Many roads, bridges and other infrastructure have been damaged or washed away. Included in the affected area is the sugar belt. Many sugar cane farms, cane access roads and rail infrastructures and mills were significantly affected by the floods. Segments of tramlines and roads have been washed away, mills have seen debris and mud deposited on their premises. The impacts of these floods were significant.

During and post-flooding, several assessments have been carried out by different government and non-government organizations to assess the extent of damage and level of humanitarian assistance required. Amongst the Non Governmental Organisations (NGOs) are the Red Cross, United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA) and Save the Children Fund. These different assessments focused on issues and responses of relevance to the respective agencies interests/mandates. Government agencies, coordinated through the DISMAC office, and later with the involvement of the Interim Prime Minister's office too, conducted their own assessments.

The Ministry of Agriculture surveyed the agricultural sector for damage to non-cane crops to identify the nature of assistance the Ministry could provide. The sugar sector was excluded. The Public Works Department conducted a survey of the public roads that were badly damaged. Cane access roads and tramline infrastructure, and drains in the sugar belt were left to the sugar industry to assess. The Fiji Lands Department conducted a survey of the state lands to assess the extent of flood damages on agricultural farms to determine what actions need to be taken by the government to give respite to state land tenants.

Detailed impacts of floods in the Nadi and Ba areas were recently assessed under a joint Secretariat of the Pacific Geoscience Commission (SOPAC) and United Nations Development Programme (UNDP) initiative. This study focused on developing an inundation 'model' for the two catchments, plus an economic assessment of the urban areas, covering households and commercial properties, and activities. Impacts on the sugar belt, covering the sugarcane farming area associated infrastructure and the mills are not included in this survey.

Sugar industry stakeholders undertook different surveys and came up with different estimates for the damage. FSC estimated an economic cost of $27 million to the sugar industry including an estimated $10.9 million for the sugarcane crops (before devaluation, which changed the mill gate price of cane). At the same time, the SRIF has given an estimate of $22.6 million required to rehabilitate the affected crops/farms. These impacts on the sugar industry/belt did not include the cost of the floods on the drainage infrastructure, including in the main drainage schemes servicing the sugar farms or the costs to the drainage schemes.

Recognising the gap in flood impact assessments, and the diverse range of estimates put forward by the different members of the sugar industry, this joint study of the IUCN and the FLIS was implemented, with the support of the European Commission under its National Adaptation Strategy Technical Assistance to Fiji, AMSP 2006[5].

5 The study was undertaken to also obtain cross sections empirical information which could be used to assess potential costs of climate change to Fiji's second most important sector.

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The study was supported by the Fiji Sugar Commission and its members, Fiji Sugar Corporation, Sugar Cane Growers Council, Sugar Industry Tribunal and the Sugar Research Institute of Fiji. The farm survey was conducted with the assistance of Chief Executive Officers of the respective industry stakeholders - Mr Deo Saran (FSC); Mr Surendra Prasad (SCGC); Mr Jai Shree Gawander (SRIF); and Mr John May (SCOF). They released their staff to help us implement the farm survey.

The field staff are too many to name them individually. Nonetheless the research team is very grateful for their willingness to work even outside normal working hours to see this survey completed in each of the sugar sectors affected by the recent floods (a list of survey team is attached as annex 1). The team though wishes to mention some key persons who helped coordinate the field staff, including Mr Mikaeli Bukuto, the then Manager Production Services, FSC Lautoka, Mr Apisalome Rokobaro, the Cane Logistics Manager, FSC Lautoka, Mr Vishwa Nadan, Field Superintendent, FSC Rarawai, Mr Sailasa Waitawa, General Manager, FSC Penang, Mr Amirka Prasad, Field Superintendent, FSC Labasa, Mr Sundresan Chetty, General Manager Operations, SCGC, Mr Rajendra Prasad, SCGC SEO Labasa, and Mr Sashi Kant, Senior Executive Officer, SCGC West. Many Sugar Cane Growers Councillors were also helpful in the field. Without their support, data required for this study could not have been efficiently collected and or compiled in the time available. Mr Sada Sivan, CEO, Fiji Sugar Fund also kindly shared information about the status of grower debts with the Fund. Mr Hemraj Mangal freely shared his practical knowledge of effects of floods on sugarcane farms. Review comments by Natalie Stalenberg of IUCN and Ms Paula Holland from SOPAC are also much appreciated. To each and every person who assisted us in this study, the team wishes to say:

Thank you, dhanyabad, and vinaka vakalevu.

Acronyms

ACRP	Accelerated Cane Replanting Programme
AMSP	Accompanying Measures Support Program
AusAID	Australian Aid
BNPL	Basic Needs Poverty Line
CPI	Consumer Price Index
CSR	Colonial Sugar Refinery
DISMAC	Disaster Management Committee
DM	Disaster Management
DRR	Disaster Risk Reduction
ECLAC	Economic Commission for Latin America and the Caribbean
EMDAT	International Emergency Disasters Database
EU	European Union
EPA	Economic Partnership Agreement
FLIS	Fiji Land Information System
FPL	Food Poverty Line
FMS	Fiji Meteorological Services
FSC	Fiji Sugar Corporation
GDP	Gross Domestic Product
GIS	Geographic Information Systems
GVP	Gross Value Product
HDI	Human Development Index
HFA	Hyogo Framework of Action
IUCN	International Union for the Conservation of Nature
LWRM	Land and Water Resource Management
NDMA	Natural Disaster Management Act
NDMC	National Disaster Management Council
NDMO	National Disaster Management Office
NGO	Non Governmental Organisation
NZAID	New Zealand Aid
PICs	Pacific Island Countries
RBF	Reserve Bank of Fiji
RSE	Relative Standard Error
SCGC	Sugar Cane Growers Council
SIDS	Small Island Developing States
SRIF	Sugar Research Institute of Fiji
SOPAC	Secretariat of the Pacific Geoscience Commission
TC	Total Costs
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
USAID	United States Aid
WHO	World Health Organisation

1. The Fiji Sugar Industry Context

Flooding has been a common occurrence in Fiji with floods accounting for almost a third of all disasters in the country since 1970 (Lal et al 2009). Flooding is generally associated with excessive rainfall beyond the regulatory capacity of landscape ecosystems causing waterlogging of low lying areas and overflowing of rivers and creeks. It may also be associated with coastal water intrusion through storm surges and high tides and breaks in physical infrastructures. Although flooding events follows natural phenomena, they are exacerbated by changes in rainfall-runoff patterns caused by changes in ecological landscape resulting from deforestation, physical infrastructure, agricultural, and urban developments. The direct and indirect effects of floods are often felt throughout the low lying areas, including the sugar belt. They may also have flow-on effects on the economy.

The sugar industry from its establishment in the late 19th century significantly influenced the natural landscape on the two main islands of Fiji. It has also been the largest contributor to Fiji's economy, that is, until recently when the tourism industry took over in the early 21st century. Even today, although sugar industry's dominance in the economy has been overtaken, it still accounts for about 5% of Gross Domestic Product (GDP) and generates about 20% of exports in 2006 (www.adb.org/statistics). The 2006 export value associated with the sugar industry was FD$234 million in 2006. It also provides around 12% of total employment in the country[6] . The sugar industry is the single most important employer in the rural areas.

Clearing of land for the sugar industry started during the early colonial period provided the basis for agricultural development in Fiji. The country was considered to have favourable climatic and suitable soil conditions for sugarcane farming, similar to the colonial power's experiences in the Caribbean Islands and South Africa.

Bringing people from India under the indenture system, the CSR (and other companies that later went out of business), established the sugar industry in Fiji on large estate plantations. The estate based farming was only scaled down to smallholding and independent farms in the early 1920s, soon after indenture system of recruiting labour was abolished, and the free 'migrants' chose to establish their own farms.

Free migrants and European settlers had difficulty in accessing good agricultural land for agriculture, because much of land was (and still is) owned by indigenous Fijians (see France (1969)). The colonial government created 'new land' by establishing large drainage schemes on coastal largely mangrove lands, land that belonged to the state. This led to the expansion of cane farms in low lying flood plains. These were developed largely at the turn of the 20th century by the CSR and also subsequently by the Fiji Government just around independence in 1970.

These mangrove reclaimed lands were developed by constructing seawalls to keep seawater out and clearing mangrove forests and reclaiming mangrove land for sugarcane plantations. Large drainage canals were constructed to encourage drainage of low lying areas. These coastal flat plains today comprise approximately 1/3 of the area under sugarcane.

Fiji sugar industry particularly expanded further following the preferential access to the markets, first in the UK under the agreement with the UK Government, and subsequently in European Commission countries' under the Lome Convention's EU Sugar Protocol. The Lome Convention was subsequently replaced by the Cotonou Agreement. Under these agreements, Fiji, and other African, Caribbean, and Pacific countries producing sugar received a guaranteed access to the EU markets at sugar prices well over double the world market price.

Such preferential prices led to the expansion of the industry (Kumar and Prasad 2004 and Lal and Rita 2005a). The number of growers doubled in less than twenty years and the area of cane harvested increased by over 50 percent. As the demand for land for sugarcane farming grew in direct response to the EU preferential access and prices, more native land was released by the Native Land Trust Board. The expansion particularly took place on hilly lands, including land over 8^0 that are considered unsuitable for agriculture under the country's Soil Conservation Act administered by the Ministry of Agriculture.

6 Estimated using data from several sources, including (http://www.statsfiji.gov.fj and the Fiji Sugar Corporation Cane Accounting System data, and 2003 Farm Economic Survey.

More recently some of the sugarcane land has commercially been farmed for non-cane crops, particularly on flat land near rivers and streams.

1.1. Harvest, Transport and Infrastructure

The sugar industry has a sugarcane harvesting and transport system supported by a web of cane access roads and tramlines. Sugarcane is harvested by harvesting gangs and cane transported to the four mills using rail or road with sugar cane transported to the main roads and tramlines via cane access roads. Mills are owned and operated by a statutory company, Fiji Sugar Corporation, in which the government has 68% ownership. Although during CSR sugar cane was harvested green, particularly since 1987, almost fifty percent of cane harvested were burnt (Lal 2006). This practice of harvesting burnt cane also meant that much of the land was exposed to the elements, resulting in excessive soil erosion.

Harvested sugar cane is transported to the mills via rail on locomotive driven trucks or Lorries over road. Over the last three years, on average 74% of cane was transported via road while the rest reached the mills via rail system. Although the amount of cane transported via road has gradually increased over time due to problems with the rail system (Lal and Rita 2008), the tramline system provides a critical mode of transport for cane from farms particularly in the low lying areas susceptible to waterlogging where lorry access is almost impossible.

The January 2009 floods had major impacts on all aspects of the sugar industry and the sugar belt. Sugar industry stakeholders undertook different surveys and came up with different estimates for the damage. FSC estimated an economic cost of $27 million to the sugar industry including an estimated $10.9 million for the sugarcane crops (before devaluation, which changed the mill gate price of cane). At the same time, the SRIF has given an estimate of $22.6 million required to rehabilitate the affected crops/farms. These impacts on the sugar industry/belt did not include the cost of the floods on the drainage infrastructure, including in the main drainage schemes servicing the sugar farms, or the costs to the drainage schemes.

Recognising the gap in flood impact assessments, and the diverse range of estimates put forward by the different members of the sugar industry, this joint study of the IUCN and the FLIS was implemented, with the support of the European Commission under its National Adaptation Strategy Technical Assistance to Fiji, AMSP 2006[7].

2. Objectives

The main objectives of this study are to:

- Assess the economic costs of the January 2009 floods on the sugarcane farmers – sugar cane production and household livelihood and cane access roads and farm drainage infrastructure
- Identify policy options for minimising flood-related disaster risk, and disaster risk management

A second phase of this study will include an assessment of the expected economic costs of climate change on the Fiji sugar industry, and policy implications for adapting to climate change.

The next section briefly examines the effects of the 2009 Floods, followed by a section on the methodology used in the study together with data sources. Section 4 provides the results of the economic analysis followed by Section 5 that discusses these results and draws out key policy recommendations for minimising flood-related disaster risks associated economic costs. Lastly, key conclusions are summarised in Section 6.

7 The study was undertaken to also obtain cross sections empirical information which could be used to assess potential costs of climate change to Fiji's second most important sector.

3. The 2009 Fiji Floods and Effects

Flood is defined by the Australian Bureau of Meteorology as "an event that causes the inundation of land that is normally dry, by excess rain or the overflowing of a body of water' (http://www.ga.gov.au/hazards/flood/). That is, flooding occurs when the natural ecosystems processes cannot cope with increased precipitation. Such events and other hydro-meteorological disasters are common occurrences in Fiji, particularly because of its geographical location and characteristics (Box 1), as well as changes in the physical landscape due to human activities.

The 2009 floods resulted from a confluence of forces – high precipitation rate, two consecutive depression zones and associated rainfall over a short period of time, intense rain coinciding with high tides - interacting together with the geographic characteristics of the various catchment areas. The Western Division and parts of the Northern Division suffered their wettest January in over a century, and with 75% of the reporting sites received at least twice their average monthly rainfall (Fiji Meteorological Service 2009a). With extensive rainful experienced for over a week, and a few areas receiving over 45 cm of rain in a day, most of the low lying areas in the country had been under water for days and in places experienced flood levels of up to 3-5 metres.

The 2009 floods was assessed by the Fiji Meteorological Services to be a one-in 50 year event (Rajendra Prasad, Chief Meteorologist, Fiji Meteorological Service Centre, pers comm. March 2009), although Fiji regularly experienced floods. Since 1970, Fiji reported about 40 floods, which is about a third of the total of 124 natural disasters reported during the 1970-2007 period. If one, however, takes a longer view, since 1840 when keeping records first began, almost one in every two disasters was recorded as floods (Lal et al 2009). Often floods are associated with cyclones but these may not be recorded as floods per se but as cyclone events. Thus the incidence of floods could be greater than recorded.

Box 1: Effect of Floods

Using the Australian Bureau of Meteorological definition of what comprises a flood (http://www.ga.gov.au/hazards/flood/), the effects of floods in Fiji are broadly defined to arise from where the heavy rainfall caused:

- Overflowing of river and creek waters and flooding of farms, houses, access roads, and other infrastructure etc., together with associated deposition of silt;
- Scouring or washing away farm land;
- Waterlogging of low lying farm lands, together with associated deposition of silt; and
- Influx of seawater onto farms and homes resulting from breaks in seawalls caused by high flow of large volumes of rainfall-runoff.

Other effects of heavy rain on hilly cane fields may include landslides and deposition of soil/silt on low lying flat lands, bila farms. While the effects of silt on the low lying lands are included in this study, the effects of loss of hilly lands are not included. To assess the economic costs of the 2009 floods it is important to first understand the direct and indirect effects of floods and then translate these into economic damages.

