



Government of Solomon Islands

SOLOMON ISLANDS

Rapid Assessment
of the Macro and Sectoral
Impacts of Flash Floods
in the Solomon Islands,
April 2014



July 2014



GFDRR
Global Facility for Disaster Reduction and Recovery

ACP-EU Natural Disaster Risk Reduction Program
An Initiative of the African, Caribbean and Pacific Group, funded by the European Union and managed by GFDRR



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CURRENCY EQUIVALENTS

(Exchange Rate Effective January 13, 2014)

Currency Unit = Solomon Islands Dollar

SI\$7.32 = US\$1

US\$1.53 = SDR1

FISCAL YEAR

January 1 – December 31

Abbreviations and Acronyms

ADB	Asian Development Bank
BBB	build back better
BSURE	Building and Strengthening Urban Resilience
CHS	community high school
CLTS	community-led total sanitation
DRM	disaster risk management
ECLAC	Economic Commission for Latin America and the Caribbean
EHD	Environmental Health Division
FOPA	Festival of the Pacific Arts
GDP	gross domestic product
HAP	Humanitarian Action Plan
MAL	Ministry of Agriculture and Livestock Development
MCA	Ministry of Civil Aviation
MDC	municipal disaster committee
MDPAC	Ministry of Development Planning and Aid Coordination
MECDM	Ministry of Environment Climate Change, Disaster Management and Meteorology
MEHRD	Ministry of Education and Human Resource Development
MHMS	Ministry of Health and Medical Services
MID	Ministry of Infrastructure Development
MFAT	Ministry of Foreign Affairs and Trade New Zealand
MLHS	Ministry of Lands, Housing and Survey
MoFT	Ministry of Finance and Treasury
NDMO	National Disaster Management Office
NSS	national secondary school
NTF	National Transport Fund
PDC	provincial disaster committee
PSS	provincial secondary school
RWASH	rural water, sanitation, and hygiene
RWSS	Rural Water Supply and Sanitation project
SIWA	Solomon Islands Water Authority
RDB	Rural Development Programme
WASH	water, sanitation, and hygiene
WSPA	World Society for the Protection of Animals

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Ita dumped intense rain on the Solomon Islands, leading to flash floods and landslides that killed 22 people, displaced 10,000 from their homes, and affected at least 50,000. Photo: credit

1. Executive Summary

A slow-moving tropical depression caused persistent heavy rains in the Solomon Islands between April 1 and April 4, 2014. The highest recorded daily rainfall associated with this event was 318mm in Honiara on April 3. The rains caused flash flooding in Honiara, Guadalcanal, Isabel, Malaita, and Makira-Ulawa. More than 732mm of rain was recorded over four days at the Honiara rain gauge, although heavier rainfall was reported inland. On April 5, as the system moved away from the Solomon Islands, it was upgraded to Tropical Cyclone Ita.

1.1 Summary of damage and loss

The total economic value of the flooding's impact is estimated at SI\$787.3 million (US\$107.8 million) (see table 1). This is equivalent to 9.2 percent of gross domestic product (GDP) in the Solomon Islands and gives an indication of the scale of the flooding.

The sectors that sustained the highest level of damage were housing and transport; these accounted for 56 percent and 23 percent of damage, respectively. In contrast, the greatest economic loss is expected in the mining sector (50 percent) and agriculture sector (31 percent).

1.2 Summary of macroeconomic impact assessment

The flooding is expected to have a substantial negative impact on growth. It is expected that output will decline by 5.1 percent from the pre-flood estimate. A substantial proportion of the negative impact is due to closure of the Gold Ridge mine. Excluding the impacts of the Gold Ridge closure, the negative impact is estimated at 2.7 percent. Ignoring any positive impacts from reconstruction stimulus, growth for 2014 could be expected to decline from baseline projections of 4.0 percent to negative 1.1 percent.

Table 1: Summary of Damage and Loss

Sector	Total Damage (SB\$ million)	Total Loss (SB\$ million)	Total Damage and Loss (SB\$ million)	Total Damage and Loss (US\$ million)	% of Total Damage and Loss
Social	223.4	16.7	240.1	32.9	31
Housing	213.2	5.6	218.8	30.0	28
Health & education	10.1	11.1	21.2	2.9	3
Productive	63.1	346.2	409.2	56.0	52
Agriculture	8.8	122.7	131.5	18.0	17
Commerce	54.3	21.0	75.3	10.3	10
Mining	-	202.5	202.5	27.7	26
Infrastructure	95.8	41.0	136.8	18.7	17
Transport	87.6	16.1	103.7	14.2	13
Water & sanitation	8.3	24.9	33.2	4.5	4
Total	382.2	403.9	786.2	107.7	100
As a % of GDP	4.5	4.7	9.2		

Source: Estimates are based on official data from the Solomon Islands government.

The current account deficit is expected to widen significantly as a result of isolated impacts of the flood. At this stage, the current account deficit is expected to increase by 2.6 percent in 2014, primarily due to the closure of the Gold Ridge mine.

Closure of the Gold Ridge mine is also responsible for the largest impact on government revenue: revenue losses of around SI\$120 million (US\$ 16.4 million) are expected in fiscal year 2014. The aggregate revenue loss, including revenue loss from the mine closure, is estimated at SI\$193.2 million. Excluding the impacts of mine closure, the estimated revenue loss is around SI\$34 million over the 2014 fiscal year.

1.3 Flood risk management

Twenty-two people lost their lives in flooding along the Mataniko River caused by the heavy rains of April 1–4, 2014. A number of “near misses” were also reported, with several people holding on to the apex of the church roof, and a boy surviving despite being washed downriver from Koa Hill to the sea. Had the flood occurred at night, with houses fully occupied and the rising floodwaters being more difficult for inhabitants to detect in the darkness, there might well have been hundreds of fatalities. In addition to causing fatalities, the flooding destroyed 235 houses along the valley, washed away the Old Mataniko Bridge, and inundated classrooms at Honiara High School. Many businesses in Chinatown were impacted by the flooding, including some that were affected by extensive riverbank erosion.

The serious impact of the disaster can largely be attributed to the exposure and vulnerability arising from significant unregulated urbanization. More specifically, it can be attributed to the many highly exposed houses located on dangerously low ground such as Koa Hill—and to the presence of low-resilience (traditional leaf) housing styles, which were disproportionately damaged (though the flood depths, velocities, and debris load were such that even block concrete houses were destroyed at Koa Hill). Limited community response to warnings may also have contributed to the impact.

