Vulnerability to natural disasters: an economic analysis of the impact of the 2009 floods on the Fijian sugar belt

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The 2009 Fijian floods caused almost F$24 million in economic costs in the country's sugar belt. As a result, almost 50 per cent of the flood-affected farm households are expected to fall below the basic needs poverty line, with at least 25 per cent of the affected farm households unable to meet their basic needs. The floods further exacerbated the sugar industry's unprofitability. Such outcomes of natural disasters are a product of interaction across a complex web of factors: the timing, duration and intensity of the disaster, and the sensitivity to disaster of affected households, communities and industry. The results suggest that to reduce such economic costs, disaster risk management must focus on a multi-pronged approach to disaster risk reduction and disaster management at all levels—national, industry and household. as well maintaining key landscape based ecosystem services.

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The impact of natural disasters is determined not only by the nature and scale of the hazard but by the vulnerability of households, communities and the society at large. Vulnerability is defined as the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard (UNISDR 2009). The purpose of this article[1] is to assess the economic costs associated with the 2009 floods on the sugar belt in Fiji and to demonstrate that vulnerability is determined by not only the nature and intensity of the event, but the health of the farm production system and the industry, as well as the timing of the hazardous event. The study also demonstrates that the government's macroeconomic policy at the time had a major influence on Fiji's vulnerability, including households' economic well-being.

The sugar industry

The Fijian sugar industry has been the largest contributor to Fiji's economy until recently, when the tourism industry took over. In 2008, sugar exports earned F$138 million, generated about 30 per cent of exports and accounted for about 3 per cent of GDP.[2] The industry provides about 12 per cent of total employment in the country[3] and is the single most important employer in rural areas.

At its peak, the sugar industry had more than 23,000 registered growers, with a registered land area of 181,976 hectares. Since 1987, the sugar industry has been on the decline due to the effects of the 1987 and subsequent coups and the non-renewal of land leases (Kumar and Prasad 2004; Prasad 2006; Lal 2008; Lal and Rita 2008). The number of active growers declined from 17,363 in 2003 to 14,096 in 2008, and is still declining. With increasing input prices and the replacement of family-worked farms with farms reliant on hired labour, farm costs have increased and almost half the farms are close to being non-viable (Lal 2008; Lal and Rita 2008).

The Fiji Sugar Corporation (FSC)—the sole miller, which operates four mills—has also been on the decline, resulting in regular mill breakdowns (Lal 2006). Milling and processing efficiency has declined from 89 per cent sugar recovery in 1968 to 81 per cent in 2003, with some mills reporting a sugar recovery as low as 79 per cent (Lal 2006). The FSC's financial situation has gradually deteriorated from a profit of F$9.6 million in 1974 to a F$19.3 million loss in the 2007/08 financial year. At the same time, the preferential EU protocol prices that Fiji enjoyed for the past four decades—which were two–three times the world market price—have been lost due to reforms in the European Common Agricultural Policy (Lal and Rita 2006; Levantis, Jotzo and Tulpule 2003).

Sugarcane production

Fijian sugarcane farming is based on rain-irrigated agriculture, with cane harvesting restricted to the June–July to November–December period. Where undertaken, planting of cane usually occurs immediately after harvesting and field preparation. Much of the initial expansion of the sugar industry was brought about by the clearing of land during the early colonial period—similar to the British colonial power's experiences in the Caribbean and South Africa. The colonial government and post-independence governments also created 'new land' by establishing large drainage schemes on coastal—largely mangrove—lands. These reclaimed lands were developed by constructing seawalls to keep seawater out and by clearing the mangrove forests. Large drainage canals were constructed to encourage drainage of low-lying areas. These coastal plains today make up approximately one-third of the area under sugar cane—areas that are often susceptible to flooding (Hemraj Mangal, then Fiji Sugarcane Experimental Extension Officer, Personal communication, 2004). Post independence, the Fijian sugar industry also expanded into hilly lands following the preferential access granted to markets—first in the United Kingdom under the agreement with the British government, and subsequently in EU countries under the Lomé Convention's EU Sugar Protocol (Kumar and Prasad 2004; Lal and Rita 2005). Much of the later expansion took place on lands with slopes in excess of 8 degrees—areas that are considered unsuitable for agriculture under the country's *Soil Conservation Act*.