Direct effects are defined as losses caused directly to growers (farms and households), millers and infrastructure due to the flood inundation. At the same time, there are also many flow-on 'indirect' effects arising from flood inundation of farms, houses, and access roads etc., such as loss in wages, decrease in national economy, and humanitarian costs.

3.1 Growers

In the sugar belt, there are many categories of farms and farmers that were affected by the floods - those producing sugar cane only, sugar cane plus non-cane crops, and sugar cane and non-cane crops and/ or livestock. There were also some agricultural farms that produced only non-cane crops (these are not included in this study).

Floods directly affect sugar cane yield as well as quality (sucrose content). The effects of floods depend on the extent as well as the duration of floods and whether flood waters were stagnant or flowing. Losses are suffered either because sugarcane drowns completely or because of decrease in sugar content (Weiss 1976 and Humbert 1968 respectively quoted in (Berning et al. 2000)). Cane may also get 'lodged' ('fall down'), which, particularly when the cane is large, relative to the flood level, tends to recover quickly once flood water recedes.

Scientific research in other countries, such as South Africa, suggests that the minimum period of flood inundation before sugarcane is completely destroyed is approximately 3 days, particularly in the summer months (Plessis 2001). This is also supported by practical experience of Mr Hemraj Mangal, Manager Cane Development, FSC (pers comm. April 2009). Mangal notes that farmers can expect to see significant damage if flood water remains stagnant for 2 days or more. If inundation remains for less duration and the flow of flood water remains, cane losses of 2-10% could be expected in Fiji, as compared with a decrease of about 20% in the first year in South Africa (Berning et al. 2000). Experience in South Africa also suggests that the effects of floods on the cane crop could last at least 2 years after the flood event and the extent of damage depends on the stage of the crop as well as the height of the cane.

On the other hand, total loss of cane crop occurs when cane is dislodged or uprooted due to the force of flood water. In the case of non-cane crops, particularly vegetables which are highly sensitive to water submersion, floods usually result in a total loss of the crop. Similarly, with animals they may be lost due to drowning and/or being washed away. Where land is scoured away, the farmer loses a proportion of their land value. Other direct effects of flooding on farmers' livelihood included the impact on family homes and household possessions.

Some of the cane farmers also had family members who worked in town or elsewhere and who also lost their wages because of the inability to either get to work or the work places were closed. These indirect costs are also regarded as a component of the effects of floods on household livelihoods. Similarly included are the costs of treatments, including transportation costs to get to medical facilities incurred by family members that suffered from water and insect-borne diseases spread by flood waters and poor conditions. Direct and indirect effects of floods on the sugarcane farming households are summarized in Table 1.

Photo 3.1 Cane and noncane crops on *bila* land on the river's edge

Table 1: Direct and Indirect Effects of Floods on the Sugarcane Farming Households

Direct Effects	Indirect Effects

• On-farm impacts
  ○ Total loss of cane and non-cane crop, or reduced productivity of crops from water logging, salt water intrusion and or siltation
  ○ Loss in productive farm land due to scouring /washing away of parts of farm and other land
  ○ Loss in livestock (such as chooks/ ducks, goats and sheep) due to drowning and or being washed away
• Loss of or damage to household possessions and housing infrastructure
	• Loss in wages due to inability to get to work either because the roads were blocked or because the work place was closed
	• Costs incurred to clean-up farms, homes and commercial sites
	• Human health effects caused by water and vector borne diseases induced by poor water and sanitation conditions following flood conditions
	• Hardship caused by loss of household possessions and belongings leaving families unable to meet their basic food and nutrition needs, clothing, and or schooling needs of the family (often difficult to quantify). Some of these would have been temporarily addressed through humanitarian assistances

3.2. The Miller

Floods also cause significant damage to mill operations, including damage to machinery and equipment and damage to key infrastructure such as tramline infrastructure. The nation also loses out on the millers' share of the industry revenue due to a decline in cane processed by the miller.

3.3. Infrastructure

Floods have a direct effect on the local infrastructure on which the sugar industry depends - cane access roads, tramlines and bridges to get the harvested cane from the farms to the mills, and infield drains and drainage scheme infrastructure. The extent of such damage on infrastructure depends on the size of floods, in terms of the volume of water that flows through the flood plains, and the length of roads, tramlines, and other structures within the floodplains (Berning et al. 2001) and the extent and value of current economic activities within the sugar belt.

In Fiji, there are also many low lying areas, particularly mangrove reclaimed lands, where the force of the deluge of water broke the seawall. This caused the influx of seawater into cane land, causing the cane fields to become inundated with saltwater. Saltwater caused a total loss of the affected areas, in areas such as the Drasa and Lovu flats. These salt-inundated farms may not produce crops for 2-3 years, depending on the rainfall and flushing of salts.

3.4. Humanitarian Assistance

In situations of disasters, civil societies, governments, and development partners come together to provide humanitarian assistance to disaster victims. Such humanitarian support helps reduce immediate human suffering and alleviate the stress. Often individuals, religious and other civil societies group together with commercial houses and international development agencies to provide post disaster reliefs, such as food, shelter, water, and medical assistance. Other forms of humanitarian assistance included direct support to communities for rehabilitation and recovery in sectors such as education. Such humanitarian efforts also have opportunity costs, which must be taken into account as part of the economic costs associated with floods [8]

8 It has often been argued that it is because of such humanitarian responses that in many developing countries' governments often do not invest in disaster risk reduction strategies, as governments know that there will be assistance in times of disasters; this is commonly known as a It has often been argued that it is because of such humanitarian responses that in many developing countries' governments often do not invest in disaster risk reduction strategies, as governments know that there will be assistance in times of disasters; this is commonly known as a moral hazard problem (see for example, World Bank (2006). Not if But When: Adapting to Natural Hazards in the Pacific Islands Region. World Bank, Sydney)..

4. Economic Costs of Floods - Methodology

The United Nation's Economic Commission for Latin America and the Caribbean (ECLAC) disaster assessment methodology was used to assess the effects of the 2009 floods (ECLAC 2003). This methodology involves 3 components: assessment of the cost of immovable assets and stock (damage), assessment of income foregone, and the secondary or macroeconomic effects. In this study, which was undertaken immediately following the disaster relief period was over, only the first two cost components are assessed using costs and values measures defined in the ECLAC (2003). The macroeconomic impacts were not assessed as these could only be assessed after a significant period has passed for the flow on effects to be realised.

4.1. With-Without Analysis

To translate direct and indirect effects of floods into economic cost estimates, a 'with and without' cross-sectional static analytical approach is used in this study[9] (See table 2). The economic cost of floods is estimated by determining, for example, the difference between cane and non-cane output in the absence of the flood ('without'), and the cane and non-cane output following the floods ('with'). These effects are then translated into economic cost estimates, using the cost estimation method described below. In addition, any related costs incurred by the farmers are also considered, such as the cost of removing the debris from the farms. A similar 'with and without' analysis approach is also adopted when determining the cost of floods on infrastructure (cane access roads, seawalls, tramlines, and drainage).

Photo 4.1 Some effects of the 2009 floods

9 It is acknowledged that this may result in an underestimation of costs, since flooding results in impacts on sugar cane farms for at least 2 years, (See Berning, C., Viljoen, M. and Plessis, L.D. (2000). 'Loss Functions for Sugar-Cane: Depth and Duration of Inundation as Determinants of Extent of Flood Damage', Water South Africa 26: 527-530). However, in the absence of time series data on the effects of floods on sugarcane in Fiji, cross sectional single-year costs are estimated.

Table 2: Economic Costs of Floods: With and Without Cost Estimation Methodology

Value of Activities	With Floods Scenario	'With and Without' Flood Damage Analysis
Farm		
Sugarcane Production (Plant & Ratoon)	Cane Output Following Flooding	$GVP_{Without\ floods} - GVP_{With\ floods}$
Non-Cane Crops & Livestock	Non-Cane Crop & Livestock Output Following Flooding (Assuming farmers lost only a 6-month equivalent of their annual non-cane crops revenue)	$GVP_{Without\ floods} - GVP_{With\ floods}$
Clean-Up of Farm Land of Debris	Non-Cane Crop & Livestock Output Following Flooding (Assuming farmers lost only a 6-month equivalent of their annual non-cane crops revenue)	$TC_{Cleanup\ due\ to\ floods} - TC_{Cleanup\ without\ floods}$
Farming Materials	Replacement (Lost) or Damaged	$TC_{Farming\ materials\ replacement/repair}$
Cane Access Road (Private maintenance)	Repair Costs Following Flood	$TC_{Cane\ access\ road\ repair}$
House & Household		
House & Household Possessions	Replacement (Lost) or Damaged	$TC_{House\ replacement/repair\ with\ floods} - TC_{Household\ Possessions\ replacement/repair\ without\ floods}$
Normal Off-Farm Income	Gross Income Earned Following Floods	$TC_{Off\text{-}farm\ Income\ without\ floods} - TC_{Off\text{-}farm\ Income\ with\ floods}$
Normal Home Clean-Up	Total Clean-Up Following Floods	$TC_{Cleanup\ due\ to\ floods\ -} - TC_{Cleanup\ without\ floods}$
Human Health	Increased Disease Incidence and Injury Following Floods	$TC_{Health\ Costs\ with\ floods} - TC_{Health\ Costs\ without\ floods}$
Mill		
Mill Infrastructure Maintenance	Regular Maintenance Costs Plus Additional Cost of Damage	$TC_{Maintenance\ with\ floods} - TC_{Maintenance\ Without\ floods}$
Miller Share of Sugar Revenue	Reduced Level of Cane Throughout	$Miller\ Revenue_{Without\ floods} - Miller\ Revenue_{With\ floods}$
Infrastructure		
Cane Access Road (Regular maintenance)	Regular Maintenance Costs *plus* Additional Cost of Damage to the Cane Access Road Due to Floods	$TC_{Maintenance\ with\ floods} - TC_{Maintenance\ without\ floods}$
Tramline (Normal maintenance)	Normal Maintenance Costs *plus* Additional Cost of Damage to the Tramlines Due to Floods	$TC_{Maintenance\ with\ floods} - TC_{Maintenance\ without\ floods}$
Drainage Scheme Canals and Drains	Normal Maintenance Costs *plus* Additional Cost of Damage to the Drainage Schemes Due to Floods	$TC_{Maintenance\ with\ floods} - TC_{Maintenance\ without\ floods}$
Humanitarian		
Humanitarian Assistance	Humanitarian Disaster Response	Monetary Equivalent of Disaster Packs, Medical Kits, Food Rations, Education Support

4.2. Cost Estimation Method

Cost estimates are derived using several different valuation methods (see e.g. (Freeman 1999) . In this study only a limited set of valuation techniques were used, as summarized in table 3:

Table 3: Cost Valuation Methods Used in this Study

Cost Valuation Methods	Item
Production Method	Gross value of loss in sugar cane production
	Gross value of loss in non-cane crops and livestock
	Gross loss in wages due to lost work time
Replacement Method	Cost to replace household possessionsl 'clean-up' costs
Replacement Method (repair cost)	Cost to repair houses, household capita, etc.
	Costs to repair infrastructure – cane access roads, tramlines, drainage, etc.
Opportunity Cost	Costs for treatment of diseases (Human health)
	Value of humanitarian assistance

4.3. Sources of Information

4.3.1. Information on the Effects of Floods on Growers' Farms and Households

Multiple sources of information were used in this study. Information about the effects of floods at the farm and household level was obtained using an economic survey of a stratified sample of sugar cane farms affected by the floods (see Box 2).

Box 2: Farm Survey

To design a stratified economic survey, several steps were followed.

1. Sugarcane sectors that were affected by the 2009 floods were identified. This information was obtained from industry field officers – FSC field officers, Sugar Cane Growers Council Senior Executive Officers and SCGC Councillors.
2. For those sectors affected by the floods, respective FSC field Officers and the Cane Grower Councillors were asked to identify those farms (by cane contract numbers) that were flooded.
3. Location of the selected farms in each sector and mill area was verified using the SUGAR_GIS (Lal and Rita 2005; and Lal 2008), and the base cadastral maps.
4. A sample of affected farms was selected to ensure geographical representation of the farms within the sector. Sample farms were selected on the basis of the nature of flooding such as waterlogged/ inundated/silted and/or affected by salt water intrusion), ensuring at least 15-20 percent of each category of farms were selected.
5. Each selected farm was then visited by trained enumerators to elicit detailed information using a specially designed questionnaire (see Annex 3).
6. Due to data quality issues, ultimately 12-22% of the affected farms per mill area were included in the analysis, except in the case of Penang where only 9% of farms were included (table 4).

Table 4: Distribution of Farms across Sectors and Mills affected by the 2009 Floods and Proportion of Farms selected for Survey

Mills	Number of Farms Affected	Number of Farms Surveyed	Percent of Farms Sampled
Labasa	223	27	12%
Lautoka	874	150	17%
Penang	184	16	9%
Rarawai	900	195	22%

Source: 2009 Flood Economic Survey

Types of information obtained from the farmers are summarized in Table 5.

Table 5: Key Categories of Information Elicited From the 2009 Flood Affected Farms

- Household characteristics (number of people, people working on farm, in house and off-farm)
- Nature of flood impact on farm (flooding/waterlogged, silted, land washed away, salt water intrusion; sugarcane and other crop production expected before flooding and after flooding)
- Nature damage/loss to house and household possessions due to floods and the cost of repair
- Human health effects (water and vector borne diseases associated with floods, actual treatment costs)
- Lost wages due to illness, temporary closure of workplace or road blockage
- Risk perception to flooding and actions taken
- Adaptation responses by government, self and or communities to minimise future flooding risks

Other information, such as time series farm level sugarcane production data was obtained from the FSC Cane Accounting, FSC. To estimate 'with' flood sugarcane output, farmers expected output was used.

4.3.2. Scaling Up of Sector Level Survey Data

Sector level data collected from the Flood Economic Survey were scaled up to mill and industry level. Sample cost estimate for each cost category was derived for the sampled farms. These category costs estimates were aggregated within a sector. This sample total for each sector was then aggregated to the sector level using the 'sector sample factor'. A 'sector sample factor' is equal to 1 divided by the percentage of sampled farms as a percentage of the number of affected farms in the sector. The sector total was then aggregated across sectors to arrive at an estimate for each mill area. Mill area estimates were further aggregated to obtain the industry total.

4.3.3. Information on Mill Damage

Only direct costs associated with the mills were obtained directly from the FSC. These estimates were based on the assessment of the mill engineers.

4.3.4. Information on Infrastructure Damage

Effects of floods on cane access roads and tramline infrastructure was assessed using information collected from the FSC field officers, civil engineers, cane logistic managers and field superintendents. These officers were asked to identify the cane access roads and tramlines that were affected by the floods,

identify the nature of damage, and repair works required to get them back to pre-flood conditions. A data template was provided to the officials to systematicaly determine the incremental effects of the floods on these infrastructures. That is the additional cost of maintainance caused by the floods as compared with their normal annual maintenance costs.
Similarly the Ministry of Land, Water, and Resource Management (LWRM), were asked to determine the lengths of drainage that were affected in each area, the nature of damage, and repair works required to get them back to pre-flood conditions. They were also asked to provide the incremental cost of reparing the damages caused by flood.