Flooding events of this type are unfortunately not unusual in the Solomon Islands, which is one of the 20

countries most vulnerable to natural hazards. Flood damage in Honiara City and Guadalcanal previously occurred as a result of Cyclone Angela (1966), Cyclone Glenda (1967), Cyclone Carlotta (1972), Cyclone Kerry (1979), Cyclone Bernie (1982), Cyclone Namu (1986), Cyclone Ului (2010), and Cyclone Yasi (2011), and as a result of excessively heavy rainfall in 2008, 2009, and 2010, and 2012.

Priority activities and investments for managing flood risk and strengthening urban risk resilience have been identified and clustered as follows: (i) actions to modify the hazard (e.g., drainage works, river bank protection, catchment forestation), (ii) actions to modify human use of floodplain (incentives, enforcement and education, informal settlement upgrading), and (iii) actions to modify the human response to flooding (strengthening of the national flood warning system, hazard-proof evacuation centers). These key actions could form the basis for an urban flood risk management master plan.

1.4 Summary of recovery and reconstruction needs

Table 2 summarizes the estimated costs for recovery and reconstruction. Total recovery and reconstruction is estimated at SI\$401 million (US\$56.03 million). Of this amount, SI\$99 million (US\$14.59 million) is required in the short term (three to six months) with the remaining activities, including some “build back better” (BBB) initiatives, focused over the medium to long term (beyond six months).

Preliminary discussions among sectors and development partners indicate that US\$13.58 million in aid may be available, which would reduce the recovery and reconstruction bill to US\$41.5 million. In addition, some sectors—health and education as well as water and sanitation—may be able to bear some of the costs of damage repair from their sector budget support. The of Development Planning and Aid Coordination and the Ministry of Finance and Treasury should establish with donor partners the full potential of their contributions. Equally, line ministries should establish the level of financial costs that can be absorbed from sector budgets.

Table 2: Summary of Indicative Recovery and Reconstruction Costs (US\$ million)

Sector	Short Term	Medium to Long Term	Total
Transport	5.84	28.81	34.65 ^a
Water & sanitation	0.74	4.50	5.24 ^b
Agriculture	2.90	2.73	5.63 ^c
Housing	2.62		2.62
Health & education	1.49	5.42	6.91
Total	13.59	41.46	55.03

Source: Estimates are based on official data from the Solomon Islands government.

a. Early indications suggest that US\$12.08 million of this has already been sourced. Please refer to the discussion of transport (section 4.1).

b. Around US\$370,000 has been received from the Department of Foreign Affairs and Trade Australia and World Vision. Please refer to the discussion of water and sanitation (section 4.2).

c. Approximately US\$1.13 million indicated; see section 4.3 on the agriculture sector.

1.5 Way forward

The damage, loss, and needs assessment points to the following as key components to inform the government's recovery and reconstruction strategy:

- The loss of production from the premature closure of Gold Ridge mine accounts for 26 percent of total loss. Loss of mine production will impact government revenues and employment and also pose an environmental risk should the mine be left in its current condition. The negative revenue implications of the mine closure should be taken into account by the government and donors when considering options and financing sources for recovery needs.
- The Solomon Islands Water Authority (SIWA) will face severe financial constraints, including significantly higher operational costs while repairs are under way and may require additional support from the government.
- The impact on livelihoods from damage to food gardens is also concerning, given the many households who rely on these gardens for both income and subsistence. In the short term, a higher-than-ordinary level of coordination will be required in the agriculture sector to address identified needs, such as by providing seeds and tools to the most affected areas.
- Repairs to roads and bridges should be addressed as soon as possible to minimize the secondary impacts to the greater economy (e.g., higher transportation costs, impaired access to goods produced in rural areas). Particular attention should also be paid to the longer-term flood resilience of roads, bridges, and the Henderson Airport.
- The underlying levels of hazard and vulnerability associated with the floods must be addressed. Unplanned urban growth, high exposure of people and key public assets to natural hazards and floods, low-resilience housing standards, lack of an effective storm water management network, and inadequate community early warning and response to flash floods are all issues that need attention. Short-term actions and next steps include flood hazard mapping, community consultation to upgrade highly vulnerable informal settlements, design and implementation of a flash flood warning system for the Mataniko River, and establishment of a flood risk coordination mechanism. A longer-term program will be needed to strengthen flood risk management and urban resilience.
- Reconstruction and recovery needs (detailed in chapter 6) and flood risk management needs (detailed in chapter 5) provide a number of options for each sector that should be considered by the government. Funding priorities should be established in consultation with the government and its development partners, possibly through a donor conference to establish the full potential of international assistance. Equally, line ministries should establish the level of financial cost that can be absorbed from existing sector budget support. Detailed recovery/resilience plans and programs will be required for sectors where clear funding options have been identified.



The flooding was the worst in living memory in some locations.

It caused 22 fatalities across the country, internally displaced some 10,000 people initially, and affected approximately 52,000 people in total. It also damaged major infrastructure and destroyed 675 houses along with the food gardens that many people depend upon for their livelihood.

2. Introduction

2.1 Overview of floods

A slow-moving tropical depression caused persistent heavy rains in the Solomon Islands between April 1 and April 4, 2014. The highest recorded daily rainfall associated with this event was 318mm in Honiara on April 3. The rains caused flash flooding in Honiara, Guadalcanal, Isabel, Malaita, and Makira-Ulawa. More than 732mm of rain was recorded over four days at the Honiara rain gauge, although heavier rainfall was reported inland. On April 5, 2014, as the system moved away from the Solomon Islands, it was upgraded to Tropical Cyclone Ita.

The flooding was the worst in living memory in some locations. It caused 22 fatalities across the country, internally displaced some 10,000 people initially, and affected approximately 52,000 people in total. It also damaged major infrastructure and destroyed 675 houses along with the food gardens that many people depend upon for their livelihood.

2.2 Socioeconomic context of Solomon Islands

The estimated population of the Solomon Islands is 515,870, and its estimated growth rate is 2.3 percent (Solomon Islands National Statistics Office 2009). The population is spread across 845 islands of the 992 islands that make up the country and that cover an area of 24,000km². With 80 percent of the total population living in rural areas, disaster response is often time-consuming and expensive; high post-disaster transportation costs place a significant burden on the government and have led to delays in the distribution of relief goods in the past.