Flooding in Fiji and the 2009 floods

Flooding is an almost annual event in Fiji, with floods accounting for almost one-third of all disasters in the country since 1970 (Lal, Singh and Holland 2009). In the past four decades, flooding alone has affected in excess of 220,000 people, causing 88 fatalities, according to statistics reported to the global databases EMDAT and GLIDE and records maintained by the National Disaster Management Office in Suva (Lal, Singh and Holland 2009).

Flooding is generally associated with rainfall in excess of the capacity of landscape ecosystems to handle, causing water logging of low-lying areas and overflowing of rivers and creeks. It can also be associated with coastal water intrusion through storm surges and high tides, and breaks in physical infrastructure. Frequent freshwater flooding and seawater intrusion affect much of the sugar belt.

The 2009 floods

The 2009 floods, which were reported as being the worst since 1931 (Rajendra Prasad, Director, Fiji Meteorological Service, Personal communication, April 2009), resulted from a confluence of factors interacting with the geographical characteristics of the various catchment areas. Several consecutive depression systems in the weather within a short duration and associated rainfall over a short period coincided with high tides. Many parts of the country were affected by floods that lasted several days—from western Viti Levu, where the impact was greatest, to the Northern and Central Divisions. Intense rainfall—more than 60cm of rain in 24 hours—led to flash floods beyond the coping capacity of the catchments. With continuous torrential rains over two weeks, most of the low-lying areas in the country were under water for days and some places experienced flood levels of up to 3–5 m (Fiji Meteorological Service 2009b). The 2009 flood event was considered to be a one-in-50 year event (Fiji Meteorological Service 2009b). Excessive floodwaters also caused breaks in coastal infrastructure, resulting in breaches in the seawalls, with the sea reclaiming parts of what used to be wetland areas. The direct and indirect effects of the floods were felt throughout the low-lying areas, including the sugar belt and the sugar industry as a whole.

Economic cost assessment: analytical framework

The United Nation's Economic Commission for Latin America and the Caribbean (UNECLAC) recommends a disaster economic cost assessment framework that has three key elements: the cost of immovable assets and stock (damage); forgone income; and the secondary or macroeconomic effects (UNECLAC 2003). In this study, only the first two cost components are assessed, using cost and value measures defined by UNECLAC (2003). For the assessment of macroeconomic impacts, a time lag of at least 18–24 months is suggested to allow for economy-wide, flow-on effects to be realised (Benson and Clay 2004).

Direct and indirect effects of the 2009 floods

Using the Australian Bureau of Meteorology's definition of a flood (http://www.ga.gov.au/hazards/flood/), the direct effects of floods in Fiji are broadly defined to arise when heavy rainfall causes

- overflowing of river and creek waters and flooding of farms, houses, access roads and other infrastructure, together with associated deposition of silt
- waterlogging of low-lying farmlands, together with associated deposition of silt
- influx of seawater onto farms and into homes resulting from breaks in seawalls caused by large volumes of rainfall run-off
- other effects of heavy rain on hilly cane

fields that can include landslides and deposition of soil/silt on low-lying flat lands and *bila* farms.[4]

Direct effects are defined as damage caused directly to growers (farms and households), millers and infrastructure due to the flood inundation. At the same time, there are many flow-on, 'indirect' effects arising from flood inundation of farms, houses and access roads, such as losses in wages, a decline in the national economy and humanitarian impacts. The direct victims of the floods in the sugar belt area are the growers and the miller.

Sugarcane growers

There are many categories of sugarcane farms and farmers that have been affected by the floods: those producing sugarcane only, those producing sugarcane and non-cane crops and those producing sugarcane and non-cane crops and/or livestock.

Floods directly affect sugarcane yield as well as its sucrose content. The effects of floods depend on the extent and the duration of floods and whether floodwaters are stagnant or flowing. Losses are suffered either because the sugarcane drowns completely or because of a decline in sugar content (Weiss 1976 and Humbert 1968, respectively, quoted in Berning, Viljoen and Plessis 2000). Cane can also become 'lodged' (fall over). When the cane is high relative to the flood level, it tends to recover quickly once the floodwater recedes. On the other hand, a total loss of the cane crop occurs when cane is dislodged or uprooted due to the force of floodwaters. In the case of non-cane crops—particularly vegetables that are highly sensitive to water submersion—floods usually result in a total loss of the crop. Similarly, animals can be lost due to drowning. Where land is scoured away, the farm loses a proportion of its land value. Other direct effects of flooding on a farmer's livelihood include the impact on family homes and household possessions.