Siltation and incremental damage to infield drains was assumed to be negligible, since the drains were already silted and the drains had not been maintained (Hemraj Mangal, Manager Cane Development, FSC, and various Field Officers, FSC, pers comm. April & May 2009). However, the costs of maintaining these drains were estimated using the industry average per kilometer cost of their maintenance provided by Mr Hemraj Mangal (Manager Cane Development, FSC (pers comm. May 2009).

4.3.5. Humanitarian-Response Data

Data was obtained directly from the DISMAC office (Fiji Government Office of the Prime Minister 2009), where available, as well as directly from various humanitarian organizations (Table 6). In order to avoid double accounting, effort was made to 'track' funds provided by the donors that were ultimately used, and if this were reported by the providers of services during and after the 2009 floods. In some cases, where in-kind assistance was provided, market value of this assistance, such as food relief packs, were estimated using retail price of the content of the pack.

Table 6: Key Local and International Communities that Provided Humanitarian Assistance

	Key activities
Red Cross	Distributed humanitarian assistance
Rotary Clubs of Fiji	Distributed humanitarian boxes and food rations
Fiji Sevashram Sangha	Distributed food rations, water, school supplies
Fiji Water	Crates of bottled water to official evacuation shelters and flood-affected areas
Air Pacific	Provided free air freight for over 40 containers of relief supplies from NZ, Australia, USA, and Canada
(Australian Aid) AusAID	School infrastructure repairs and furniture plus paid for a year's school fees (planting material in non-cane farms)
EU	School infrastructure repairs and furniture plus paid for a year's school fees
(New Zealand Aid) NZAID	Provided humanitarian assistance post disaster
UN agencies (UNICEF, UNOCHA	Undertook rapid appraisal, coordinated UN assistances, and supplied humanitarian assistance

Price and cost data were collected from different sources summarized in Table 7.

Table 7: Key Data Sources

	Source
Farm	
Sugarcane Price	FSC (previously Fiji Sugar Marketing) data
Price of Livestock	Flood Economic Survey, unit price values supplemented/validated by FSC Field Officer and SCGC Senior Executive Officer
Cane Inputs	Fertilizer costs from the South Pacific Fertilizer Company. Harvest and transport costs from Flood Economic Survey (Lal & Rita 2008) updated with information obtained from the Flood Economic Survey in April 2009
House and Household	
Household Goods	Flood Economic Survey of farms, supplemented and validated by price data from local retail outlets
House Repair	Flood Economic Survey of farms, supplemented/validated by sectoral FSC Field Officers', and SCGC Senior Executive Officers' local knowledge
Other Sources of Income	Flood Economic Survey of farms & local knowledge
Mill	
Millers Share of the Value of Cane Production	FSC projected price, with sensitivity analysis done using EPA negotiated price minus industry cost* and miller's share of 30% as formulated in the Master Award (see (Lal 2006 & 2008)).
Mill Cleanup & Repairs	FSC engineers
Infrastructure Costs	
Cane Access Roads	Sectoral level damage estimates by FSC Field Officers and cost estimates by FSC Civil Engineers
Tramline	Sectoral level damage estimates by FSC Field Officers and cost estimates by FSC Civil Engineers
Drainage Scheme	Divisional LWRM technical staff, including civil engineers, European Commission report 2004
Infield Drains	Manager Cane Development, FSC
Humanitarian Assistance	
Food and Food Packs, Disaster Relief Packs, Clothes, Books, Water	Local and international organisations (such as Rotary, RamaKrishna Mission), commercial houses, DISMAC and UN agencies (see table 5)**
Education Assistance	AusAID, EU, DISMAC and Save the Children Fund

* CEO, FSC pers comm., 120509 - cost of production over the last three years is $326/tonne sugar and $32.03/tonne cane.

** Not all humanitarian assistance could be estimated because of difficulty in getting a comprehensive list of domestic assistance, as well as difficulty in getting detailed information about the contents of assistance provided from abroad.

5. Economic and Social Costs of the 2009 Floods – The Results

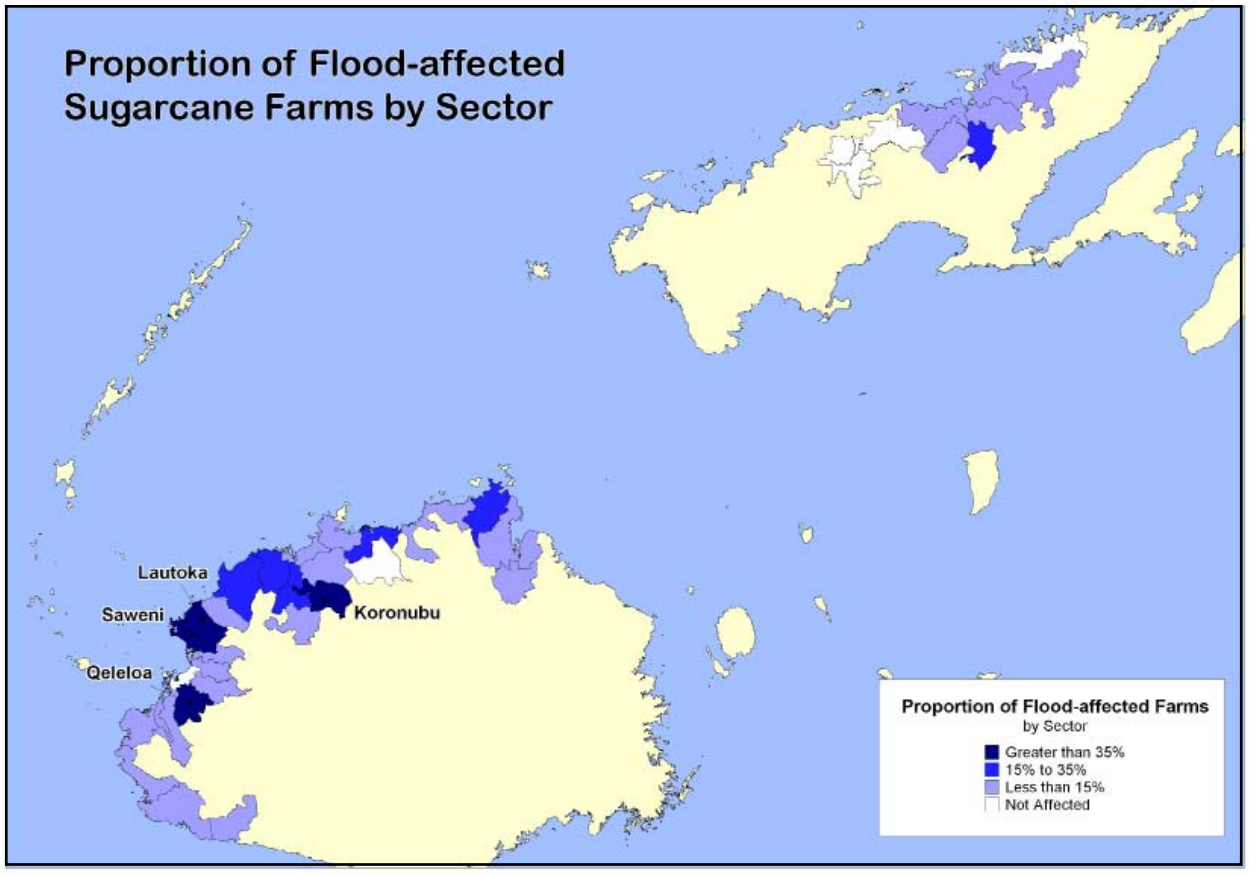
Floods in Fiji have always caused significant social and economic costs, and this time was no different. The officially reported economic cost of the 2009 floods for the country is over $100 million dollars. DISMAC reported that over 20 percent of Fiji's population was affected by the floods across the three main Divisions, Western, Northern, and Central, including urban and sugar belt areas. There was also a loss of eleven lives during the 2-week period. In addition, during the peak flooding period almost 12,000 people took shelter in government evacuation shelters (Fiji Government Office of the Prime Minister 2009). These estimates included some but not all flood related costs in the sugar belt. In order to avoid double accounting, the impact of the main infrastructure, such as public roads, utilities, and other related costs are not included in the sugar belt costs provided in this study.

5.1. Areas of Sugar Belt Affected

A detailed survey of the sugar belt in this study reveals, as expected, the impact of the flood was not homogeneous. Nor were the floods as devastating in aggregate on the sugarcane growers, as reported in the local media.

In total only 15 percent of active sugarcane growers were affected by the floods. These farms were distributed across 34 of the 39 sugar sectors in the industry, excluding the FSC estate-sectors. Only four sectors, Lautoka, Koronubu, Saweni and Qeleloa, had over 35 percent of the farms affected by the floods. More than half the sectors had less than 10 % of the farms that were waterlogged/'flooded'. In the rest of the sectors, only a small proportion of farms were flood- affected (see map1).

Map 1: Sector Affected by the Floods – by Percentage

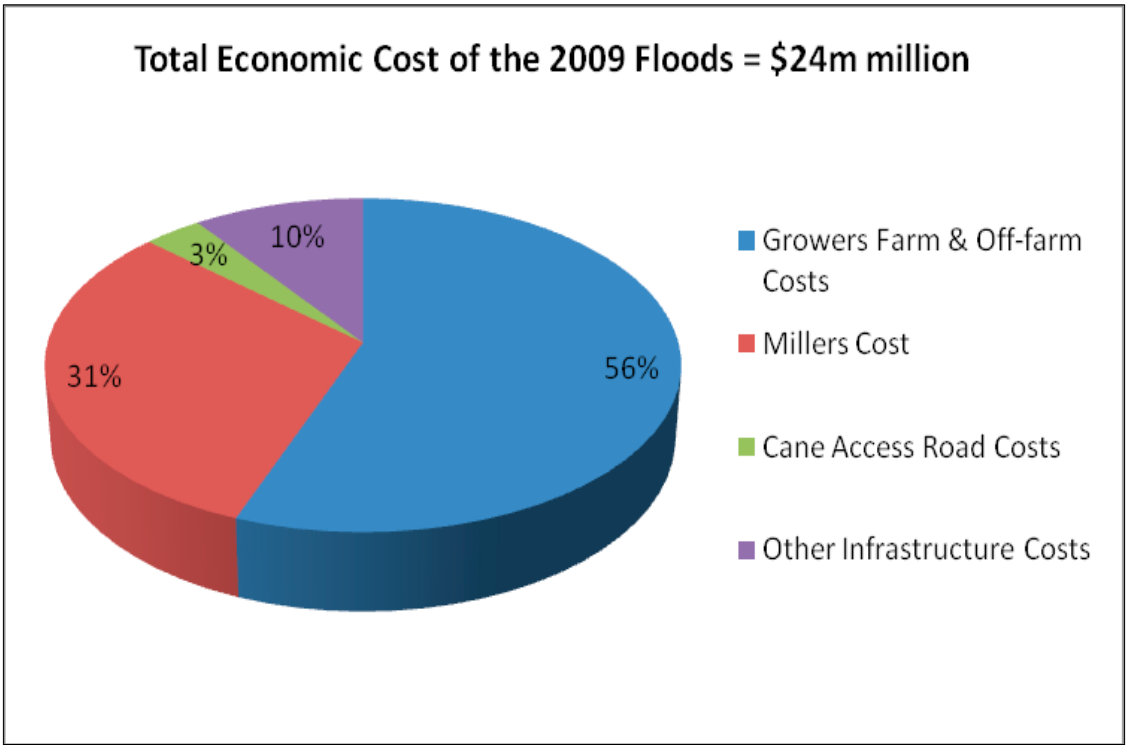


Source: 2009 Flood Economic Survey

5.2. Economic Costs

The total economic cost of the floods on the growers' farms and non-farm costs, millers' costs, damage to the cane access roads and other infrastructure is estimated to be about $24 million[10] (figure 1). These separate costs clusters are discussed next.

Figure 1: Total Economic Cost of the 2009 Floods on the Sugar Belt, Excluding the Humanitarian Assistance



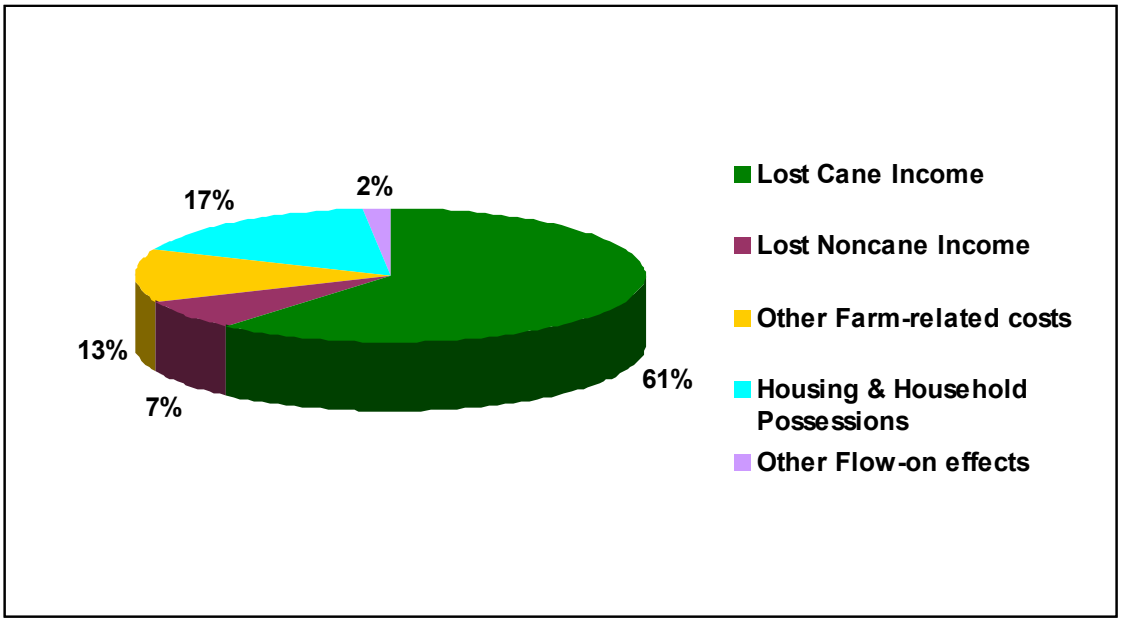
Source: 2009 Flood Economic Survey

5.2.1. Costs to Growers

Growers' costs accounted for over 50 percent (56%) of the total costs. These comprise of lost farm (cane and non-cane crops/livestock) and off-farm income, farm-related costs (lost/damaged farming materials, cleanup costs and cane access repairs), cost of lost/damaged houses and personal possession, and other flow-on effects such as evacuation costs, health costs and house cleanup costs. These costs to growers totalled $13.4 million.