The Solomon Islands economy is largely based on services (around 40 percent of GDP), agriculture (around 15 percent of GDP), and forestry (around 15 percent of GDP). Manufacturing remains a minuscule sector, and much of the population depends on subsistence agriculture for their livelihoods. In the last five years,

average annual real GDP grew by 4.9 percent, driven by a consolidation of government finances, the accumulation of significant foreign exchange reserves despite ongoing trade deficits, and easing inflationary pressures. These conditions were the result of a supportive external environment in the wake of the 2009 global financial crisis, as well as continued strong donor support.

2.3 Initial response

In the wake of the flooding, Honiara City and Guadalcanal Province were declared a disaster zone. On April 5, the Solomon Islands government requested international emergency assistance to aid relief efforts.

The Solomon Islands government has worked with the international community, civil society organizations, and other stakeholders to address humanitarian response needs. The government has sought assistance from Pacific Humanitarian Team personnel (which is led by the United Nations Office for the Coordination of Humanitarian Affairs), and has also requested supplies to support response efforts. As part of Pacific Humanitarian Team support and through the Australian government-funded Pacific Risk Resilience Programme, the United Nations Development Programme has provided early-recovery technical advice to the Ministry of Provincial Development and surge capacity to the National Disaster Management Office (NDMO). The Secretariat of the Pacific Community has provided disaster coordination capacity support to the NDMO as part of package to assist the government with response and long-term recovery.

Approximately SI\$58 million (US\$7.9 million) has been donated by development partners, international organizations, local nongovernmental organizations, businesses, and individuals in the form of cash grants and aid in-kind (e.g., hygiene kits, tarpaulins, water purification tablets).

The Solomon Islands government has authorized the release of SI\$5 million (US\$685,000) from the contingency

fund to facilitate initial response and relief activities. An additional contingency warrant of SI\$9 million (US\$1.2 million) has been approved; approximately SI\$6 million (US\$822,000) is being provided by Papua New Guinea.

The disaster relief budget allocated to the National Disaster Council is small—SI\$1.9 million (US\$260,000)—and was quickly exhausted following the floods. This is the second year in a row that a single disaster has exhausted not only the relief budget but also the operational budget of the council. The fiscal year is the same as the calendar year; both the floods in 2014 and the Santa Cruz earthquake in 2013 occurred in the first four months of the year, leaving the NDMO with only enough funds to cover its fixed costs for the remainder of the year. This situation is potentially serious since another hazard event could affect the Solomon Islands in 2014.

2.4 Methodology

This assessment was conducted by a multidisciplinary, multi-agency team—comprising the World Bank, Global Facility for Disaster Reduction and Recovery, Asian Development Bank (ADB), UN agencies, and other relevant stakeholders—that consulted with the Solomon Islands government. The assessment team was able to use the results of the initial damage assessments and the Humanitarian Action Plan (HAP) (Solomon Islands Government 2014). A full list of references can be found at the end of this report.

The damage and loss methodology was developed by the United Nations Economic Commission for Latin America and the Caribbean (ECLAC), based on its work in Central America in the early 1970s and in the Caribbean in the 1980s and 1990s. This methodology has evolved over time, and the *Guidance Notes for Damage, Loss and Needs Assessment* (GFDRR 2010) and the recently revised *Handbook for Disaster Assessment* (ECLAC 2014) have been used to guide this assessment.

2.5 The conceptual framework

The methodology used for assessing the effects of a disaster or extreme event proceeds from the bottom up: information about the effects of the event is captured sector by sector, and the data are aggregated to arrive at the event's total effect on society and the economy. The methodology makes use of a country's national accounting framework for valuation of the damage and loss and for categorization of the effects.

The effects are described as damage and losses. In keeping with the standard definitions, *damage* is the “total or partial destruction of physical assets existing in the affected area. Damage occurs during and immediately after the disaster and is measured in physical units (... square meters of housing, kilometres of roads...). Its monetary value is expressed in terms of replacement costs according to prices prevailing just before the event”. *Losses* are “changes in economic flows arising from the disaster. They occur until full economic recovery and reconstruction is achieved, in some cases lasting for several years. Typical losses include the decline in output in productive sectors (agriculture, livestock, fisheries, industry, commerce, tourism)” (GFDRR 2010, 2:2).

Estimating the damage and loss is one of the critical components of the assessment methodology. A second critical component is analyzing the event's impact on the economy and society; drawn mainly from the estimate of losses, this analysis can be used in planning for recovery and reconstruction. The value of damage is used as the basis for estimating reconstruction needs, while the value of losses provides the means for estimating the financial needs for economic recovery.

The ultimate goal of the assessment is to measure in monetary and social terms the disaster's impact on the society, economy, and environment of the affected country or region. This information in turn makes it possible to quantify the financial needs for economic recovery and reconstruction with risk reduction.

3. Macroeconomic Impact

3.1 Summary of total effect

The total economic value of the effects caused by the flooding is estimated at SI\$787.3 million (US\$107.8 million). This is equivalent to 9.2 percent of GDP in the

Solomon Islands and gives an indication of the scale of the flooding (see table 3).

Table 3: Summary of Disaster Effects

Sector	Total Damage (SB\$ million)	Total Loss (SB\$ million)	Total Damage & Loss (SB\$ million)	Total Damage & Loss (US\$ million)	% of Total Damage and Loss
Social	223.4	16.7	240.1	32.9	31
Housing	213.2	5.6	218.8	30.0	28
Health & education	10.1	11.1	21.2	2.9	3
Productive	63.1	346.2	409.2	56.0	52
Agriculture	8.8	122.7	131.5	18.0	17
Commerce	54.3	21.0	75.3	10.3	10
Mining	-	202.5	202.5	27.7	26
Infrastructure	95.8	41.0	136.8	18.7	17
Transport	87.6	16.1	103.7	14.2	13
Water & sanitation	8.3	24.9	33.2	4.5	4
Total	382.2	403.9	786.2	107.7	100
As a % of GDP	4.5	4.7	9.2		

Source: Estimates are based on official data from the Solomon Islands government.

Just over half (51 percent) of the total effect is attributable to loss, and just under half (49 percent) is attributable to damage (see figure 1). The majority of damage and loss—52 percent—came from the productive sectors, mostly mining and agriculture (figure 2). To stimulate future growth, appropriate recovery and reconstruction plans will need to be developed that address the needs in these sectors.