Some of the cane farmers also had family members who worked in urban areas or elsewhere and who lost wages because of the inability to get to work or because the workplaces 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 reach a medical facility—incurred by family members who suffer from water and insect-borne diseases spread by floodwaters and poor conditions. Direct and indirect effects of floods on the sugarcane farming households are summarised in Table 1.

The miller

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

The miller, growers and the State: infrastructure costs

The miller, growers and the State also have to bear the cost of the effects of floods on infrastructure. Floods have a direct impact on the local infrastructure on which the sugar industry depends: cane access roads, tramlines and bridges to get the harvested cane to the mills, and infield drains and drainage scheme infrastructure. The costs of these are borne by the miller, growers and the government, according to a complex industry arrangement (see Lal 2006).

The extent of such damage to infrastructure depends on the size of floods, the volume of water that flows through the floodplains, the length of roads, tramlines and other structures within the floodplains (Berning, Plessis and Viljoen 2001) and the extent and value of current economic activities within the sugar belt. In several places, flooding and the force of the deluge of water broke the seawall; this caused the cane fields to become inundated with saltwater. Saltwater caused a total loss of the affected areas in places such as the Drasa and Lovu flats. These salt-inundated farms might not produce crops for two–three years depending on the subsequent rainfall and flushing of salts (Hemraj Mangal, Manager, Cane Development, FSC, Personal communication, June 2009).

Determining 'with and without' costs

The economic cost of each category of flood effect is most appropriately estimated using a 'with and without' benefit–cost analytical framework (Sinden and Thampapillai 1995), which involves identifying the economic value of each of the activities in the system without the floods and comparing this with the situation with floods. Thus, for example, the effect of floods on cane output is estimated as the difference between sugarcane output expected in the absence of the flood ('without') and the cane output after the flood ('with'). These effects are translated into economic values of damage by multiplying the reduction in cane output times the forecast price of cane for the 2009 crop. In addition, any related costs incurred by the farmers are considered, such as the cost of removing debris from farms and bringing the remaining field to its pre-flood state. We summarise the cost categories assessed using the 'with and without' analysis (Table 2).

Table 1 **Direct and indirect effects of floods on sugarcane farming households**

Direct effects	Indirect effects
On-farm impacts	Loss in wages due to inability to get to work either because the roads are blocked or because the workplace is closed
total loss of cane and non-cane crops or reduced productivity of crops from waterlogging, saltwater intrusion and/or siltation	Costs incurred to clean up farms, homes and commercial sites
loss of productive farmland due to scouring/washing away of parts of farm and other land	Human health effects caused by water and vector-borne diseases induced by poor water and sanitation conditions after flood conditions
loss of livestock (such as chickens, ducks, goats and sheep) due to drowning	Hardship caused by loss of household possessions and belongings, leaving families unable to meet their basic food and nutrition, clothing and/or schooling needs (often difficult to quantify). Some of these would have been addressed temporarily through humanitarian assistance.
Loss of or damage to household possessions and housing infrastructure.	

Table 2 **Cost categorises estimated using the 'with and without' methodology**

Value of activities	With-floods scenario	'With and without' flood damage analysis
Farm		
Sugarcane output (plant and ratoon)	Cane output after flooding	$GVP_{\text{without floods}} - GVP_{\text{with floods}}$
Non-cane crops and livestock	Non-cane crop and livestock output after flooding, assuming farmers lost only six-month equivalent of their annual non-cane crop revenue	$GVP_{\text{without floods}} - GVP_{\text{with floods}}$
Clean-up of farmland debris	Total clean-up costs after floods	$TC_{\text{clean-up due to floods}} - TC_{\text{clean-up without floods}}$
Farming materials	Replacement (lost) or damaged	$TC_{\text{farming materials replacement/repair}}$
Cane access road (private maintenance)	Repair costs after flood	$TC_{\text{cane access road repair}}$
House and household		
House and household possessions	Replacement (lost) or damaged	$TC_{\text{house replacement/repair}} + TC_{\text{household possessions replacement/repair}}$
Normal off-farm income	Gross income earned after floods	$TC_{\text{off-farm income without floods}} - TC_{\text{off-farm income with floods}}$
Normal home clean-up	Total clean-up after floods	$TC_{\text{clean-up due to floods}} - TC_{\text{clean-up without floods}}$
Human health	Increased disease incidence and injury after floods	$TC_{\text{health costs with floods}} - TC_{\text{health costs without floods}}$
Mill		
Mill infrastructure maintenance	Regular maintenance costs plus additional cost of damage	$TC_{\text{maintenance with floods}} - TC_{\text{maintenance without floods}}$
Miller's share of sugar revenue	Reduced level of cane throughput	Miller $\text{revenue}_{\text{without floods}}$ – Miller $\text{revenue}_{\text{with floods}}$
Infrastructure		
Cane access road (Regular maintenance)	Regular maintenance costs <u>plus</u> additional cost of damage to the cane access road due to floods	$TC_{\text{maintenance with floods}} - TC_{\text{maintenance without floods}}$
Tramline (normal maintenance)	Normal maintenance costs <u>plus</u> additional cost of damage to the tramlines due to floods	$TC_{\text{maintenance with floods}} - TC_{\text{maintenance without floods}}$
Drainage scheme canals and drains	Normal maintenance costs <u>plus</u> additional cost of damage to the drainage schemes due to floods	$TC_{\text{maintenance with floods}} - TC_{\text{maintenance without floods}}$
Humanitarian		
Humanitarian assistance	Humanitarian disaster response	Monetary equivalent of disaster packs, medical kits, food rations, education support