10 Does not include the value of the loss of land scoured out by the flood water.

Figure 2: Breakdown of Growers' Costs



Source: 2009 Flood Economic Survey

5.2.1.a. Loss in Cane Income

The industry is projected to lose about 131,400 tonnes of sugar cane or a gross value to the farmers of almost $8 million, using 2009 the projected cane price of $61.17/tonne. This is in comparison with $10.9 million estimated by FSC and $22.6 million estimated by the Sugar Research Institute of Fiji, using pre-devaluation cane prices of $44/tonne.

Of the farms surveyed, the majority (65%) of growers lost less than a quarter of their expected individual cane output (table 8). However, 14 % of the growers reported 50% or more loss in cane. Out of these, 3% of active growers lost all their cane, particularly those farms in the low lying coastal areas where breaks in the seawall occurred in areas such as Drasa, Lovu and Rarawai flats.

Table 8: Distribution of Sugar Cane Farmers by Cane Lost Category

% Area of Cane Lost	% Affected Farms that Lost Respective Amounts of Cane
100%	3%
50% - 99%	11%
49% - 25%	21%
<24%	65%

Source: 2009 Flood Economic Survey

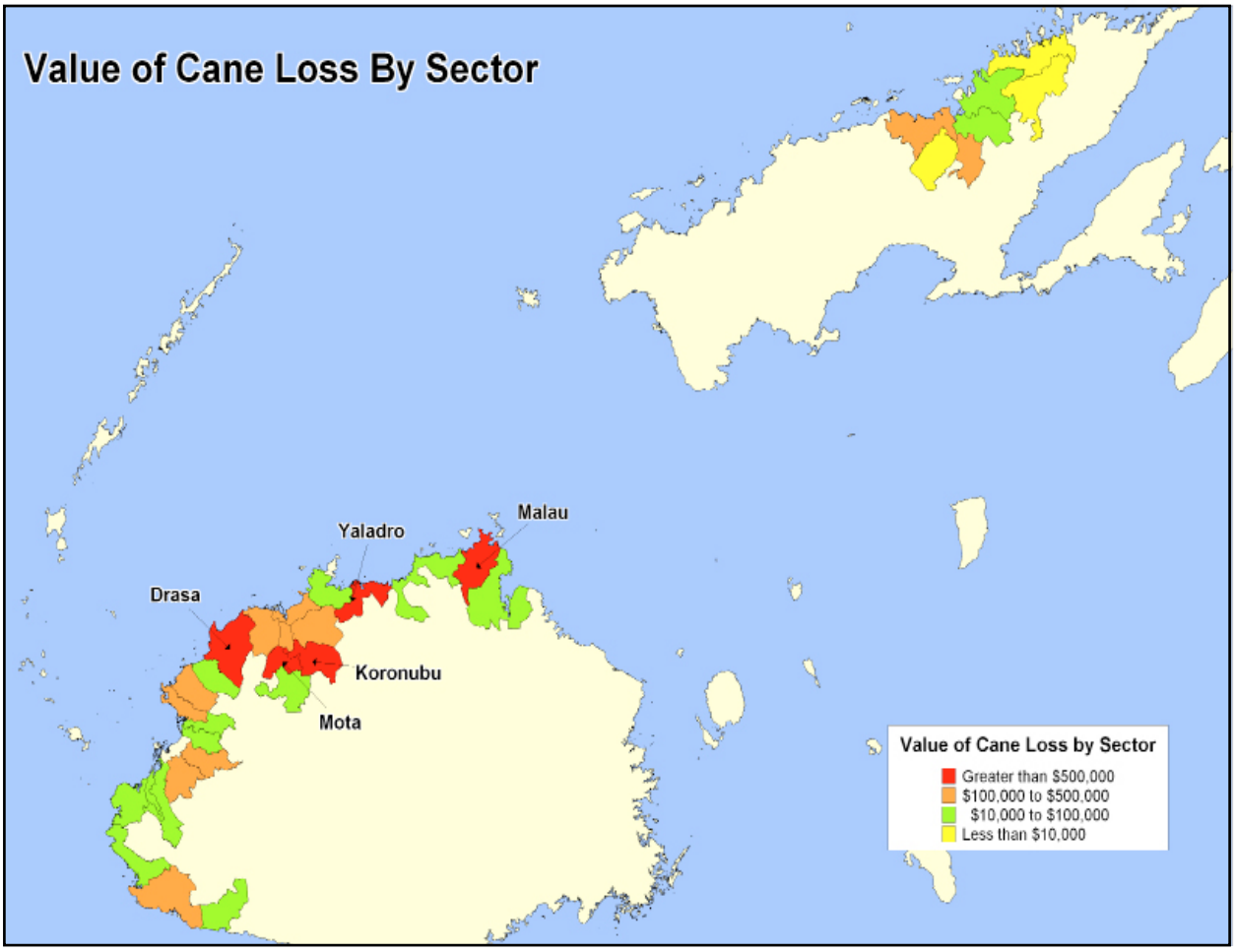
The largest loss in cane output is expected in Rarawai and Lautoka mills, accounting for 86% of the losses, 113,000 tonnes or $6.9 million. This is not surprising since Rarawai and Lautoka mill areas had the largest number (and area) of flood-affected farms.

Table 9: Total Loss to Growers and the Miller Due to Loss in Cane Output

	Loss to Growers	
Mills	Cane Loss (rse)	Value Loss (FJD$)
Labasa	6,853 (7.87)	$419,192
Lautoka	48,666 (0.65)	$2,976,878
Penang	11,506 (4.37)	$703,794
Rarawai	64,385 (0.44)	$3,938,443
Industry	131,409	$8,038,307

Source: 2009 Flood Economic Survey

Map 2: Loss in Cane Income by Sector



Source: 2009 Flood Economic Survey

5.2.1.b. Loss in Non-Cane

Of the farms that were flooded, about 32% reported they also had non-cane crops that were lost as a result of the floods. Some growers also stated that they had lost livestock they had been rearing for sale.

Table 10: Growers' Farm and Off-Farm Losses

Cost Categories	Labasa	Lautoka	Penang	Rarawai
% Farms Affected by The Floods	7%	16%	11%	20%
% Farm with Non-Cane Losses	2%	12%	1%	16%
% Farm with Livestock Losses	1%	2%	1%	1%
% Growers with Damage to Their Home	1%	1%	0%	8%
% Growers with Damage/Loss to Their Household Possession	1%	7%	1%	16%
% Growers Reported Flow Health Effects	4%	14%	2%	18%
% of Growers With Loss in Off-Farm Income	2%	15%	1%	9%

Source: 2009 Flood Economic Survey

The total loss in non-cane crops and livestock across the sugar belt is estimated to be about $732,162, with almost 50 percent of these losses reported from the Rarawai mill area. Majority of the losses were reported from sectors Rarawai, Nalato, Koronubu and Yaladro.

Table 11: Non-Cane & Other Farm-Related Costs

	Non-Cane Losses (FJD$)
Labasa	$38,009
Lautoka	$231,989
Penang	$128,806
Rarawai	$333,359
Industry	$732,162

Source: 2009 Flood Economic Survey

5.2.1.c. Loss to Homes, Household and Other Costs

Official statistics indicate that 164 houses were completely destroyed in the country (Fiji Government Office of the Prime Minister 2009) during the 2009 floods. None of these were in the sugar belt areas. Nonetheless, where the flood water did enter family homes of sugarcane farmers the flood damage was significant, as discussed next.

Generally speaking, only a small proportion of cane farmers had flood waters enter their homes, and even a smaller proportion of them had to leave their homes for higher grounds or evacuation shelters. Approximately a third of the growers reported water entering their home, and with only about half of these people evacuated. Majority went to neighbour's houses, with only 14 percent of growers evacuated to official evacuation centres.

24% (or 91) of growers surveyed reported damage to their homes and household possessions. Of these, 35 surveyed farms reported some damage to their homes out of which 17 farms had over $1000 damage to their homes. These families lost most if not all their household possessions – foods, cooking utensils, clothing, beds, and other furniture. There were also many flow-on effects of the flood, such as loss of wages

because of inability to travel to work or work places were closed. Approximately 42% of the 380 households surveyed reported family members suffering from water and vector-borne diseases, such as diarrhoea, dengue and leptospirosis.

The total economic cost associated with the damage to growers' homes, loss in household possessions, human health costs as well as loss to the off-farm income is estimated to be almost $2.5 million. The low lying flood plains of the Ba River suffered the highest loss, accounting for 61% of the losses, followed by farm households in the flood plains around the Nadi River and low lying coastal areas in the Lautoka mill area (table 11).

Table 12: Direct and Indirect Economic Losses to Grower HH Income, Excluding Farm Costs

Cost Categories	Labasa	Lautoka	Penang	Rarawai	Industry
Injury Costs	$0	$935	$0	$74	$1,009
Disease Costs	$19,086	$39,515	$5,680	$32,987	$97,268
Housing Costs	$15,244	$66,271	$0	$185,655	$267,170
Personal Possessions Costs	$85,129	$547,740	$708	$1,132,557	$1,766,134
House Cleanup Costs	$3,499	$54,221	$666	$58,060	$116,446
Lost Earnings Costs	$3,554	$116,769	$6,283	$92,424	$219,030
Evacuation Costs	$352	$3,784	$0	$898	$5,034
TOTAL	$126,864	$829,235	$13,337	$1,502,655	$2,472,091

Source: 2009 Flood Economic Survey

5.2.2. Costs to Millers

The Fiji Sugar Corporation suffered three types of economic losses: loss in the miller's share of industry revenue due to a decline on the cane output and associated loss in industry revenue; direct cost of damage to the mills; and the additional costs to the maintenance of the tramline infrastructure, which is the sole responsibility of the miller.

Under the Master Award, the sole miller received 30% of the industry revenue net of costs. Taking the grower's cane price of $61.17 /tonne projected by FSC, the miller share of the industry net revenue would be $26.22/tonne. This results in an equivalent miller's loss in gross revenue of about $3.4 million. Only Rarawai mill was directly affected by the floods. The damage to the Rarawai mill was estimated by the FSC engineers to be $2.43 million. The cost of extra maintenance of the tramlines due to the floods ('with and without' flood costs) is estimated to be about $1.57 million, giving a total miller costs of the 2009 floods to be about $7.5 million (table 12).

Table 13: Miller Costs

	Corresponding Sugar Revenue Loss to the FSC	Tramline/Bridges	Mill Repairs	Total
Labasa	179,654	294,000	-	473,654
Lautoka	1,275,805	541000	-	1,816,805
Penang	301,626	192,000	-	493,626
Rarawai	1,687,904	544,000	2,430,270	4,662,174
Industry	3,444,989	1,571,000	2,43,270	7,446,259

Source: 2009 Flood Economic Survey

5.2.3. Infrastructure Costs

There are 336km of main tramline, together with 184 km of secondary lines (European Commission 2008).

In addition there are about 5,039 km[11] of cane access roads, which are maintained by the industry using co-financing by the Government (2/3) and the growers (1/3)[12]. Annual maintenance of the cane access roads usually happened just before the start of the crushing season.

Table 14. Infrastructure Statistics

Mill	Cane Access Roads	Tramline -Main & Branch (km)	Main Drains (km)	In-field Drains (km)	Drainage Schemes	
					Seawall Drains (km)	Internal Drains (km)
Labasa	1,174	114	85	40	N/A	N/A
Lautoka	1,595	221	191	174		
Penang	540	35	40	34		
Rarawai	1,730	150	74	82		
Industry Total	5,039	520	390	330	32	273,048
Source	*FSC*	*Lal 2005 in European Commission 2008*	*Hemraj Mangal, FSC, pers comm., May 2009*		*Latchman Mudaliar, LWRM, pers comm., May 2009*	

Source: 2009 Flood Economic Survey

All aspects of the sugar industry infrastructure were badly affected. Of the 5,039 km of cane access roads, 23% of roads (1,136km) were damaged, requiring various forms of repairs, from grading, gravelling, drainage, and/or culvert replacement (table by mill area). In the case of tramlines, many parts of the tramlines, including in places foundations of bridges and culvers, were washed away in the low lying areas. Parts of tramlines were blocked by debris and covered by silt/soil. In at least the Rarawai mill area, over 10% of the 130 km of main tramline network and 25 % of the affected bridges (50) had serious damages, which required a total overhaul (Mr Vishwa Nadan, Field Superintendent, with inputs from his Field Officers, FSC Rarawai, pers comm. April 2009). The total cost of cane access roads and tramlines, including related bridges (except the Sigatoka Bridge) is estimated to be $2.4 million. This is much lower than the $4.0 million estimated by FSC (unpublished Fiji Sugar Corporation, 2009, pers comm.), which included all maintenance costs and not just the incremental costs due to the floods.

Flooding also damaged many drainage schemes due to breaks in the seawall, scouring of drains, culvert crossings, flood gates, and flap gates. The total costs of additional work required on the cane access roads, tramlines, and drainage infrastructure was estimated to be about $4.8 million.

Table 15: Infrastructure Costs ($)

Mill	Cane Access & Tramline Infrastructure	Drainage Scheme Infrastructure	All Infrastructure
Labasa	362,030	211,500	
Lautoka	984,400	2,169,789	
Penang	418,550		
Rarawai	620,000		
Industry Total	2,384,980	2,381,289	4,766,269

Source: 2009 Flood Economic Survey

11 FSC figure used; differs slightly from European Commission Report 2008 figure.

12 In 2008, the Interim Government had changed this, removing the responsibility of sugarcane farmers, with the government deciding to pay the total cost of maintenance.

5.3. Humanitarian Responses

For the 2009 floods, humanitarian assistance in the west and the north is estimated to be $3.67 million, provided by many different domestic and international organizations. Assistance came in various forms, including disaster emergency boxes, food aid, school lunches, bus fares and medical kits (see Table 15). Many commercial houses also provided assistance either directly or indirectly through other relief agencies. The EU and AusAID provided almost $2 million in the form of school levy payments for children attending schools that were affected by floods, as well as towards repairs and rehabilitation of school buildings, library, and furniture (Fiji Government Office of the Prime Minister 2009). There was also $3.57 million in-kind assistance provided by the AusAID, NZAID, and United States Aid (USAID) to other humanitarian groups, such as Red Cross, UNICEF, and World Health Organisation (WHO). This assistance is in addition to the $2.01 million in the Prime Minister's Disaster Relief Fund, which was distributed in all areas of Fiji, including the areas in the Central Division. There were also many commercial houses that either provided in cash or in-kind assistance directly or indirectly through other relief organizations. Their values are not captured in the estimate provided, nor are the hundreds of person hours and days spent by relief workers.