Damage was largely incurred in the transport and housing sector. Work has begun to repair access roads, and owners of private dwellings are expected to have begun repairs to their own homes. The repair to both these sectors is expected to boost growth in the commercial sector.

3.2 Pre-disaster economic outlook

This section discusses the pre-disaster economic outlook for the Solomon Islands and gives a brief overview of the

Figure 1: Contribution of Damage and Loss to Total Effect

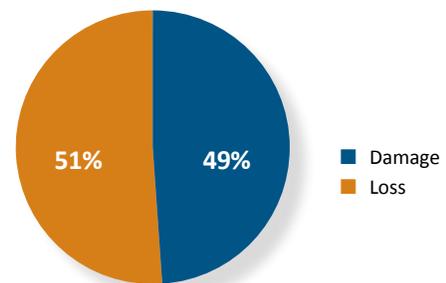
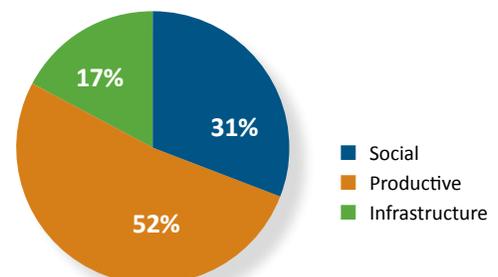


Figure 2: Total Damage and Loss, by Sector



Source: Estimates are based on official data from the Solomon Islands government.

baseline projections for output, the current account, and the central government's fiscal position.

3.2.1 Growth

Growth of 4.0 percent in 2014 was projected on the basis of steady production at the Gold Ridge mine and improvements in logging and agricultural production. Following the rapid growth in 2010 and 2011, which was driven by expansion of gold and strong timber production, growth moderated to 3.8 percent in 2012.

Growth of 3 percent in 2013 reflected unresponsive export prices during the first half of the year and associated weakening of key commodity production. Declines in logging and gold output—driven by low prices, interruptions to production at the Gold Ridge mine, and (possibly) the depletion of natural forest stocks—were not completely offset by improvements in export commodity prices and production during the second half of the year. The baseline GDP for the five years beginning in 2011 is shown in table 4.

Table 4: Baseline GDP

	2011	2012	2013	2014 (F)	2015 (F)
Nominal GDP (SI\$ billion)	6,637	7,281	7,946	8,800	9,345
Real GDP growth (%)	10.7	3.8	3.0	4.0	3.6

Source: Based on official data from the Solomon Islands government.

3.2.2 Current account

The current account deficit was expected to widen to 13 percent of GDP in 2014. In December 2013, foreign exchange reserves reached a new peak of SI\$3,555 million (US\$487 million), up from SI\$3,431 million (US\$470 million) at the end of 2012. This amount provides over 11 months of import cover, which will help to provide a buffer to protect the Solomon Islands from adverse movements in global prices. The baseline current account deficit for the five years beginning in 2011 is shown in table 5.

3.2.3 Fiscal position

Before the flooding of April 2014, the government was forecasting a balanced budget for 2014. The Ministry of Finance and Treasury (MoFT), realizing a surplus of approximately SI\$175 million in fiscal year 2013 (the result of underspending in the consolidated development budget), projected a balanced budget for the year. Cash reserves stood at around SI\$600 million (US\$82 million) immediately before the flooding, comfortably above the International Monetary Fund benchmark floor of SI\$411 million (US\$56 million). Baseline fiscal aggregates for the five years starting in 2011 are shown in table 6.

Table 5: Baseline Current Account Deficit

	2011	2012	2013	2014 (F)	2015 (F)
Current account deficit (% GDP)	6.7	+0.2 (surplus)	4.2	13.0	12.4

Source: Based on official data from the Solomon Islands government.

Table 6: Baseline Fiscal Aggregates (SI\$ million)

	FY11	FY12	FY13	FY14 (F)	FY15 (F)
Total revenue & grants	2,713.7	3,164.3	3,139.4	3,502.3	3,580.9
Tax revenue	2,076.6	2,282.2	2,420.1	2,610.3	2,793.1
Non-tax revenue	205.4	196	227.6	227.6	230.6
Recurrent grants	267.5	171.8	276.8	584.4	342.8
Development grants	164.2	514.3	214.9	80	214.4
Expenditure	2,393.1	3,309.3	3,021.9	3,503	3,580.7
Recurrent	1,870	2,402.1	2,318	2,861.9	2,692.3
Development	523.1	907.2	703.9	641.1	888.4
Fiscal balance (including grants)	320.6	-145.0	175.2	-0.7	0.2
Cash balance			602.0	601.3	601.5

Source: Based on official data from the Solomon Islands government.

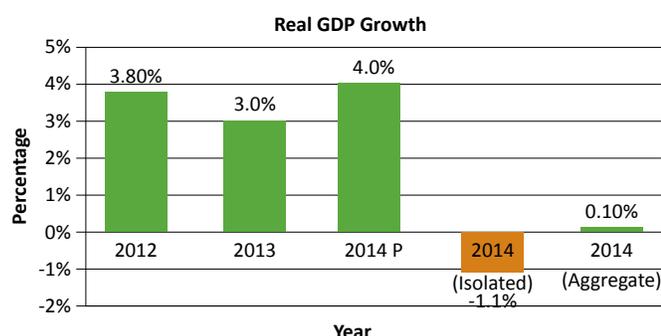
3.3 Post-disaster economic outlook

This section presents the estimated impacts of the Honiara flooding on economic growth, the government's fiscal position, and the balance of payments. It is important to note that any consideration of potential positive impacts on growth, revenue, and the balance of payments arising from government or donor responses to the flooding have been omitted. These estimates should be viewed as providing a sense of the scale of negative impacts, rather than a forecast of likely outcomes.

3.3.1 Growth

Ignoring any positive impacts from reconstruction stimulus, growth for 2014 could be expected to decline from baseline projections of 4.0 percent to negative 1.1 percent. If positive impacts from recovery activities are taken into account, we estimate GDP growth of 0.1 percent in 2014. This is illustrated in figure 3.