Cost estimates were made using several different valuation methods, as summarised in Table 3.

Results and discussion

About 15 per cent—or 2,181—sugarcane farms were affected across all four mill areas by the 2009 floods. The impact was, however, not uniform throughout the industry. Affected farms were distributed across 34 of the 39 sugar sectors, excluding the FSC estate sectors. Four sectors—Lautoka, Koronubu, Saweni and Qeleloa—with significantly large areas of low-lying and coastal plains, accounted for more than one-third (35 per cent) of the farms affected by the floods. On the other hand, more than half the sectors had less than 15 per cent of the farms with only small patches that were waterlogged/'flooded' (Figure 1).

Total economic costs to industry

The total economic cost to the industry due to the 2009 floods was estimated to be F$24 million,[5] including the miller's costs and damage to cane access roads and other infrastructure (Figure 2). Of this, the growers' cost was a little more than half, or about F$13.4 million.

Sugarcane farmers in the two mill areas of Rarawai and Lautoka, where low-lying land is dominant, incurred almost 90 per cent of all flood-related costs (Table 4).

Within these mill areas, the low-lying sectors—Drasa, Koronubu and Mota—were the most affected, with each losing more than F$500,000 worth of cane.

Loss or damage to the cane crops accounted for the largest share (61 per cent) of costs borne by the farmers—or about F$8 million—with other direct and indirect costs accounting for the balance (Figure 3).

Household poverty

The flooding had a significant impact on household well-being. Almost 50 per cent of the affected sugarcane farming families—or a little less than 10 per cent of growers in the industry—are expected to fall below the poverty line, and almost 40 per cent will

Table 3 **Cost valuation methods used**

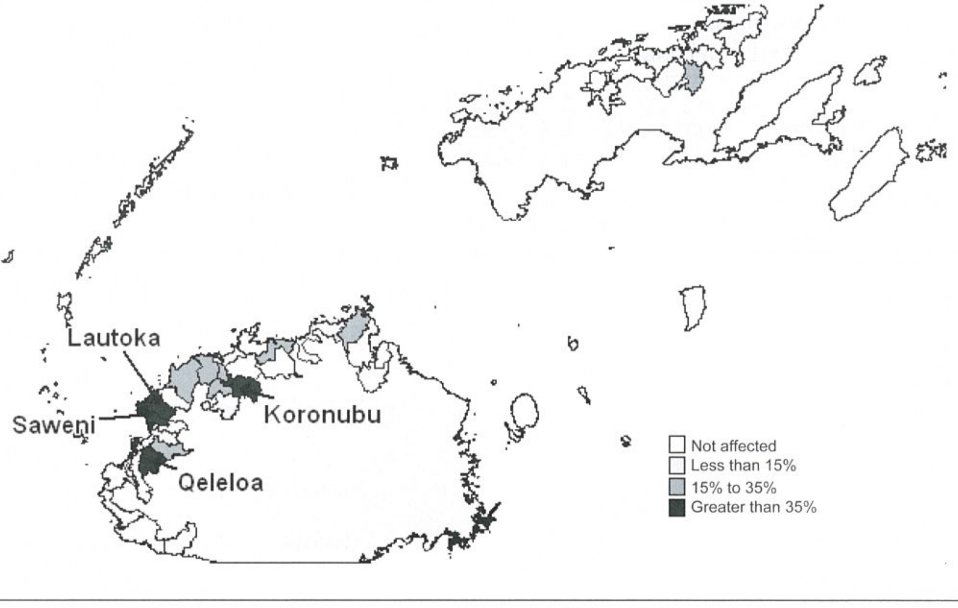
Production method	Item
	Gross value of loss in sugarcane production
	Gross value of loss in non-cane crops and livestock
	Gross loss of wages due to lost work time
Replacement method	Cost to replace household possessions; 'clean-up' costs
Replacement method (repair cost)	Costs to repair houses, household capita, and so on
	Costs to repair infrastructure: cane access roads, tramlines, drainage, and so on
Opportunity cost	Costs for treatment of diseases (human health)