Table 16: Humanitarian Response

Humanitarian Partners	Activities	Contributions
Rotary	Disaster Relief Kits, Medical Kits	720,000
Air Pacific	Air Freight For at Least 30-Container Load of Relief Supplies from Australia, New Zealand, Canada and USA.	600,000
EU	School Levy and Building Repairs, Furniture, and Library Supplies	1,806,209
AusAID	School Levy and Building Repairs, Furniture, and Library Supplies	142,440
Fiji Water	900,000 Litres of Bottled Water	1,000,000
Save the Children	School Fees and Lunches	84,960
Others (Yadeen, Fiji Sevashram Sangha, Rama Krishna, Couriers, etc.)	Relief Supplies (Food, Food Packs, School Lunches, Clothes, Etc.)	359,096
Subtotal Post Disaster Humanitarian		**2,679,096**
Subtotal Rehabilitation & Education Assistance)		**2,033,609**
Total Sugar Belt		**4,712,705**
In-Kind Donations (AusAID, NZAID, USAID) through the UN Agencies, Red Cross, etc.		3,576,000*
Other External Humanitarian through the PM Relief Fund		2,005,903*
Total Humanitarian Assistance		**10,296,610**
*Some of these may also have been spent in the sugar belt area, but difficult to disaggregate.		

6. Discussion

Changes in natural landscape for agricultural development unintentionally cause a decline in regulatory ecosystem services, including those responsible for reducing peoples exposure to floods (Millennium Ecosystem Assessment 2005). The extent of flooding experienced in an area is thus a product of the interaction between natural precipitation, the dynamics of natural ecosystem services, as well as the effects of man-made changes in an area. The effects of floods also depend on the ability of the excessive water to be flushed out of the system, the speed with which the flood waters recede, and the socioeconomic status of the communities. The vulnerability of households, communities, and countries is a product of the interaction between the hazard, the economic status of households, the sensitivity of the environment and economy to hazards, the state of infrastructure, as well as the ability to respond and cope with disaster events. These also have some broad ranging policy implications which go beyond the sugar industry, as discussed below.

6.1. Increased Exposure to Floods

Alongside changes in the landscape for agricultural development, an extensive drainage system was established to ensure proper drainage and reduce risks of flooding especially in flood plains and mangrove reclaimed lands. These systems were traditionally well maintained, especially during the CSR days. However, over time major drainage canals, in-field and main drains have become inadequately maintained. Similarly, the good farm husbandry practices, which minimizes soil erosion, that were strictly enforced during the CSR days have progressively declined after the company's departure. For instance, following the signing of the Lome Convention which provided an incentive to increase production, sugarcane farms have expanded onto steep lands.[13] Generally speaking, farm management practices have deteriorated, particularly since at least the 1987 coups when contour planting was generally not practiced, and farm husbandry was also found lacking. Soil erosion was exacerbated by the practice of increased pre-harvest burning of cane, which exposed bare cane fields to the elements following the 1987 coups (see (Lal and Rita 2008)) for details about cane burning and its causes). Consequently, with even short periods of intensive rain, excessive soil erosion and even landslides seem to have become common, silting up drains, waterways, and rivers.

In recent years, there has also been ad hoc housing and other developments in the peri-urban areas around the major towns and cities in the West and the North. This too would have affected the balance in the ecological services and a change in the rainfall-runoff patterns. Consequently, with intense rainfall beyond the capacity of the natural system to cope with excessive volume of water, sugar belt areas easily became waterlogged, drains overflowed and water levels in rivers rose, with water overflowing from the river and creek embankment. In the long term, if the 'business as usual' sugarcane farming practices continues, vulnerability of the sugar belt will continue and may even increase with climate change and climate variability.

6.2. Sensitivity of Sugar Cane and Non-Cane Crops to floods

The impact of floods on the sugar cane crops is particularly dependent on the stage of the crop cycle when flooding occurs, the duration of the flood condition, and the speed of water flow, as well as the height of the cane relative to the flood level (Weiss 1976 and Humbert 1968 respectively quoted in (Berning et al. 2000)). Since the flooding occurred around the mid season in the sugarcane growth cycle, experience from South Africa suggests that the impact of flooding is normally expected to be above the average. On the other hand, damage to crops is below the average during the winter months (Plessis 2001).

Since the January floods were at the tail end of the summer, the damage could have been high. However, partly because the flood levels relative to the cane height were low the damage to the cane crop was not as high as expected. Based on the South African experiences, had the flood heights relative to the height of cane been higher and the flood water remained stagnant for longer periods of time, the impact could have been much higher (Berning, Plessis et al. 2001). Sugarcane is considered to be a relatively hardy plant

13 Lome Convention provided preferential access to Fiji sugar at prices two-three times greater than world price.

(Vashist et al. 2003). On the other hand, 85 percent of farms that were also engaged in commercial non-cane crops lost all their non-cane cash crops, such as vegetables, which are highly sensitive to flooding.

6.3. Vulnerability & House and Household Losses

Loss to homes and household possessions, were also relatively low (compared to other reported costs) although it was still significant ($2 million). The relatively low cost is largely because only a small proportion of homes are located in flood-prone areas, and thus was subject to the effects of the floods. Majority of farmers have their home sites on relatively higher grounds even if their farm fields are not. Furthermore, the economic loss is very much a function of the economic status of the families.

6.4. Floods and Infrastructure

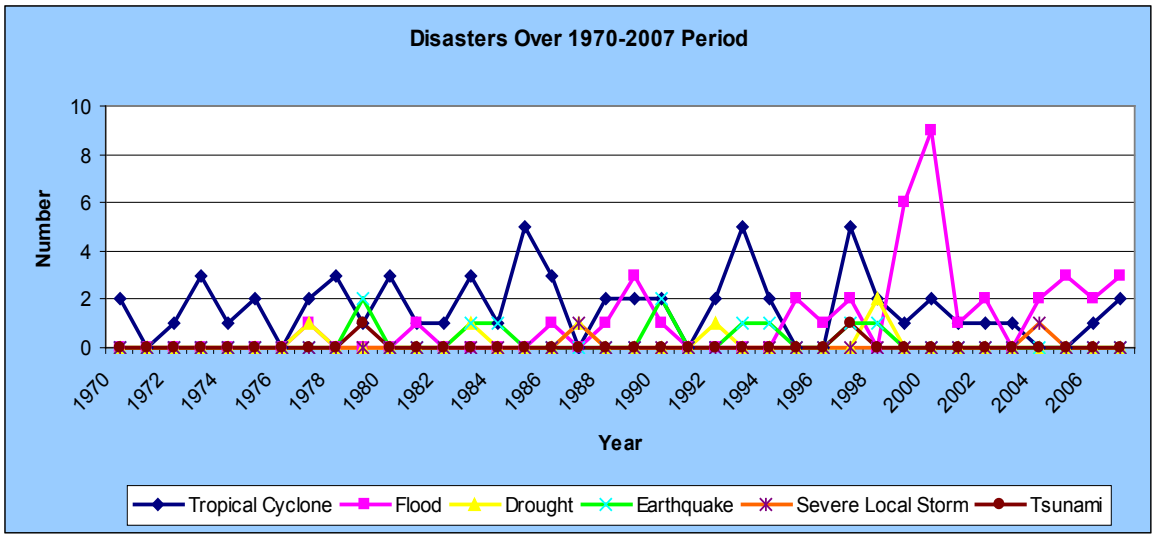
The impact of the floods is not homogeneous across the sugar belt. As discussed earlier, Lautoka and Rarawai mill areas accounted for about 80 % of the farms affected, and incurring $15.67 million (81%) of the total industry costs. The impacts are no doubt associated with the presence of major rivers, Nadi, Sabeto and Ba, that broke their banks in some places, as well as areas where bridges and culverts were broken. In addition, in the low lying reclaimed coastal areas, such as Drasa, Lovu and Rarawai, breaks in the seawalls and high tides coinciding with flash floods caused major damage.

Basic infrastructure that includes cane access roads, tramlines, and drains, as well as drainage schemes also have not properly been maintained for at least the last 20 years. Under the CSR days, the company had drainage maintenance schemes, where each year after cane harvest, staff were employed to clean and maintain main and other drains (Mr Jagannath Sami, ex Chief Executive Officer (CEO), Sugar Cane Growers Council, pers comm. April 2009). Since the late 1980's this system has been abandoned. Similarly, the Drainage Board used to annually maintain each of the drainage schemes. In recent times, because of shortage of funds, only spot maintenance of flood outlets and limited mechanical drainage of arterial drains is practiced.

This deterioration of the drainage infrastructure is also confirmed by the European Commission in its 2008 report on infrastructure (European Commission 2008). It particularly commented on the state of what used to be CSR drain infrastructure at the foothills in the sugar belt area, essentially upstream of the lower drainage system. These drains have become 'totally derelict' the report notes, which have contributed to the increased flooding in the sugar belt. The European Commission report notes that this has been the case 'since the past 20 years or so and this has resulted in major farming areas being seriously affected by temporary or permanent waterlogging' (p 34). Cane access roads and tramlines have not been maintained adequately, with funds allocated to just get the infrastructure to the stage that meets the immediate transport needs. The cumulative effects of these changes have been an increase in the sensitivity of the drainage system, rivers, and the catchments to high rainfall, resulting in regular flooding.

This also supports the observations made by the sugar cane farmers surveyed who noted that they regularly experienced flooding following heavy rains. In some areas, farmers reported having 3-4 events of floods a year following heavy rainfall, and which seems to be a recent phenomenon. This observation is also found to be consistent with the recent disaster statistics. For Fiji, while the number of climatic events (precipitation, cyclones and storms) does not seem to show an upward trend, the incidence of flooding events has increased, particularly following the departure of the CSR in the late 1970s, and then mid 1987, when Fiji's first coup was carried out (Figure 3).

Figure 3: Number of Different Disaster Events in Fiji, 1970-2007



Source: Lal et al 2009, based on data compiled from The International Emergency Disasters Database (EMDAT), Glide, Fiji Meteorological Services, and National Disaster Management Office

Thus, while the climatic condition that led to the 1-in-50 year flood events may have been unusual, the poor drainage infrastructure exacerbated the scale and duration of flooding.

6.5. Poverty Effects of the Floods

Disasters cause significant impact on the wellbeing of farmers'. Natural (and other) disasters are known to increase national level poverty of opportunities in Fiji, measured in terms of human development index (Lal et al 2009).

At the household level too, natural disasters can be a cause for pushing families below the poverty line. Household poverty in Fiji has been defined in terms of basic FPL and BNPL, which includes also non-food basic needs (Narsey 2008). Using the 2002-2003 FPL and BNPL estimates of Narsey (2008), and time series CPI reported by the International Monetary Fund (www.imfstatistics.org), the 2008 equivalent measures are $4,054, and $8,361 respectively. That is, any family earning less than the FPL, or $4,054, will not have sufficient income to meet their basic nutritional needs, and may even 'go hungry'. On the other hand, any household earning less than $8,361 a year will struggle to meet basic needs of their family.

Using these poverty line measures, the gross margin analysis of the farms affected by the 2009 floods indicate that about 42 % of them would struggle to provide even their basic food needs. This is an increase from 19 % of farmers had the floods not affected their crops, off-farm income, and other indirect costs. This 'with and without' analysis reflects loss of income, including off-farm income earned by members of the sugarcane household. This analysis excluded flood-related farm costs such as lost farming materials and cleanup, and household-related flood costs such as health costs, housing & possessions, cleanup, and evacuation. The analysis also does not include considerations of any debt which the farmers have.[14] In spite of this, the loss in income alone due to floods would mean 77% of the flood affected sugarcane families will fall below the basic needs poverty line, as compared with 54% of the families, had they not suffered from flooding. Labasa and Rarawai mill areas were worst affected (table 16). It is noted that many sugarcane families would have had negative cash flow (table 17) because of the high costs of their sugarcane farms (see (Lal 2008) for details).

14 Practically all of the surveyed households have debt recorded with FSC. Average debt per household is $5200.

Table 17: Percentage of Surveyed Farms That Fell Below the FPL and BNPL

Mill Area (farms surveyed)	Food Poverty Line (=$4,054)	Basic Needs Poverty Line (=$8,361)
Labasa (26)	46	92
Lautoka (148)	35	75
Penang (16)	19	56
Rarawai (190)	49	79
Industry (380)	42	54

Source: 2009 Flood Economic Survey

It is thus not surprising that many sugarcane farmers and others in the flood affected areas were forced to make some difficult choices immediately following the floods. Many families had to choose whether, for example, to send their kids to school or to meet their basic food requirements. Had it not been for the humanitarian assistance provided by many national and international organizations, it is likely that many children would have dropped out of school this year.

Table 18: Net Revenue of Surveyed Farms (With and Without Flooding)[15]

	'Without' Floods Household Income	'With' Floods Household Income
Range	-$1002 to $25,110	-$3009 to $18,475
Average	$8263	$5345
rse	0.15	0.21

Source: 2009 Flood Economic Survey

6.5.1. Positive Effect of the Devaluation

Devaluation provided some cushioning effect for farmers. Had the Government not devalued the Fiji dollar, the impact of the floods experienced by the sugarcane farmers would have been much more drastic. Without devaluation, more than three quarter (71%) of the surveyed affected farms would be expected to have fallen below the FPL, as compared to 42% with devaluation. On the other hand, almost all (98%) of the surveyed sugarcane families affected by the 2009 floods would have been considered to live below the BNPL, as compared with about 77% had the floods not occurred (table 18).

This is not surprising, since the cost of sugarcane farming in Fiji is very high and with the loss in preferential prices from the EU, pre-devaluation cane price was projected to be $41.24 per tonne.[16] Without floods and other changes, almost 60 % of farms were expected to have had a negative gross margin (Lal and Rita 2005b). The 2009 devaluation cushioned the effect of both the loss in preferential prices as well as the flooding. The extent of this cushioning effect in the future is difficult to predict given the recent increase in the fertilizer price and uncertainty in farmers' behaviour in the light of increased input prices.

15 Household Net Revenue = Gross Margin Cane Income + Gross Non-Cane Farm Income + Off Farm Income.

16 Calculated using the EU contract price of Euro 301.68 per tonne CIF and standard industry deductions described in (Lal and Rita 2005).