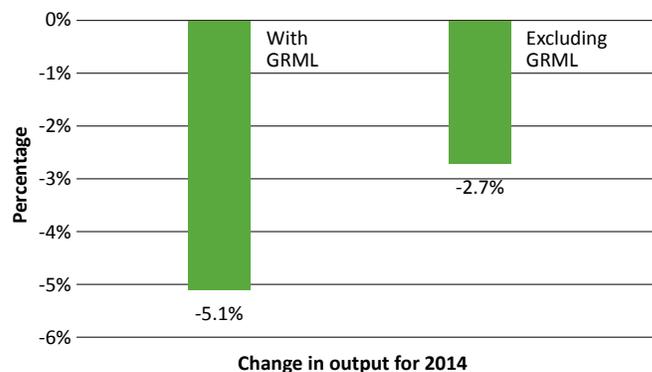
Figure 3: Growth in Baseline vs. Post-Flood GDP (including Gold Ridge Mining Ltd.)



The flooding is expected to have a substantial negative impact on growth. We estimate that the floods will cause a reduction in output of 5.1 percent from the pre-flood baseline in 2014. A substantial proportion of the negative impact of the floods is through closure of the Gold Ridge mine. Excluding impacts of Gold Ridge

closure, the negative impact is estimated at 2.7 percent, as shown in figure 4.

Figure 4: Change in Output (isolated flood impacts)



3.3.2 Current account

The current account deficit is expected to widen significantly as a result of isolated negative impacts of the flood. A 2.6 percent increase in the current account deficit is expected in 2014, primarily because the Gold Ridge mine has been closed. Impacts over the medium-term will depend on whether the mine reopens. Table 7 shows potential impacts if the mine remains closed at the end of 2014 and also under a permanent closure scenario. Both scenarios assume no positive or negative impacts from donor inflows.

3.3.3 Fiscal impacts

The largest impact on revenue comes from the closure of the Gold Ridge mine. The closure is likely to result in revenue losses of around SI\$120 million (US\$16 million) in fiscal year 2014. Additional revenue losses will arise from the loss of output for businesses supplying the mine, and from disruption of business activity and lost profits outside the mining sector. The aggregate revenue loss, including revenue loss from closure of the mine, is SI\$193.2 million (\$US 26.5 million). Excluding the

Table 7: Potential Current Account Impacts of Gold Ridge Mine Closure (% GDP)

	Temporary Closure			Permanent Closure		
	2014	2015	2016	2014	2015	2016
Flood impact relative to baseline	2014	2015	2016	2014	2015	2016
Baseline CAD	-13.0	-12.4	-11.9	-13.0	-12.4	-11.9
Post-flood CAD	-15.6	-13.5	-12.9	-15.6	-15.4	-14.7
Change in CAD, % GDP	-2.60	-1.10	-1.00	-2.60	-3.00	-2.80
Forex reserves (SI\$ million)	-157	-153	-150	-157	-331	-506

Source: Based on official data from the Solomon Islands government.

Note: CAD = current account deficit; forex = foreign exchange.

impacts of the mine, we estimate revenue loss of around SI\$34 million over the fiscal year:

Fiscal costs to date have been relatively minor. SI\$5 million (US\$685,000) has been spent from the NDMO recurrent budget allocation. An additional SI\$6 million (US\$820,000) has been accessed through the contingency fund. A flash appeal account (held at Central

Bank of Solomon Islands) and managed by the National Disaster Committee has been used to finance a further SI\$2.3 million (US\$315,000) for emergency recovery needs. SI\$15 million in constituency fund allocations has been distributed to members of Parliament to assist with recovery needs; these funds are expected to be recouped from budget support pledged by Taiwan.



The largest impact on revenue comes from the closure of the Gold Ridge mine. The closure is likely to result in revenue losses of around SI\$120 million (US\$16 million) in fiscal year 2014. Additional revenue losses will arise from the loss of output for businesses supplying the mine, and from disruption of business activity and lost profits outside the mining sector.

Ignoring any positive impact from reconstruction, growth for 2014 could be expected to decline from baseline projection to negative 1.1 percent.

4. Damage, Loss, and Needs

4.1 Transport

The government's vision for the transport sector is effective transport infrastructure and services that support sustained economic growth and social development in the Solomon Islands. The country's transport sector includes land, maritime, and aviation subsectors. Investment in the transport sector is prioritized in the National Transport Plan 2010 and financed through a combination of grants and normal budget appropriation. The National Transport Fund (NTF) is the main source of funding for the transport sector. The government of New Zealand, the government of Japan, the European Union, and the ADB are also investing in the transport sector but are not contributing to the NTF, opting instead to directly finance projects through parallel funding arrangements. The government's capital and recurrent budgets, supplemented by grants from the government of Australia, provide the funds for the NTF.

The government has invested significantly in transport infrastructure, with budget allocations of SI\$100 million (US\$13.7 million) in 2012 and SI\$118 million (US\$16.16 million) in 2013. The majority of the funding allocated is for the rehabilitation and maintenance of roads and bridges and reconstruction of wharves and jetties. Responsibility for the transport sector lies with the Ministry of Infrastructure Development (MID) for land and maritime subsectors and with the Ministry of Civil Aviation (MCA) for the aviation subsector.

The transport infrastructure affected by the April 2014 floods included the road and bridge network across Guadalcanal, Makira, Malaita, and Isabel Provinces; the international and domestic terminals at Henderson Airport in Honiara; and the market wharf in Honiara.

4.1.1 Description of the damage

This section describes the physical damage observed following the April 2014 Solomon Islands floods. A detailed list of transport infrastructure damaged due to floods is in annex 2.

Land subsector. A combination of large flows and debris buildup caused extensive damage to bridges in the network: piers, abutments, approaches, scour protection, and service connections all sustained damage. The Old Mataniko Bridge in Honiara's central business district was completely washed away, and erosion occurred at the eastern approach to the new Mataniko Bridge, the only bridge connecting East and West Honiara. Two of nine upstream piers of the Mberande Bridge in East Guadalcanal were damaged, and bridge approaches in several bridges in Guadalcanal, Makira, and Isabel Provinces collapsed or were washed away.

Headwalls and wing walls of several box and pipe culverts and causeway approaches were damaged, and several culverts were completely washed away due to excessive flows. The accumulation of debris and sediments blocked roadside drainage, and some channels were eroded.

Because of overtopping floodwaters and the resulting erosion, road shoulders were damaged and potholes were created in the roadway. Landslides were also recorded in Honiara, West Guadalcanal Road toward Lambi, and Isabel Province. Where the road formation was submerged for an extended period after the flooding, degradation of the pavement will be accelerated, observable at first as widespread potholing, rutting, and cracking of pavement before eventual failure.