Table 4 **Direct and indirect economic losses to growers' household income, excluding farm costs** (F$)

Cost categories/mill areas	Labasa	Lautoka	Penang	Rarawai	Industry
Cane costs	419,192	2,976,878	703,794	3,938,443	8,038,307
Non-cane farm costs	38,009	231,989	128,806	333,359	732,162
Direct and indirect other costs	126,864	829,235	13,337	1,502,655	2,472,091
Total sugarcane farmers' direct and indirect cost	584,065	4,038,102	845,937	5,774,457	11,242,560

Source: Lal, P.N., Rita, R. and Khatri, N., 2009. *Economic costs of the 2009 floods on the sugar belt*, IUCN-Oceania Technical Report, 2009.1, IUCN Gland, Switzerland.

Figure 1 **Sector affected by the floods, by percentage**



Source: Lal, P.N., Rita, R. and Khatri, N., 2009. *Economic costs of the 2009 floods on the sugar belt*, IUCN-Oceania Technical Report, 2009.1, IUCN Gland, Switzerland.

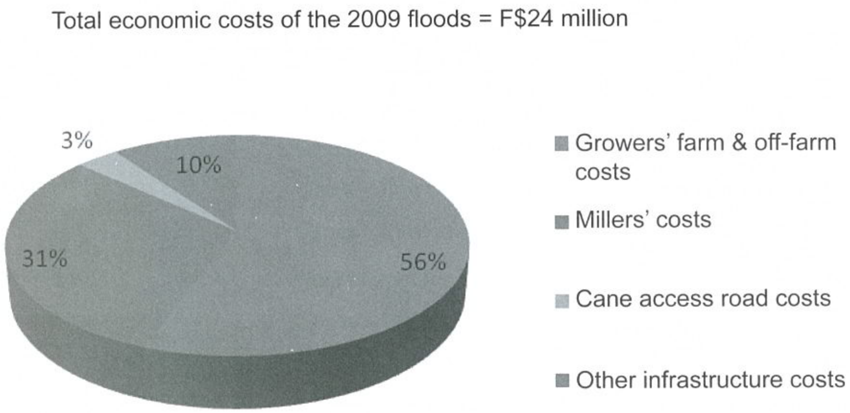
not be able to meet their basic nutritional needs.[6] Families in the Labasa and Rarawai mill areas are likely to be worst affected (Table 5).

Considering that the sugarcane farming families were already in a poor financial state due to the loss of preferential market conditions (Lal 2008), the 2009 floods increased the number of families living below the poverty line. An additional 25 per cent of families are expected to fall below the basic needs poverty line as a result of the floods (Table 6). Similalry an additional 23 per cent of the affected farms were expected to be not able to provide even the basic food needs of the family.

It is important to note that, for the sake of consistency and the ability to compare 'apples with apples', the analysis took into account only the loss in income due to the direct effect of the floods. It excluded flood-related farm costs such as lost farming materials and clean-up costs, and household-related flood costs, such as health costs, loss of housing and possessions, clean-up costs and evacuation costs. This analysis also does not include consideration of any debt, which almost all farmers have.[7] Had such costs been included, almost all the farmers would have fallen below the basic needs poverty line.