Table 19: Percent of 2009 Flood-Affected Sugarcane Families Expected to Fall Below FPL &BNPL

	% of Farms Below FPL (=$4,054)	% of Farms Below BPNL (=$8,361)
Post Devaluation		
"Without" Floods	19	54
"With" Floods	42	77
Pre-Devaluation		
"Without" Floods	55	98
"With" Floods	71	91

Source: 2009 Flood Economic Survey

6.5.2. Disaster Assistance

Farmers reported that several organizations, including the Sugarcane Growers Council, Fiji Farmers Union, and the Fiji Sugar Corporation visited them. In some areas, the Department of Agriculture also visited the cane farms, particularly those areas where non-cane crop is also grown in significant amounts. These visits were mainly focused on undertaking assessments, without, it seems, any follow-up assistance. For example, 70 % of the surveyed farms in Koronubu had different agencies visit the farms, but majority of them reported that these visits were for 'assessment only'. It seems that while many government and statutory agencies visited cane farmers, less than 20 % of the farmers in the most seriously affected areas received any form of assistance, humanitarian, or as part of disaster rehabilitation. Nor did it seem many sugarcane farmers who lost their household possessions and crops received assistance in the form of short duration crops' planting material. Ministry of Agriculture's agricultural support, with the assistance of the Secretariat of the Pacific Community, targeted mainly non-cane farmers, and sugarcane farmers were generally not included in the assistance scheme. Only about 4 % of the farmers received planting material. In some areas, such as in Vunimoli and Labasa, farmers relied on planting seeds obtained from neighbours 'on loan' to recover from the effects of floods; the farmers were expected to 'return' the seeds when the farmers harvested their crops.

The survey data suggests that, particularly with farmers living close to poverty line, their ability to respond to disasters is limited, and a little helping hand in time of need could help them respond to and cope with the aftermath of disasters. This is particularly critical for people who do not have much personal savings of their own and have limited support from extended families living in Fiji or abroad.

6.6. Increased Vulnerability

For the industry and the nation, the January 2009 floods could not have come at a worse time than when it did.

6.6.1. Increased Vulnerability Due to Poor State of the Industry

For the industry the January 2009 floods could not have come at a worse time than when it did. The industry has been struggling to reform its operations, despite several attempts in the last decade. All sectors of the industry, farm production, harvest and transport, and the milling and processing sectors have been declining since at least the 1987 political coups (see (Lal 2008)).

The number of active and efficient growers has gradually decreased over the last two decades due to a complex set of forces – the 1987 coups, the non-renewal of land leases, as well as regular mill breakdowns and shortage of farm labourers. With increasing input prices and substitution of the family-worked farms to farms reliant on hired labour also meant that farm costs have increased, and in many cases sugarcane farming has become non-viable. In the last five years alone the number of active growers decreased from 17,363 to 14,503. Milling and processing efficiency had decreased from 89% sugar recovery to 81% in 2003, with some mills reporting a sugar recovery of as low as 79% (Lal 2006). The FSC's financial situation has gradually decreased from FJD$9.6 million in profit in 1974 to FJD$19.3 million in loss in 2008 financial

year. The 2009 floods without doubt further aggravate their cash flow, and the industry's financial situation. This will cause flow on effects on the national economy and households' well being. The effects of the floods on the growers and the miller will thus be adding to the already existing woes in the industry, and the economy, which in itself is not doing too well.

6.6.2. Vulnerability and National Economy

Disasters, including floods, are known to have negative effects on national economic conditions, particularly in those countries heavily reliant on the primary sector (Benson and Clay 2004). This relationship between national level disaster outcome and the health of the national economy was also confirmed for Fiji, together with other factors, such as coups (Lal et al 2009).

The total gross value of farm based output lost due to the 2009 floods is $10.9 million, plus another $3.4 million equivalent lost by the miller. That is, sugarcane farming related costs due to the floods is about to 2.3 % of the 4-year average (2004-2008) industry gross revenue product of $FJ523 million. While Fiji has had similar, if not higher, disaster related economic costs on the sugarcane farming sector (see table 17), the 2009 effects are likely to be much more serious, particularly given the recent downturn in the economy, following the December 2006 political events. The flood outcomes will be further aggravated by the retraction in the national economy, which has retracted by 6.4% since 2006 (Reserve Bank 2009) and the loss of the full Euro120 million allocated to Fiji under the National Adaptation Strategy (unless of course firm steps are taken to return the country to a democratically elected government). Secondly, in October 2009, Fiji will be losing its last set of price 'subsidies' from the EU, and thus its cash flow is expected to decrease considerably. Such economic woes will have flow on effects throughout the country, and many of the regional towns in the Western and Northern Divisions, where cane is the lifeline, are likely to become ghost towns.

Table 20: Examples of Economic Impact of Cyclones and Floods (FJ$)

Item	Navua Floods 2004	Cyclone Ami (& Flooding) 2003
Household	6.7 million	N/A
Business	3.0 million	12.3 million
Agriculture (Non-Cane)	0.8 million	39.3 million
Agriculture(Cane)	-	13.6 million
Government Losses:		
Replacement, Rehabilitation and Provision of Emergency Supplies	2.5 million	29.2 million
Other Costs, Such as of Humanitarian Assistance	Not known	Not known
Estimated Total (Not Including 'Unknown' Values)	ca. 13 million	104 million

Source: Adapted from Holland 2008 (Navua floods); and Mckenzie et al 2005 (Cyclone Ami)

6.7. Other Issues: Data Availability

The availability of robust data is a serious limitation in this type of economic impact assessment of natural

disasters. Historic data about economic costs of past flood events are limited to only a couple of studies. In some cases, flooding accompanied cyclone events and thus the effects would have been magnified.

Past reported data on the sugar belt were based on industry projections, and as was discovered during this study, they do not seem to have been based on consistent methodology. Cost estimates were based on different concepts of value. At times, cane loss values were estimated in terms of rehabilitation costs (such as the ones reported by the Sugar Research Institute of Fiji for the 2009 cane loss due to the floods), whereas at other times, these were based on the value of loss in standing cane (such as the ones reported by the FSC for the 2009 floods).
Furthermore, scientific 'field based', experimental, or historical information on the impact of floods on sugar and sugarcane yield is not available for Fiji and it was difficult to validate projections provided by the farmers. There is always an incentive on the part of the farmers to overestimate the projected outcome[17], particularly when there is an expectation of some compensation or assistance due to the effects of the floods.[18] Fortunately, past production records of registered cane farmers were available for each surveyed farm. These were used as the 'without' floods base measure. It is recognised though that this may have led to an underestimate of the losses, particularly in those cases where farmers had participated in the Accelerated Cane Replanting Programme program and had new plant cane, which has higher yield.

Similarly in the case of infrastructure costs, the researchers had to rely on the damage estimates provided by the FSC field and engineering staff. Initially, the infrastructure estimates provided by the FSC staff captured annual cost of the maintenance of key infrastructure, such as cane access roads, or tramlines. FSC impact assessments did not reflect additional cost of infrastructure maintenance due to the effects of the floods. In this study, the additional cost due to the floods is reported as the 'with and without' infrastructure cost.

6.7.1 General Data Issues

The above observations applies to other disasters as well, even though once an event is declared as a national disaster, government agencies are required to provide the NDMO with information on immediate losses and costs (damage to buildings, replacement costs for infrastructure, etc.). Such data are collected to underpin immediate post-disaster humanitarian assistance and plan for rehabilitation. Accordingly, the NDMO retains historical records of natural disaster events, yet that data are incomplete and, in some cases, do not match the data reported by international agencies.

Time series data were limited because there is no agreed damage assessment method for use in Fiji. Neither is there an agreed cost measure for determining a dollar value of losses. In some cases, rehabilitation cost estimates are used; but for the agricultural sector, for example, the recorded cost of the standing crop lost or the costs of rehabilitation, is used. Similarly, a formal definition of 'number of people affected' is not available. That measure may, therefore, reflect variously the number of people whose livelihood was affected, the number dead, the number hurt and/or those affected indirectly. As a result, it is difficult to compare with the certainty the economic costs or the people affected by disasters.

The industry needs to develop a standardized definition of key terms, as well as methodology for estimating economic costs of disasters, such as floods, for ease of comparison as well as to support disaster risk reduction and disaster management decisions.

It is worth noting that the economic cost estimate arrived in this study is still lower than the $27 million figure provided by the industry stakeholders. This is despite the industry stakeholders using the lower pre-devaluation cane prices, and not including many other costs, such as non-cane crop losses, costs of house and household losses and damages, drainage schemes, or humanitarian costs.

It should also be noted that many of the subcategories of costs estimated in this study are less than those earlier provided by the industry stakeholders, including cane access and tramlines damages and loss in cane crop. This may be as a result of differences in the assessment methodology used, and more importantly perhaps the lack of capacity in the industry to undertake appropriate 'with and without' disaster impact assessment.

17 This is what appeared to have happened in the survey completed by the Fiji Sugar Cane Growers Council, with flooding impacts reported in areas that were known not to have been flooded.

18 Many growers asked the enumerators, whether this survey will lead to any assistance from the Government or the EU. Despite strongly indicating that this survey is not about any compensation, there is still some possibility of overestimation.

7. Policy Recommendations

Given the relationship between factors that determine vulnerability to floods and disaster outcomes, disaster risk management would need to adopt a targeted disaster risk reduction and disaster management strategies.

One key point that needs to be emphasized is that flood-related disaster risk reduction and disaster risk management strategies cannot be treated in isolation. Flood-related disaster management is part and parcel of the institutional improvements needed to tackle all hazards. Disaster risk reduction and disaster management of all hazards must become everyone's business. For a more integrated approach to disaster risk reduction and disaster management and Hyogo Framework of Action -based recommendations see (Lal et al 2009).

Here only immediate policy issues that need to be tackled specifically in relation to the flooding in the sugar belt are discussed. Two categories of recommendations are relevant in this context of flooding in the sugar belt area: national level policy recommendations that go beyond the sugar industry and those that are of direct relevance to Fiji sugar within its disaster risk management context.

7.1. National Level

As noted earlier, the probability of flooding is increased with changes in landscape for agriculture and urban development. Such developments affect the regulatory ecosystem services provided by natural systems, including the level of rainfall-runoff, and the amount of water that is not flushed out of the natural waterways.

Recommendation 1: *Invest in improving the health of the natural ecosystem for flood mitigation through integrated river catchment management, including sustainable management of upstream forestry, good farm husbandry, and management remnant natural freshwater wetlands.*

Disaster risk reduction produces higher benefits, particularly for the poor, than disaster management does. For every dollar invested in disaster risk reduction, between two and four dollars are returned in terms of avoided or reduced disaster impacts. Poor people are more sensitive to disasters because they often live in hazard-prone areas, live in poor conditions and have limited capacity to respond to/recover from disasters. Disaster events also increase the poverty level thus increasing the vulnerability of people who live below or near the poverty line.

Recommendation 2: *Adopt a pro-poor development strategy that targets poor communities living in areas prone to natural hazards.*

In the past, the Fiji Government, together with the sugar industry regularly invested in drainage and flood protection infrastructure, but the level of investment has decreased in recent years, particularly following the 1987 political coup. Poor maintenance of the drainage infrastructure affects not only the sugar cane farmers and the industry but also causes externality costs on the urban and peri-urban residents downstream.

Recommendation 3: *Investigate appropriate insurance and other financing schemes for risk reduction and disaster management for the sugar belt.*

The government needs to seriously consider establishing a disaster risk financing scheme that takes the responsibility of maintaining all drainage infrastructures in the sugar belt area. Poor maintenance of the drainage infrastructure affects not only the sugar cane farmers and the industry but also causes externality costs on the urban and peri-urban residents downstream.

***Recommendation 4**: Increase investment in the maintenance of physical infrastructures including drainage canals, drains, and infield farm drains to reduce probability of flooding.*

Unplanned and ad hoc peri-urban development also increases rainfall-runoff, increasing the probability of flooding beyond the natural systems regulatory capacity. Developments in hazard prone areas also increase sensitivity of humans to flooding. Such impacts can be avoided through appropriate regulation of developments.

***Recommendation 5:** Integrate disaster risk reduction considerations in all development initiatives, including:*

- Integrate (in other words, 'mainstream') disaster risk considerations in national development planning and budgeting processes at national, provincial, district, and village/settlement levels, and in development design
- Revise infrastructure development planning, maintenance, and funding to reflect requirements for hazard and risk assessments
- Revise development approval processes and guidelines to require hazard and risk assessments of development initiatives, particularly in hazard-prone areas
- Develop and enforce proper land-use planning and development as a flood mitigation strategy

***Recommendation 6:** Integrate disaster risk reduction considerations in all infrastructure construction and maintenance initiatives and resource allocations that reflect considerations of disaster risk reduction, particularly in flood prone areas.*

7.2. Industry Level

Sugar industry covers a wide area, and thus has a significant impact on the dynamics of rainfall-runoff in the sugar belt and associated riverine systems.

***Recommendation 7:** Establish a Fiji sugar industry disaster response strategy in partnership with the National Disaster Management Office and the Divisional Commissioners, including coordination for post disaster rapid assessment, disaster relief efforts, and post disaster rehabilitation.*

***Recommendation 8:** To minimize the risk of regular floods the industry, as a minimum, needs to "go back to the future" and:*

- *Ensure farmers adopt appropriate farm management practices that minimise farm level soil erosion, including the banning of agricultural development on slopes greater than 8^0 under the Soil Conservation Act;*
- *Re-establish maintenance of key infrastructure, main and arterial drains, and infield drains, as well as tramline drains and cane access road drains if the risk of regular flooding is to be minimized;*
- *Re-establish the old CSR drains, and reintroduce annual drainage gang system for maintaining key drain infrastructure; and*
- *Re-establish regular (annual) maintenance of drainage scheme infrastructure, including seawalls, bridges, and culverts.*

7.3. Information System

Good information is critical for disaster risk reduction and disaster management efforts. Fiji has limited quality data on flood and climate related hazards, flood-prone areas and disaster impacts, including coverage of disaster events and their effects on household welfare, sectoral activities and national economy. For the sugar belt, a SUGAR-GIS information system is already available, that integrates various layers of information including, sugarcane farms, land owners, and land tenure, mill catchment areas, rivers and streams as well as cadastral maps. This can be extended to key infrastructure, such as cane access roads, tramlines, and drainage schemes. Using flood inundation models for each river system, the database can be extended to create flood hazard maps, as well as flood impact areas, to support future decision-making.