In summary, access was cut off at one location in Honiara, two locations in East Guadalcanal, eight locations along West Guadalcanal, and one location along the Buala-Garanga Road in Isabel Province. A map showing cutoff locations in East to West Guadalcanal is in annex 3.

Aviation subsector. Henderson Airport in Honiara was closed for two days due to submergence of the runway and apron. Floodwater damaged a 500m length of the airport fence and deposited debris on the runway. Damage was also recorded to the drainage culvert outlet, domestic terminal and offices, runway markings,

runway lighting system, perimeter road, back road, outer drainage, and domestic car park.

Maritime subsector. Significant damage occurred to the central market wharf in Honiara. The bow of a small ship severed the landward span of the wharf, and the concrete slab of the wharf collapsed onto the beach below. The Solomon Islands Ports Authority confirms that the wharf was not operational prior to the disaster, however, so the impact of the damage is considered minimal.

4.1.2 Description of the losses

Land subsector. Economic losses for road transportation include increased travel times as a result of congestion and alternative routes, as well as direct payments required by some landowners for use of road diversions at cutoff locations. Vehicle operating costs will also increase due to poor road conditions and diversions. The majority of the loss is attributed to the unprecedented congestion at the new Mataniko Bridge, a result of the Old Mataniko Bridge being washed away. Increased travel times prevailed until completion of the temporary Bailey bridge at the Old Mataniko Bridge site in June 2014. Bus operators continue to lose revenue because travel delays have reduced the number of trips they can make per day.

Aviation subsector. Aviation sector losses are those incurred due to the two-day closure of the international and domestic terminals of Henderson Airport in Honiara. The main losses are (i) revenue loss due to cancellation of international and domestic flights, and (ii) disruption loss due to rescheduling of flights both in international and domestic segments.

Maritime subsector. At the time when the weather warning was issued—about 72 hours before the worst

weather hit in Honiara on April 3—about 140 vessels, including 40 fishing vessels, were in operation in the territorial seas. The heavy weather, wind, and swell affected the vessels for about 96 hours after the storm had passed. Of the 140 vessels, 9 were blown ashore on Guadalcanal around Honiara port. Six of these vessels have since been refloated, while three have been recorded as a total loss. Cargo operations were severely hampered for about 12 hours because of debris at Honiara port. The revenue losses arising from operational delays are the main contributor to the losses in the maritime sector.

4.1.3 Damage and loss summary

Table 8 summarizes the cost of damage to transport infrastructure and the value of losses attributed to the damage. The cost of the damage includes (i) emergency costs to restore connectivity, and (ii) the cost of restoring structures to their pre-disaster state.

Given that there are no records of privately owned transport infrastructure (such as logging roads), the responsibility for the costs of damage and losses falls entirely on the government. The damage to the central market wharf in Honiara is not included in table 8 because, as explained above, the wharf was not an operational prior to the disaster.

The losses from damage to shipping vessels and the revenue loss of bus operators have not been included in table 1. They are covered separately under the commercial sector.

4.1.4 Government recovery initiatives

The government has directly procured materials, machines, and labor to construct a temporary bridge over the unsupported eastern approach slab to the new Mataniko Bridge. The government has waived the

Table 8: Damage and Loss Summary for Transport (US\$ million)

	Damage	Losses	Total
Land	8.49	2.26	10.75
Aviation	1.40	0.26	1.66
Maritime	–	4.50	4.50
Total	9.89	7.02	16.91

Source: Ministry of Infrastructure Development; Ministry of Civil Aviation; Solomon Islands Ports Authority; Solomon Islands Maritime Safety Authority.

Note: – = negligible.

normal procurement process to allow shopping for emergency repair works at other sites. The initial focus is on restoring connectivity.

Through MID, the government has designed and called tenders for three emergency-repair contract packages to restore connectivity in West Guadalcanal. These contracts will likely be awarded by early May 2014, and work will commence immediately afterwards.

At the request of the government, the government of New Zealand has pledged assistance to supply and erect a new single-lane Bailey bridge at the Old Mataniko Bridge site. A New Zealand-based contractor (Downer New Zealand) has been commissioned to carry out the project. Preliminary work for construction of the center pier is in progress, with the entire structure likely to be completed by late June 2014.

The Government has requested the Government of Japan to advance the proposed assistance to improve Kukum Highway which includes construction of an

additional two lane bridge upstream of new Mataniko Bridge and a two lane bridge at Old Mataniko bridge site. Construction of the new bridges will commence in April 2015 rather than August 2015 as originally proposed.

A contract package has been prepared to repair damage to Henderson Airport, and the government has asked donor partners for additional financing to make transport infrastructure more resilient to natural hazards.

4.1.5 Proposed recovery plan

Short-term recovery. The priority for the transport sector is to restore connectivity to essential services such as hospitals, schools, markets, and the main commercial centers in Honiara. The estimated total cost of short-term recovery for emergency repairs is given in table 9.

Medium- to long-term recovery. The medium- to long-term recovery needs are included in table 10. Medium-term needs represent the cost of returning the damaged transport assets to their pre-flood condition. Long-term

Table 9: Short-Term Recovery Needs for Transport

Activity	Needs (US\$ million)
Repair to unpaved roads	0.05
Repair to paved roads	1.83
Repair to bridges	2.36
Repair to culverts and road-related drainage	0.21
Repair to Henderson Airport	1.39
Total	5.84

Source: Ministry of Infrastructure Development; Ministry of Civil Aviation.

Table 10: Medium- and Long-Term Recovery Needs for Transport

Activity	Medium-Term Needs (US\$ million)	Long-Term Needs (BBB) (US\$ million)
Repair to damaged unpaved roads	0.23	
Repair to damaged paved roads	0.52	
Repair to damaged bridges	2.66	
Repair to damaged culverts and related drainage	0.64	
Improvements to bridges, including climate change proofing		23.89
Improvements to culverts, including climate change proofing		0.88
Improvements to Henderson Airport (ring levee and associated drainage)		1.00
Total	4.05	25.77

Source: Ministry of Infrastructure Development.

needs represent the cost of building back better—that is, reconstructing the damaged transport assets to incorporate climate proofing and disaster risk reduction measures. The time frame for medium-term needs is six months to one year. The BBB option requires a longer time frame for necessary geotechnical, engineering, economic, environmental, and climate change impact analysis.

A preliminary list of land transport infrastructure identified for the BBB option is in annex 4.