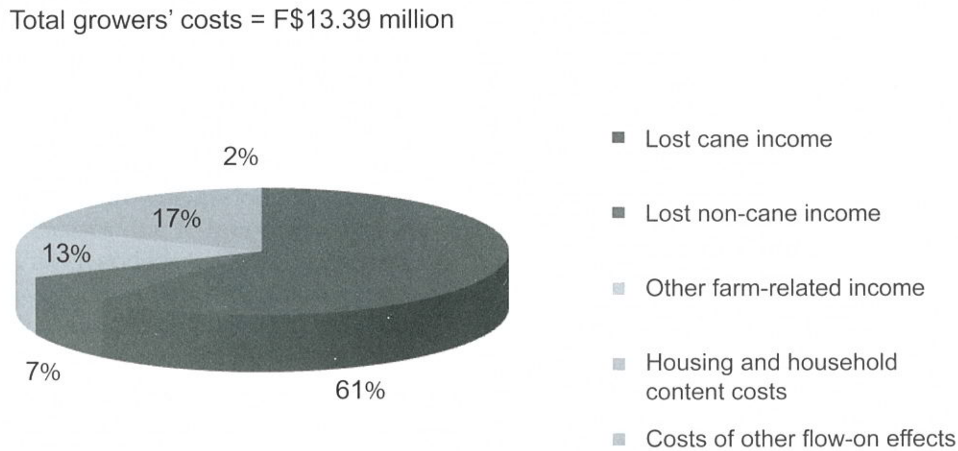
The analysis of the 2009 floods on the sugarcane growers confirmed that their ability to respond to the effects of the floods is also very low, particularly since many of the farmers already had debts and little savings (based on the FSC Accounting System Data; see Lal 2008 for further details). The vulnerability of sugarcane farmers is also heightened by the latest (and final) reduction in the EU sugar protocol prices, which will cause many sugarcane farmers to struggle to make ends meet. Before the 2009 floods and the April 2009 20 per cent devaluation of the Fijian dollar, when the forecast growers' sugar cane price

Figure 2 **Total economic cost of the 2009 floods on the sugar belt, excluding humanitarian assistance**



Source: Lal, P.N., Rita, R. and Khatri, N., 2009. *Economic costs of the 2009 floods on the sugar belt*, IUCN-Oceania Technical Report, 2009.1, IUCN Gland, Switzerland.

Figure 3 **Breakdown of growers' costs** (F$13.4 million)



Source: Lal, P.N., Rita, R. and Khatri, N., 2009. *Economic costs of the 2009 floods on the sugar belt*, IUCN-Oceania Technical Report, 2009.1, IUCN Gland, Switzerland.

Table 5 **Percentage of surveyed farms that fell below the food poverty line and basic needs poverty line**

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 (average across flood-affected farms)	42	54

Source: Lal, P.N., Rita, R. and Khatri, N., 2009. *Economic costs of the 2009 floods on the sugar belt*, IUCN-Oceania Technical Report, 2009.1, IUCN Gland, Switzerland.

was F$41.24 a tonne,[8] almost 60 per cent of farms were expected to have negative gross margins.[9] This is not surprising since the average production cash cost of sugarcane farming in Fiji was F$39 a tonne (Lal and Rita 2008). With the currency devaluation, the forecast sugarcane price is F$61.17/tonne, and the average farm household net income is estimated to be F$8,263 (Table 7), which is below the basic needs poverty line, as discussed earlier.

It is thus not surprising that many sugarcane farmers, and others in the flood-affected areas, were forced to make some difficult choices immediately after the floods. Many families were reported by the local media having to choose between sending children to school and meeting their basic food requirements. Had it not been for the humanitarian assistance provided by many national and international organisations, it is likely that many children would have dropped out of school this year.

Table 6 **Percentage of 2009 flood-affected sugarcane families expected to fall below the food poverty line and basic needs poverty line**

	Percentage of farms below FPL (F$4,054)	Percentage of farms below BPNL (F$8,361)
After devaluation		
'Without' floods	19	54
'With' floods	42	77
Before devaluation		
'Without' floods	55	98
'With' floods	71	91

FPL = food poverty line
BNPL = basic needs poverty line
Source: Lal, P.N., Rita, R. and Khatri, N., 2009. *Economic costs of the 2009 floods on the sugar belt*, IUCN-Oceania Technical Report, 2009.1, IUCN Gland, Switzerland.

Table 7 **Net revenue of surveyed farms (with and without flooding)**[10]

	'Without floods' household income	'With floods' household income
Range	–F$1,002 to F$25,110	–F$3,009 to F$18,475
Average	F$8,263	F$5,345
Rse	0.15	0.21

Source: Lal, P.N., Rita, R. and Khatri, N., 2009. *Economic costs of the 2009 floods on the sugar belt*, IUCN-Oceania Technical Report, 2009.1, IUCN Gland, Switzerland.