Recommendation 9: *Enhance its SUGAR-GIS information system and develop a flood hazard layer of information, together with a robust system for collecting and analysing disaster impact assessments to support disaster risk reduction and disaster management. As a minimum:*

- *Establish a robust sugar industry-based rapid assessment methodology that takes advantage of the field knowledge of FSC field and extension workers, and cane growers councillors;*
- *Develop a layer hazard related information system as part of the SUGAR-GIS information system, including maps of hazard and disaster-prone areas, the geographic distribution, and socioeconomic characteristics of poor; and*
- *using the Sugar-GIS based information system and the results of objective rapid disaster impact assessment, assist with targeted humanitarian assistance as well as post disaster rehabilitation in partnership with the Divisional DISMAC office, relevant government ministries, humanitarian nongovernmental agencies, as well as development partners.*

Recommendation 10: *Improve the coverage and quality of data on floods and other climate-related hazards, including flood maps, and on the impacts of floods and other disasters on human livelihood and wellbeing at household, sectoral, and national levels.*

- Develop time series information on determinants of natural disasters to support the forecasting of disaster events
- Compile time series information on household income and expenditure, the human poverty index and human development index, and their key determinants to inform both development policies
- Link the enhanced SUGAR-GIS with the national GIS based disaster information system, including maps of hazard and disaster-prone areas, the geographic distribution and socioeconomic characteristics of poor, disaster records and disaster impact assessments, to help improve DRR&DM

Recommendation 11: *Strengthen capacity in appropriate 'with and without' disaster impact assessments.*

Recommendation 12: *Investigate appropriate insurance and other financing schemes for risk reduction and disaster management for the sugar belt.*

There are no financial mechanisms, including insurance schemes, available particularly to the farmers. Even where available, such as to the miller, they had recently opted not to insure their assets. The government needs to seriously consider establishing a disaster risk financing scheme for disaster risk reduction and disaster management. Recently, the World Bank had helped the Caribbean island countries to establish a Catastrophic Insurance Scheme. The experiences of the Caribbean island countries with the insurance scheme may have some relevance to Fiji (and other PICs).

8. Concluding Remarks

The severe rainfall pattern in January 2009 was considered to be a one-in-50 year event and the volume of water in the rivers and creeks were beyond their normal discharge capacity. However, the nature and duration of flooding of the low lying areas in the sugar belt is also a product of the changes in the regulatory services provided by the landscape due to increased agricultural developments, particularly on the steep lands and mangrove reclaimed lowlands. Some of the damage could have been avoided had the sugar industry and the Government invested adequately in the maintaining the natural health of the ecosystems, particularly by maintaining the drainage systems.

To minimise future flood-related costs, a multipronged disaster risk reduction and disaster management approach is required at all levels – national, industry, and household levels. The government, the sugar industry in partnership with the NDMO and other catchment-based stakeholders must invest in enhancing regulating ecosystem services provided by the natural landscape, as well as in the maintenance of the drainage systems. As a minimum, unless the industry 'goes back to the future' and invests in at least maintaining the key drainage infrastructures - including the old CSR drains, main drains and infield drains in the sugarcane farms, as well as the drainage schemes in the reclaimed mangrove and other coastal areas - such floods will continue, and will get worse with extreme weather events associated with climate change. Disaster risk management in the sugar belt area though must also go beyond what the sugar industry should do. Economic wellbeing of rural households must also be improved to make them less sensitive to disaster events, and better cope with the residual risks they may face. Without adopting a multipronged approach to disaster risk reduction and disaster management, Fiji will continue to suffer the effects of flooding, particularly the poor, and regular floods would force more people in the sugar belt to fall below the basic needs poverty line.

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ANNEX 1: Survey Team

Labasa Mill	Lautoka Mill	Rarawai Mill		Penang Mill
FSC staff	*FSC staff*	*FSC staff*	*SRIF staff*	*FSC staff*
Bimlesh Kumar Lal	Abhinash Prasad	Ali Aiyaz	Ashish Chand	Jagdish Prasad
Dach Raj	Altaf Buksh	Arun Prakash	Rajnesh	Jimilai Temo
Makario Tabuakuru	Anare Sikoa	Asis Chand	Renil	Saula Sevakasiga
Mani Rudra	Anil Kumar	Atish Chand	Rizwan Haque	Umendran Dass
Sanjeev Prasad	Asaeli Tawake	Bimlesh Chand		Viliame Kidia
Sanjeev Prasad	Asis Chand	Bimlesh Nath	*SCGC staff*	
Saula Senidamanu	Bala Krishna	Jagdish Prasad	Jain Kumar	
Shiva Nandan	Chandar Singh	Manasa Takala	Sashi Kant	
Subbarmani	Daniel Yankaiya	Parmen		
Sunil Chaudhary	Jagdish Singh	Ronesh Prasad		
	Jitendra Lal	Sachin N Naidu		
SCGC staff	Jitendra Prasad	Sailosi Navukoro		
Rajendra Prasad	Josevata Rajale	Sailosi W		
Uraia Waqa	Kanda Gounder	Sandeep Sharma		
	Osea Rile	Satish Chand		
SRIF staff	Peni Vuevuelala	Satye Vijay Raj		
Daven Sharma	Rajendra Kumar	Sekove Raikalevu		
Shiva Ram	Rakeshwar Kant	Semisi Lane		
	Ramesh Reddy	Shiu Kumar		
	Ravendra Kumar	Umesh Prasad		
	Raymond Q	Waisea Lovolovo		
		Walter Pickering		

ANNEX 2: Additional Relevant Key DRR&DM Policy Recommendations for Flood Risk Reduction and Management (Adapted from Lal et al 2009)

3.1. Mainstreaming of Disaster Risk to Policy Development

Disaster risk reduction benefits the poor more than disaster management does. For every dollar invested in disaster risk reduction, between two and four dollars are returned in terms of avoided or reduced disaster impacts.

Recommendation 1: *Adopt a pro-poor development strategy that targets poor communities living in areas prone to natural hazards.*

Recommendation 2*: Increase investment in disaster risk reduction as an effective measure to reduce the disaster vulnerability of the poor and thereby improve overall economic development.*

In the past, the Fiji Government has regularly invested in drainage and flood protection infrastructure, but the level of investment has decreased in recent years, particularly following the 1987 political coup.

The government has no dedicated strategy to ensure the development planning and budgeting processes at national, provincial, district and village/settlement levels address hazard and risk considerations. Building codes, where they exist, do not include considerations of increased risks from climate change-related disasters, for example, and where codes and guidelines are available for certain hazards, these are not enforced.

Recommendation 3: *Investigate appropriate insurance and other financing schemes for risk reduction and disaster management for the sugar belt.*

The government needs to seriously consider establishing a disaster risk financing scheme that takes the responsibility of maintaining all drainage infrastructures in the sugar belt area. Poor maintenance of the drainage infrastructure affects not only the sugar cane farmers and the industry but also causes externality costs on the urban and peri-urban residents downstream.

Recommendation 4: *Integrate disaster risk reduction considerations in all development initiatives.*

- Integrate (in other words, 'mainstream') disaster risk considerations in national development planning and budgeting processes at national, provincial, district, and village/settlement levels, and in development design
- Revise infrastructure development planning, maintenance, and funding to reflect requirements for hazard and risk assessments
- Revise development approval processes and guidelines to require hazard and risk assessments of development initiatives, particularly in hazard-prone areas

3.2. Disaster Management

Disaster management constitutes having emergency plans, equipment, and trained and knowledgeable people to help monitor hazards, operate end-to-end early warning systems, and manage emergency responses. The nature and frequency of awareness programs, the strength of the media in reaching every part of the country, past experiences of the public, and cultural beliefs also determine the extent of a community's vulnerability.

A weak end-to-end early warning system increases the vulnerability of the poor, along with their ability to make decisions and respond appropriately during an emergency. Although Fiji has sophisticated equipment at the Fiji Meteorological Centre in Nadi, other parts of the country lag in having updated early warning systems. In recent years, this discrepancy has severely affected efforts to distribute warnings in time to different parts of the country.

Also constraining the early warning system are poor hazard monitoring capabilities due to limited institutional capacity, difficulty in retaining qualified staff, and limited monitoring stations in key locations in the hazard-prone areas. In addition, poor communication equipment, a lack of proper rescue equipment, and insufficient personnel training in disaster management have resulted in the inefficient operation of the Disaster Management Team in some parts of the country.

Recommendation 5: *Review the disaster monitoring and early warning system.*

- Review monitoring capabilities for climate-related hazards, including the distribution of appropriate monitoring stations and gaps in technical expertise in data analysis and forecasting. This review may also cover gaps in the current network arrangements, with specialised international partners monitoring and forecasting disaster events
- Review the end-to-end warning system for floods and other climatic hazards to identify how to strengthen monitoring, the generation of appropriate information, and the communication of early warnings to communities. This review should cover the required equipment and personnel training
- Develop appropriate training and communication material to improve community awareness of disaster events, community preparedness, and practical household response strategies for each type of disaster event

Under the Natural Disaster Management Act (NDMA) 1998, the NDMO focuses on post-disaster response, recovery, and rehabilitation. The NDMA institutes a number of bodies and individuals responsible for aspects of disaster management, including the National Disaster Management Council (NDMC), Fiji Red Cross, the Emergency Committee, the National Disaster Controller, and the NDMO. Disaster management efforts are constrained by organisational and operational issues, including (Rokovada 2006):

- The absence of appropriate information to predict, assess, or respond to disaster events (for example, hazard maps, the scale of inundation, and disaster impacts)
- The institutional design of the decision-making and coordination process
- The inadequate resources available to the NDMO
- The inadequate equipment at emergency operations centres at the divisional and district levels
- The fact that NDMO operations are not linked to/integrated with Fiji's rural development/administrative machinery make it difficult to directly engage with and coordinate disaster response initiatives at divisional, provincial, district, and community levels

Recommendation 6: *Review the authority of the NDMO and its organisational arrangements in relation to the Ministry of Provincial Development and other government agencies, and information systems available to the office for strengthening capacity for DRR&DM.*

- Clarify the appropriate authority of the NDMO in disaster management, including the coordination of disaster assessments following disaster events to underpin appropriate domestic humanitarian and rehabilitation responses
- Review the coordination of disaster responses from national and international humanitarian agencies, and improve the coordination of disaster assistance from government and nongovernment agencies
- Review the scope and depth of different GISs and databases available in the country that could support disaster risk management

All levels of government and all communities should simultaneously pursue DRR&DM, including the sugar industry stakeholders. The Fiji Government agreed, under a Pacific regional framework for action, to establish appropriate mechanisms for developing and promoting DRR&DM, and to review regularly all DRR&DM arrangements. The government has not fully acted on these commitments, although the National

Disaster Management Plan of 1995 and the NDMA have been under review for several years.

Recommendation 7: *Urgently complete the review of the National Disaster Management Plan of 1995 and the Natural Disaster Management Act 1998, and develop a national action plan for DRR&DM, reflecting the regional framework of actions for disaster risk management and climate change.*

- Urgently develop and implement a DRR&DM national action plan linked to the national development plan and budget processes, meeting the Fiji Government's commitment to the Pacific Island Forum Leaders to systematically implement the Pacific regional framework for DRR&DM (and the Pacific Island Framework for Action on Climate Change).
- Develop appropriate DRR&DM policies and legislation that set appropriate institutional arrangements for ensuring the coordination of DRR initiatives across all sectors and across all levels of government, as well as appropriate DRR&DM strategies, decision-making processes and initiatives
- Develop a funding strategy for addressing a prioritised and appropriately sequenced set of actions, which the national action plan will articulate, and which will reflect a programmatic approach explained in both the Paris Principles of Aid Effectiveness and the Forums Principles of Aid Effectiveness
- Strengthen the operating guidelines of the Budget and Aid Coordinating Committee and the Development Sub-committee to include DRR&DM considerations in all development projects
- Encourage development partners to help strengthen DRR efforts

3.3. Disaster Risk Management: Data

To develop and implement targeted DRR&DM strategies, good quality data are critical. Fiji has limited quality data on flood and climate related hazards, flood-prone areas, and disaster impacts, including coverage of disaster events and their effects on household welfare, sectoral activities, and national economy.

Recommendation 8: *Improve the coverage and quality of data on floods and other climate-related hazards, including flood maps, and on the impacts of floods and other disasters on human livelihood and wellbeing at household, sectoral, and national levels.*

- Develop time series information on determinants of natural disasters to support the forecasting of disaster events
- Compile time series information on household income and expenditure, the human poverty index and human development index, and their key determinants to inform both development policies
- Develop a GIS based disaster information system, including maps of hazard and disaster-prone areas, the geographic distribution and socioeconomic characteristics of poor, disaster records, and disaster impact assessments, to help improve DRR&DM.

ANNEX 3: Sample Questionnaire

IUCN and FLIS

In Partnership with the Sugar Commission of Fiji

2009 FIJI FLOOD ECONOMIC ASSESSMENT SUGARCANE FARM HOUSEHOLD QUESTIONNAIRE

Section Contents and Purpose

A **PERSONAL BACKGROUND –** get an understanding of the number of people affected by floods and their social characteristics.

B **PERSONAL LOSSES –** understand the scale of flooding, get an understanding of how much householders lost as a result of the flood. This information can be used to predict future flood impacts in the future.

C **LOSS ON FARM –** understand the scale of flooding, get an understanding of how much was lost on the sugarcane farm and other agricultural activities as a result of the flood. This information can be used to predict future flood impacts in the future, such as due to climate change.

D **FLOOD RELIEF ASSISTANCE –** understand the nature of flood relief assistance that may have reached the flood affected areas in the cane belt.

E. **ACCESS TO COMMUNICATIONS –** get an understanding of how the Government might be able to advise people of an on-coming flood in the future.

F. **FLOOD WARNING RECEIVED AND ACTIONS TAKEN –** understand the SPEED OF flooding, warning received and actions taken to reduce the impact of flooding to personal property, possession and lives.

G. **FLOOD PREVENTION OR MINIMISATION OF IMPACTS** – get an understanding of the types of actions the Government, community and individuals can take to prevent or minimise flood impacts.

H. **FINAL COMMENTS**

Date	
Interviewer's name	
Interviewer's mobile no.	

Sector Name : _____ Sector No : _____ Cane Contract Number _____

A PERSONAL BACKGROUND

The purpose in this section is to get an understanding of the number of people affected by floods and their social characteristics.

A1) Interviewee's position in the household (head of household, wife of the head, son, daughter, daughter in law etc.)

_____

A2) How many people normally live in this family? _____ .Of these:

(i) How many are below school age? _____

(ii) How many go to school? _____

(iii) How many **work at home** or on **your own farm**? _____

(iv) How many **work away from home** (as a labourer on other people's farm, in town, driving taxi, work in government)? _____

B. PERSONAL LOSSES

The purpose in this section is to get an understanding of how much your family lost as a result of the recent flood.

Household Possessions

B1) Did your family lose any personal and household possessions? (Tick)

Yes No

If yes, go to B2 *If no, go to B4*

B2) If YES (please fill this table by asking the following questions)

a. What did you lose?

b. Number of each item?

c. How much will it cost to replace it today?