4.1.6 Potential funding options

The 2014 work plan for MID includes SI\$10 million (US\$1.39 million) as a contingency reserve for new emergency repairs in 2014. The MCA can request funding for emergency repair works at Henderson Airport through the NTF. The government will reassess repair priority to include the repair of damage caused by the April 2014 flooding. The estimated cost of erecting a Bailey bridge at the old Mataniko Bridge site with assistance from the New Zealand government is US\$0.69 million. The estimated cost of having the government of Japan construct two bridges across the Mataniko River is estimated to be US\$10 million.

The summary of recovery needs, potential funding sources, and the financing gap for the transport sector is included in table 11.

The ADB has offered the government US\$200,000 for life-preserving activities through the Asia Pacific Disaster Response Fund. MID can ask the MoFT for part of the proceeds from this grant to use for site clearance and

debris removal to ensure access to affected communities awaiting humanitarian assistance.

4.1.7 Recommendation

The following short-term, medium-term, and long-term recovery strategies are recommended.

For short-term recovery (up to 6 months):

- *Continue rapid restoration of roads, bridges, culverts, and the Henderson Airport to basic trafficable condition.* Once several contract packages prepared by MID and MCA are approved, private sector contractors will commence these works.

Use national private sector consulting resources for construction supervision. Doing so will guard against the pitfalls of implementing a large volume of restoration work over a relatively short period of time, most notably a lack of attention to quality requirements, with a consequent reduced service life of the investment.

- *When carrying out reconstruction, keep in mind lessons learned from the impact of this flood on transport infrastructure assets.* To determine if restoration to pre-flood conditions is sufficient, commence studies of upstream river catchment activities, hydraulic design, alternative pavements, resilient structures accommodating climate change adaptation, and disaster risk reduction measures.
- *Commence studies on long-term flood protection measures at Henderson Airport.* It is noted that Henderson airport is frequently inundated even by ordinary weather events.

Table 11: Potential Funding Sources and Financing Gap for Transport

	Recovery Needs (US\$ million)	Potential Funding Sources		Financing Gap (US\$ million)
		Source (government or donors)	Funding (US\$ million)	
Short term	5.84	National Transport Fund	1.39	3.76
		Government of New Zealand	0.69	
Medium term	4.05	–	–	4.05
Long term	24.77	Government of Japan	10.0	14.77
Total	34.66		12.08	22.58

Source: Ministry of Infrastructure Development.

Note: - = negligible.

For medium-term recovery and reconstruction:

- *Procure contracts and commence reconstruction activities based on a sensible prioritization of works.* This approach ensures that the most critical works are done first.
- *In conjunction with relevant agencies, complete the resilience-related studies.* Hydraulic studies for the Mataniko River and other river basins should be a particular focus. Findings from these studies should be progressively input into the designs for the remaining reconstruction works.

For long-term recovery and reconstruction:

- Continue with the reconstruction works, ensuring that supervision and quality control are adequate.
- Progressively adopt and mainstream the results of the resilience-related studies into all road design and construction activities.

4.2 Water, sanitation, and drainage

Before the early April flood, there were two major service providers of water and sanitation in the Solomon Islands: the Solomon Islands Water Authority, also called Solomon Water, which is a state-owned enterprise; and the providers falling under the Environmental Health Division (EHD) of the Ministry of Health and Medical Services (MHMS). The latter includes the Honiara City Council EHD, the Rural Water Supply and Sanitation project (RWSS), and the Guadalcanal Province EHD.

Currently, both Solomon Water and the RWSS are engaged in long-term reform programs. These institutions have limited capacity and are under pressure to meet existing program outputs. Resourcing of additional recovery and reconstruction programs must not divert focus from existing long-term reform programs; on the contrary, every opportunity must be taken to strengthen them.

4.2.1 Rural service providers (RWSS, Guadalcanal Province EHD)

To support the priorities in rural water, sanitation, and hygiene (RWASH), the MHMS and its partners/stakeholders have developed the following:

- The RWASH Policy, which was approved by the cabinet in 2014.
- A draft Strategic Plan for RWASH 2015–2020 (still in development)
- A Capacity Development Roadmap and Technical Assistance needs assessment
- A RWSS Transition Plan 2013–2015

Approximately 80 percent of Solomon Islanders live in rural villages, where 65 percent of residents have access to safe water (35–40 percent functioning water supply systems) and 18 percent of residents have access to improved sanitation facilities (RWSS 2014a). Estimating the impact of the flooding on water and sanitation services is difficult, since the only pre-disaster data available (from the 2009 census) have to do with access, not level of service or the condition of the assets. But anecdotal evidence suggests that most assets are in poor condition.

According to ISF-UTS (2011), “Diarrhoea remains a leading cause of death in the Solomon Islands, contributing to 7% of mortalities in 2002. The Solomon Islands ranks toward the bottom of Pacific countries for all WASH-related health statistics.” (See table 12 for summary health statistics).

Table 12: Summary Health Statistics for Water and Sanitation Sector

Infant mortality rate (deaths per 1,000 births)	36
WASH-related DALYs (% of all DALYs)	9%
Total WASH-related DALYs (years)	7,826
Total WASH-related deaths per year	197
WASH-related proportion of deaths	8%

Source: ISF-UTS 2011, citing World Bank and World Health Organization.

Note: DALY = disability adjusted life year.

4.2.2 Urban service providers (Solomon Water, Honiara City Council EHD)

In August 2010, the Solomon Islands government replaced the SIWA board, and in April 2011, with the support of the Pacific Region Infrastructure Facility, an interim general manager and interim financial and administration manager were appointed. The two interim managers prepared a short-term recovery and action

plan to guide urgent reforms to SIWA's organization, finances, and operations. The plan was presented to the government and development partners and endorsed by the SIWA board in May 2011.

Following a request from the Solomon Islands government, the Australian government agreed to fund the recovery and action plan's implementation from September 2011 onward. The improvements under the plan should have been or were concluded in March 2014. In addition, Solomon Water and the Australian Department of Foreign Affairs and Trade agreed to develop and implement a long-term partnership in two phases: a two-year phase starting in May 2013, based on corporate planning and program design activities in 2012–2013; and a five-year phase starting in 2015, based on corporate planning and program design activities in 2014–2015.