Economic costs of floods and the stage of the sugarcane crop

The effects of floods on the sugarcane industry could have been higher had the flooding occurred during later stages in the crop cycle—closer to the harvesting season when the cane crop is tall and can easily lodge. Losses are suffered either because the sugarcane plants drowns, are lodged or sugar content decreases due to inundation stress (Berning,Viljoen and Plessis 2000). Research in countries such as South Africa suggests that the minimum period of flood inundation before sugarcane is completely destroyed is approximately three days, particularly in the summer months (Plessis 2001). This point is supported by the experience of the Fiji Sugar Experimental Station (Hemraj Mangal, Manager, Cane Development, FSC, Personal communication, April 2009). The FSC notes that farmers can expect to see 'significant' damage if floodwater is stagnant for two days or more. Cane losses of 2–10 per cent can be expected in Fiji, depending on the height of the cane crop. This is compared with a decline of about 20 per cent reported in South Africa (Berning Viljoen and Plessis 2000).

The state of the industry and vulnerability

The January 2009 floods could not have come at a worse time for the sugar industry. The industry has been struggling to reform its operations during the past decade. Without doubt the floods aggravated farmers' cash flow and the industry's financial situation. While Fiji has experienced similar, if not larger, disaster-related economic impacts on the sugarcane sector, the 2009 effects are likely to be much more serious, particularly given the downturn in the economy after the December 2006 coup. The national economy has contracted by 6.4 per cent since 2006 (Reserve Bank of Fiji 2009). As well, Fiji has not received the €120 million allocated to it by the European Union under the National Adaptation Strategy. These impacts, together with the loss of EU preferential pricing, 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.

Economic costs and industry management

While the severe rainfall in January 2009 was considered to be a one-in-50 year event, and the volume of water in the rivers and creeks was beyond the normal discharge capacity, changes in the natural landscape would have caused a decline in regular ecosystem services. In the sugar belt, major changes in the landscape occurred during the expansion of sugarcane farming onto steep slopes and reclaimed mangrove wetlands. To minimise the loss in ecosystem services, an extensive drainage system was established to ensure proper drainage and reduce the risks of flooding. These systems were well maintained, especially during the Colonial Sugar Refinery (CSR) days. With time, however, major drainage canals and in-field and main drains have been inadequately maintained (European Commission 2008). Similarly, the good farm husbandry practices that minimise soil erosion—which were strictly enforced during the CSR days—progressively declined after the CSR's departure.

Generally speaking, farm management practices have deteriorated, particularly since at least the 1987 coups, with contour planting generally not practised and farm husbandry also lacking. Soil erosion has been exacerbated by the increased practice of pre-harvest burning of cane (Lal and Rita 2008), which exposes bare cane fields to the elements. Consequently, with even short periods of intensive rain, excessive soil erosion and even landslides seem to have become more common, together with silting-up of drains, waterways and rivers. If the 'business-as-usual' sugarcane farming practices continue, the vulnerability of the sugar belt will continue and could even increase with climate change and increased climate variability.

The government, the sugar industry in partnership with the National Disaster Management Office (NDMO) and other catchment-based stakeholders must invest in enhancing the ecosystem services provided by the natural landscape, as well as in the maintenance of the drainage systems. Unless the industry 'goes back to the future' and invests in maintaining the key drainage infrastructure—including the old CSR drains, the main drains and the infield drains in the sugarcane farms, as well as the drainage schemes in the reclaimed mangrove and other coastal areas—the impacts of floods will become worse with extreme weather events. In the past, the Fijian government, together with the sugar industry, regularly invested in drainage and flood protection infrastructure; but the level of investment has diminished, particularly since the 1987 political coups. The industry must also revert to best-practice farming and refocus on farm management practices that minimise farm-level soil erosion, including the banning of agricultural development on slopes greater than 8°, as required under the *Soil Conservation Act*.

Disaster risk management in the sugar belt must also go beyond focusing on flooding *per se*. The economic well-being of rural households must also be improved to make them less sensitive to disaster events and better able to cope with the residual risks they face. In the sugar belt, this would mean increasing the profitability of sugarcane farming by reducing the farming, harvest and transport costs, as well as increasing efficiency in the milling sector.

The 2009 floods compared with other disasters

Although the 2009 floods were considered to be the worst in recent history (Fiji Meteorological Services 2009b), it is difficult to compare the effects with other flood events because of limitations in the data and the use of differing cost estimation methodology. For example, McKenzie, Prasad and Kaloumaira (2005) reported economic cost estimates of about F$13.6 million for Cyclone Ami and associated flood damage. These were based on gross estimates provided by the industry. Caution in accepting these estimates is advocated since such estimates might be not only inflated but based on inappropriate methodology, as was discovered in the course of this study.