	What did you lose (Tick if yes)	**Number** of items lost.	What will it cost to **replace/repair** them? **(Total Cost** FJ$)
Appliances			
a) Television			
b) Radio			
c) DVD player			
d) Washing machine			
e) Refrigerator			
f) Gas or electric stove			
g) Telephone – land line			
h) Mobile phone			
i) Computer, printer, software			
Furniture			
j) Sofas			
k) Chairs			
l) Mats			
m) Beds and mattresses			
n) Tables			
Vehicle (s)			
o) Motor car			
p) Carrier			
q) Truck			
r) Bicycles			
s) **Food**		Na	
t) **Clothing**		Na	
u) Other _____ _____ _____ _____			

B3) If you are going to replace the items lost, what will you use (or have used) to do so? (Tick one or more as appropriate)

(i) Private savings

(ii) Help from extended family in Fiji

(iii) Help from extended family living abroad

(iv) Charity donations

(v) Government assistance

(vi) Other (specify) _____

Housing

B4) Was there any structural damage to your home? (Tick)

Yes No

If yes, go to B5 *If no, go to B6*

B5) If so, how much will it cost to repair $_____or replace? $ _____

Human health

B6) Did any member of the family get hurt during the floods? (Tick)

Yes No

(i) If yes, please describe what happened

_____

_____

(ii) How much did it cost to treat the person (s)? $ _____

B7) Following the floods, did any of the family member get sick from any illnesses associated with the after-effects of flooding (such diarrhoea, dengue, etc)

Yes No

If yes, go to B8 *If no, go to B9*

B8) If yes, how many household members were affected and how much did the family spend for treatment in total

	No. of family members who suffered from …..	Did you get treatment (Tick if yes)	Total cost to treat the family (for doctors fees, medicine, transport)	If you did not pay for the cost of treatment who did? 1. Red cross 2. government 3. other relief agency 4. Other (specify)
Diseases:				
(a) Diarrhoea				
(b) Dysentery				
(c) Dengue/high fever				
(d) Skin diseases, such a ringworm				
(e) Red eye or conjunctivitis				
(f) Other				

Loss in wage or other earning

B9) Did any member of your family lose their wage/ pay because of the flood (either could not get to work, or the place of work was closed)?

Yes No

If yes, go to B10 *If no, go to B11*

B10) If yes, for each people who works outside (own farm) please indicate where the person works, their normal wage rate, how many days they could not work because of the floods

	Specify what type of work does he/she does 1. farm labourer 2. work in town (shop assistant) 3. work in town (government) – state profession 4. school teacher 5. taxi driver 6. other (specify)	Normal wage/ earnings (however one is paid)	Specify Unit 1. Per day 2. Per week 3. Per fortnight 4. Other (specify)	No. of days could not get to work because of damage to your own home or were in evacuation centre	No. of days lost the pay for because the roads were blocked
(a) Person 1					
(b) Person 2					
(c) Person 3					
(d) Person 4					

Evacuation

B11) Did you have to evacuate your home?

Yes No

If yes, go to B12 *If no, go to B16*

B12) If yes, where did you evacuate to? (Tick)

i) Official evacuation centre

ii) Neighbours/Relatives house

iii) Other (specify) _____

B13) If yes, how did you evacuate? (Tick)

(i) On foot

(ii) Used own or family vehicle

(iii) Hired a vehicle

(iv) Boat

(v) Helped by evacuation team

(vi) Other (specify) _____

B14) How much did it cost you to go from your home to the evacuation place, if any $ _____

B15) For how many days did you stay away from home (either at an evacuation centre or elsewhere)

_____ days

Clean up and getting back services

B16) How many days did it take to clean up your house and the immediate surrounding after the flood?

(i) Less than 3 days
(ii) 3-7 days
(iii) 1-2 weeks
(iv) More than 2 weeks
(v) Not applicable

B17) How much did it cost to clean your house (buying detergent, etc) and compound? $ _____

B18) How many hours would you need to hire a tractor to clear your farm of debris? _____ hours

B19) Did you experience disruption in basic services and how many days were you without the service? (N/A – not applicable, if service not available)

(i)	Transport	[ ]Yes	[ ]No		Number of days _____
(ii)	Water supply	[ ]Yes	[ ]No	[ ] N/A	Number of days _____
(iii)	Electricity	[ ]Yes	[ ]No	[ ] N/A	Number of days _____
(iv)	Telephone	[ ]Yes	[ ]No	[ ] N/A	Number of days _____

C. LOSSES ON FARM

The purpose in this section is to obtain specific information regarding losses on your farm due to flooding.

Cane crop

C1) How many acres of sugarcane did you harvest in **2008**? _____ acres

C2) a. How much cane did you harvest in the **2008** season? _____tonnes

b. For **2009** season, what was the area of:

(i) ratoon? _____ acres

(ii) plant cane? _____ acres

C3) a. What proportion of your farm was underwater or water-logged?

_____% of farm area **OR** _____ area (acres)

b. How long did it take before the water receded? (Tick)

(i) Less than 1 day
(ii) 1-2 days
(iii) More than 2 days

C4) What is the total area of cane that was affected:

(i) due to salt water intrusion? _____ Acres
(ii) due to excessive water logging? _____ Acres
(iii) covered by silt? _____ Acres
(iv) washed away? _____Acres
(v) due to landslide? _____Acres
(vi) due to cane lodging? _____Acres

C5) a. What is the area of cane that is remaining? _____ Acres

b. For the area of cane that is remaining, to get the farm back to 'normal', as relevant specify:

(i) total number of bags of fertilizer required again? _____ bags

(ii) total number of days required for spraying (weedicide)? _____days

(iii) total number of days spent on trashing? _____ days

(iv) total number of days of drainage work? _____

C6) **As a result of flooding losses**, how much cane do you expect to harvest in 2009 year? _____tonnes

C7) In 2008, who harvested your cane? (Tick one)

(i) Substitute cutters

(ii) Mechanical harvester

(iii) Self or family as a member of harvest gang

C8) In 2008 season, what did you use to transport your cane to the mill (Tick)

(i) Lorry

(ii) Rail

C9) In 2008, how much did you pay for the following:

(i) Harvesting _____ $/t ;

(ii) Transport _____$/t

(iii) Harvesting and transport if paid for as one activity _____$/t

Non-cane crop

C10) a. How many acres of land did you use for other crops? _____ acres

b. How much of this was for:

(i) Vegetable _____ acres

(ii) Fruits (mangoes, papayas, etc) _____ acres

(iii) Other (specify) _____ acres

C11) What is the area (acres) or proportion of crops that was totally destroyed by the flood?

(i) Vegetables _____acres **OR** _____% of area under vegetables

(ii) Other (specify)_____acres **OR** _____% of area under other crops

C12) On an average how much income (if any) did you receive last year <u>from selling</u> vegetables and other crops?

$_____

C13) As a result of the effect of floods, if any,

(i) how much do you expect to earn from non-cane crops in 2009? $_____

(ii) what is the equivalent dollar value of non-cane subsistence crop lost? $_____

Farming Material

C14) Which of the following did you lose during the floods and what will it cost to replace/repair them?

	Tick if yes	the number	What will it cost to replace them today (total)
Farm equipment/machinery			
a) Farm Implements (forks, spades, knives)			
b) Spray pumps, etc			
c) Tractor & accessories			
d) Fertilizer (no of bags)			
e) Weedicide (litres)			
Livestock/Animals			
f) bullock / horse			
h) **Others (eg. chicken feed)**			

Livestock

C15) Do you produce chicken/ducks <u>for sale</u>? (Tick)

Yes No

If yes, go to C15 *If no, go to C19*

C16) (i) In 2008, how **many** chicken/ ducks did you sell <u>per month</u> _____; <u>per year</u> _____?

(ii) How **much** money did you earn from the sale of chicken/ducks

Chickens/ducks $_____ / month; $ _____per year?

C17) How **many** chicken/ ducks did you lose during the floods?

Chickens/Ducks _____

C18) How much will it cost to get the production back to where you were in December 2008?

(i) to repair the chicken pens /duck pond $_____

(ii) to buy feed etc $_____

C19) Do you produce goats <u>for sale</u>? (Tick)

Yes No

If yes, go to C19 *If no, go to C24*

C20) In 2008

(i) how **many** goats did you sell? _____

(ii) how **much** money did you earn from the sale of goats? $ _____

C21) How **many** goats did you lose in the floods, if any? _____ (number)

C22) How much will it cost to get your goat production back to where you were in December 2008?

(i) To repair the goat pen $ _____

(ii) To buy the goat kids $ _____

(iii) Other (specify) $ _____

C23) How many goats do you expect to sell in 2009? _____ (number)

Cane access roads

C24) a. Did the cane access road to or near your farm get damaged during the January floods? (Tick)

Yes No

b. If yes, did you take any actions to improve/repair the cane access road

Yes No

c. If yes, what did you do?

_____

d. How much did it cost you? $ _____

C25) Did the damage to the cane access affect your family's movement (to get to work, school, shops, etc)?

Yes No

C26) If relevant, did ANY part of the tramline in your sector get damaged by the floods? (Tick)

Yes No

C27) a. As a result of flooding, did you have to do any work (cleaning, etc) on your farm drains?

Yes No

b. If yes, how many days did you spend? _____ days

c. How much did it cost? $ _____

D. FLOOD RELIEF ASSISTANCE

D1) Did any of the following people visit your farm/ sector? (Tick if yes) If yes, what help did they give?

Agency	Farm	Sector	Activity / Type of assistance offered
a) FSC field officers			
b) SCGC councillors/ staff			
c) Red Cross			
d) Government agency (specific which agency)			
e) Other relief agency (specify) _____			

D2) Have you received any agricultural planting material? (Tick)

Yes No

If yes, go to D3 *If no, go to D4*

D3) If yes, who provided the assistance and what planting material did you receive?

Agency	Assistance provided	Type of planting material received
a) FSC extension staff		
b) SCGC councillors/ staff		
c) Red Cross		
d) Government agency (specific which agency)		
e) Other relief agency (specify)		

D4) Has your school child/ children received any assistance from external agencies following the floods?

Yes *If yes, go to D5*

No *If no, go to D6*

D5) If yes, then specify the nature of assistance

	Tick if received one or more of these	No of children received assistance	Total Value ($)
a) school fees			
b) school supplies (bag, books, stationary)			
c) school lunch			
d) bus fares			
e) other (specify)			

D6) If you did not receive any assistance, then describe how you are coping? (Tick one or more options)

(i) assistance from family

(ii) assistance from family living aboard

(iii) assistance from neighbours

(iv) using own saving

(v) other (explain) _____

E. ACCESS TO COMMUNICATIONS

The purpose in this section is to get an understanding of how the government might be able to advise people of an oncoming flood in the future.

E1) Which of these facilities/ services do you regularly have at home? Put N/A if not applicable

	Tick if 'yes'
(a) Electricity	
(b) Phone land line	
(c) Mobile phone	
(d) Electricity powered radio	
(e) Battery powered radio	
(f) Television	
(g) Email at home (Computer with access to the internet)	
(h) Newspaper (Fiji Times, Fiji Sun, Daily Post etc)	
(i) Fax	

F. FLOOD WARNINGS

The purpose in this section is get an understanding of whether or not a short term warning system (1-3 hours) would make any difference to what you could do to reducing losses in the future.

F1) How often have you experienced flooding (in significant parts) in **your farm**?

(i) More than once a year

(ii) At least once a year

(iii) Once every 2 years

(iv) Once every 3 or more years

(v) Other (specify) _____

F2) How often have you experienced flooding of **your house**?

(i) More than once a year

(ii) At least once a year

(iii) Once every 2 years

(iv) Once every 3 or more years

(v) Other (specify) _____

F3) Before January this year, in which year did you **last** suffer from flooding of a **similar scale** on your farm?
_____(year) _____(never)

F4) In 2009, how did you find out about the prospect of flooding of your farm/house?

(i) Saw heavy rain and knew from past experiences that flooding was inevitable

(ii) Saw water rise in the river/ drains

(iii) Water in the farm rise

(iv) Radio

(vi) Television

(vii) Phone call from friend/colleague

(viii) Text message

(ix) Contacted in person by friends/neighbours

(x) Other (specify) _____

F5) How much warning did you get before water came into your **farm**? (Tick)

(i) Less than 30 minutes

(ii) 30 minutes – 1 hour

(iii) 1 – 2 hours

(iv) More than 2 hours

F6) How much warning did you get before water came into your **home**? (Tick)

(i) Less than 30 minutes

(ii) 30 minutes – 1 hour

(iii) 1 -2 hours

(iv) More than 2 hours

(v) Not applicable

F7) How long did you wait before taking action (moving things to higher ground) after learning about possible flood reaching your house/farm? (Tick)

(i) Less than 30 minutes
(ii) 30 minutes – 1 hour
(iii) 1 -2 hours
(iv) More than 2 hours
(v) Not applicable

F8) What action(s) did you take to protect your property and possessions? (Tick)

(i) a. Move household goods to higher level
b. Did it help? Yes No
(ii) a. Move animals to higher ground
b. Did it help? Yes No
(iii) Could not do anything as the floods came in too quickly
(iv) Not applicable

F9) What action(s) did you take to save you and your family? (Tick)

(i) climbed on top of the roof/higher level within your house
(ii) left home for higher grounds (Proceed to F10)
(iii) Not applicable

F10) If you left for higher ground, when did you decide to leave your home for safety? Specify stage of flooding. (Tick)

(i) Water entered the field
(ii) Water entered the house
(iii) Water in the house reached knee-length or higher
(iv) Not applicable

F11) Where did you move to? (Tick)

(i) Higher grounds on own property
(ii) Higher grounds on neighbours property
(iii) To government declared shelter place
(iv) Not applicable

G. FLOOD PREVENTION OR MINIMISATION OF IMPACTS

The purpose of this section is to identify what could be done by the Government, yourself and/or the community to minimise the frequency/intensity of flooding in your area.

G1) a. Do you think anything can be done to minimise the frequency of flooding in your area?

Yes No (If no, proceed to Section H)

b. If yes, name <u>two</u> actions that:

(i) The Government could do to minimise flooding
a. _____
b. _____

(ii) Your family could do to minimise the damage to your family's possession and farm

a. _____

b. _____

(iii) Your village or the sector can do collectively to minimise the frequency of flooding and or damage to your farms, houses and possessions

a. _____

b. _____

H. FINAL COMMENTS

Would you like to add any general comments about:

(i) Flooding _____

_____

_____

(ii) Flood warnings _____

_____

_____

(iii) Flood assistance _____

_____

_____

(iv) Rehabilitation _____

_____

_____

Other comments

_____

_____

_____

_____

Conclusion

Explain that the results of the survey will be made available to the Sugar Commission of Fiji, the EU and the Government around May and that these will be released to the public after verification. The results of the survey will be produced in a report that will be submitted to the EU and stakeholders later in the year.

THANK YOU FOR HELPING US IN THIS WORK.

If you have any questions, please contact:

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Cover photo — Farmer surveying cane field damaged by seawater intrusion due to flooding, Drasa Sector. © Neehal Khatri

Photo 3.1 — Cane and noncane crops on *bila* land on the river's edge. © Peter Hedrie

Photo 4.1 — Left: Post-flood debris piled outside house. © Barbara Malimali
Top Right: Flooded drains in the mangrove-reclaimed coastal land. © Padma Narsey Lal
Bottom Centre: Cane lodged as a result of flooding. © Padma Narsey Lal
Bottom Right: Coriander plant surrounded by silt after flood. © Neehal Khatri