The economic cost estimate arrived at in this study of the 2009 floods was lower than the gross estimate of F$27 million provided by 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, damage to drainage schemes and humanitarian costs. It is also noted that many of the subcategories of costs estimated in this study are less than those provided earlier by industry stakeholders, including cane access and tramline damage and loss of cane crops. This could be as a result of differences in the assessment methodology used or, more importantly, perhaps the lack of capacity in the industry to undertake appropriate 'with and without' disaster impact assessment. In particular, the FSC impact assessments did not reflect the additional cost of infrastructure maintenance due to the impact of the floods. The infrastructure cost estimates provided by FSC staff reflected the annual cost of the maintenance of key infrastructure, such as cane access roads or tramlines, as well as costs of repairs due to the floods. In this study, only the additional cost due to the floods is reported, being the difference between the 'with' and 'without' infrastructure costs.

These datum challenges also apply to impact assessments of other natural disasters. Although government agencies are required to provide the NDMO with information on immediate losses and costs (damage to buildings, replacement costs for infrastructure, and so on), the historical NDMO data-sets are incomplete and, in some cases, do not match the data reported by international agencies. Time-series data might also not be reliable because there is no agreed damage assessment method in Fiji. There is also no agreed 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 cost of rehabilitation is used. Similarly, a formal definition of the 'number of people affected' is not available. That measure could, 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 the economic costs or the people affected by disasters.

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

Conclusion

The 2009 Fijian floods caused almost F$24 million worth of economic costs in the sugar belt. As a result, almost 50 per cent of the flood-affected farm households are expected to fall below the basic needs poverty line, with at least 25 per cent of the affected farm households not able to meet their basic needs. The floods further exacerbated the sugar industry's unprofitability. Such outcomes of natural disasters are a product of interaction across a complex web of factors: the timing, duration and intensity of the disaster, and the sensitivity to the disasters of affected households, communities and industry. This study demonstrates that because of the poor state of sugarcane farming, and the poor health of the milling and processing sector, as well as the poor status of drainage systems constructed to increase drainage affected by land clearing and agricultural development, the sugar industry suffered extensive economic costs—confirming global observations of the types of factors that influence disaster outcomes (UNISDR 2009).

The results are consistent with experience elsewhere, where households with poor socioeconomic status, as well as weak and poorly performing industries and economies, are highly sensitive to natural disasters and face significant difficulties in absorbing and recovering from disaster impacts (for example, Benson and Clay 2004). This study emphasises the importance of robust baseline information and consistent methodology in economic cost assessment of floods and other natural disasters. The results also suggest that to reduce such economic costs, disaster risk management must go beyond the traditional post-disaster management. It must also focus on adopting a multi-pronged approach to disaster risk reduction and disaster management at all levels—national, industry and household - national, industry and household- as well maintaining key landscape based ecosystem services.

Notes

1 This article is based on a Lal, Rita and Khatri (2009)

2 Drawn from Fiji Islands Bureau of Statistics (http://www.statsfiji.gov.fj/Key%20Stats/Foreign%20Trade/8.5_Major%20Domestic%20Exports.pdf).

3 Estimated using data from several sources, including (http://www.statsfiji.gov.fj) and data from the FSC (n.d., 2003).

4 Landslides were reported but were not assessed here due to limited data about the areas affected. Similarly, scouring or washing away of farmland was also reported, but due to limited data it was not included in this assessment.

5 This does not include the value of the loss of land scoured out by the floodwater.

6 Household poverty in Fiji has been defined in terms of the basic food poverty line (FPL) and basic needs poverty line (BNPL), which includes non-food basic needs (Narsey 2008). Using the 2002–03 FPL and BNPL estimates of Narsey (2008), and the consumer price index (CPI) reported by the International Monetary Fund (IMF: www.imfstatistics.org), the 2008 equivalent measures of FPL and BNPL were estimated to be F$4,054 and F$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 could even 'go hungry'. Any household earning less than $8,361 a year will struggle to meet the basic needs of the family.

7 Practically all of the surveyed households have debt recorded with the FSC. Average debt per household is F$5,200.

8 Calculated using the EU contract price of €301.68 a tonne. CIF and standard industry deductions described in Lal and Rita (2005).

9 Estimated using Lal and Rita's (2008) survey data of 2003 and the 2008 FSC production data.

10 Household net revenue = gross margin cane income + gross margin non-cane farm income + off-farm income.

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