Solomon Water was created under the Solomon Islands Water Authority Act (1993) to provide water and sewerage services in urban areas of the country (currently Honiara and three provincial centers). It is subject to the State-Owned Enterprises Act (2007), has a board of directors, and reports to the minister of Mines, Energy and Rural Electrification and the minister of Finance. Solid waste management is limited to the Greater Honiara region and is overseen by Honiara City Council EHD with assistance from the Ministry of Foreign Affairs and Trade New Zealand.

4.2.3 Drainage

No drainage infrastructure exists outside the transport and agriculture sectors. Damage and loss in the transport and agriculture sectors are addressed in their respective chapters. In light of the flood damage and the recommendations of the flood risk management specialist, drainage—and in particular storm-water management—should be investigated. This is beyond the scope of this assessment, however. A medium- to long-term recommendation would be to develop a drainage master plan for Honiara city.

During our assessment we were unable to obtain information on damage to the drainage infrastructure and tailings dams at the Gold Ridge mine. A team from

United Nations Disaster Assessment and Coordination has assessed the situation and its environmental impacts, and the assessment has been passed on to the Solomon Islands government.

4.2.4 Description of the damages

It was difficult to ascertain the level of damage in rural Guadalcanal Province, due to a lack of pre-disaster data, and resourcing constraints following the flooding. However, data from initial assessments suggest that around 1,000 shallow unprotected wells in the floodplains of East Guadalcanal were inundated with silt and trash and suffered significant damage. There was also inundation damage to improved sanitation facilities, but the relatively low coverage of facilities in the country (18 percent) means the extent of damage is quite low.

Assessments also indicated that there has been significant damage to the gravity feed and rainwater catchment systems. Because these covered only 37 percent of the population before the disaster and were poorly maintained, distinguishing the damage directly attributable to the flooding from already existing damage has been difficult. The cost of damage identified in this assessment includes direct damage such as flood-induced landslides, scouring of dam foundations and pipelines, reticulation damage, and damages to guttering and water tanks.

The damage to the urban infrastructure was limited, but the effect of this damage on operational capacity and service delivery has been large. Damage to the Kongulai gravity main has required installation of additional cross connections in White River on a temporary basis. Other minor damage to water infrastructure included loss of some 300 revenue meters and destruction of sections of the small-diameter distribution network. The sewerage system suffered from flooding, blockages, and overflow, and seven sea outfalls were damaged by debris such as logs and timber. Municipal septic tanks operated by Solomon Water have been affected by debris and other solids being washed into them.

4.2.5 Description of the losses

The majority of loss incurred in rural Guadalcanal Province was due to the extensive use of existing RWSS

warehouse materials, which were used following the flooding and will require replacement. Additional labor costs during the emergency response, along with additional hygiene promotion and associated materials, were minor contributors to losses.

Impacts on health and broader macroeconomic losses due to asset damage need to be included in the calculation of losses. Global cost-benefit analysis of water supply and sanitation interventions conducted by the World Health Organization and others (Hutton, Haller, and Bartram 2007; Hutton and Bartram 2008; Evans, Hutton, and Haller 2004; OECD 2011) estimate that in developing regions, the return of a US\$1 investment ranges from US\$5 to US\$46. Using the low end of the range—US\$1 in damage equals US\$5 in lost economic output—and assuming that the losses would be incurred until the preexisting level of service was recovered, we estimated that the loss resulting from damage to assets was approximately US\$2.2 million.

Solomon Water has incurred additional operating costs because of higher electricity consumption, additional chemical dosing, and additional labor costs. It has also experienced lost revenue from its issuance of flat-rate bills, from an increase in unpaid bills, and from its supply of water to evacuation centers free of charge. Solomon Water consequently faces higher operational

costs coupled with reduced revenue. This situation will likely continue until November–December 2014. *The current budget projections suggest that Solomon Water will incur significant cash flow problems and face considerable financial strain in the coming months. Additional budget support should be sought to address these issues.*

Overall total damage and loss for the water and sanitation sector is estimated to be US\$4.53 million (see table 13). This is largely driven by the level of loss in the rural sector, which is illustrated in figure 5.

Table 13: Damage and Loss Summary for Water and Sanitation (US\$ million)

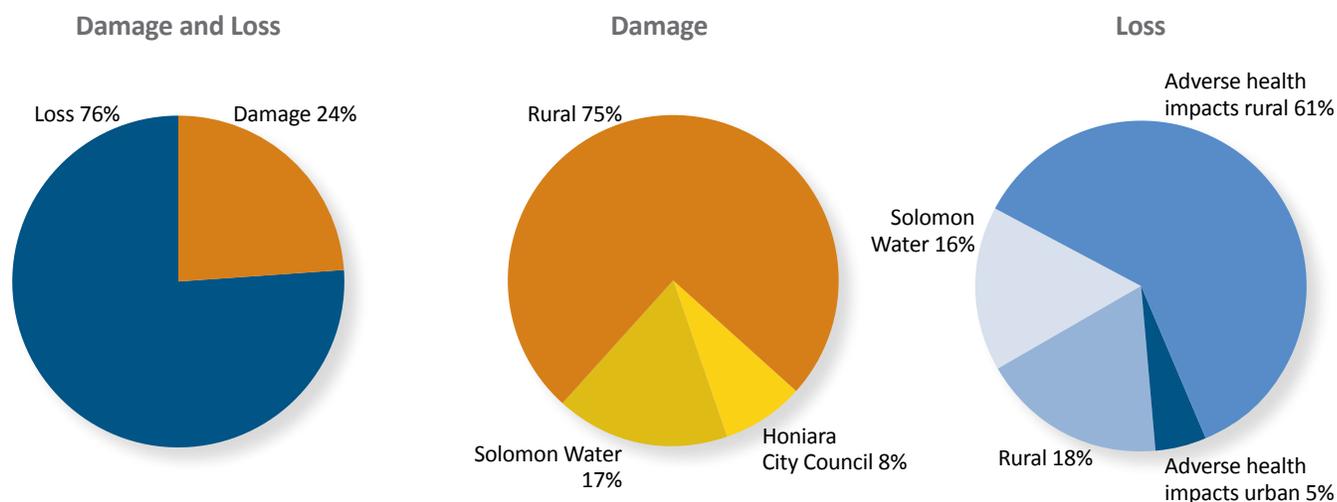
	Damage	Loss	Total Damage & Loss
Rural	0.83	2.71	3.53
Urban	0.30	0.70	1.00
Total	1.13	3.41	4.53

Sources: GP EHD 2014; Solomon Water 2014a, 2014b 2014c; HCC 2014a 2014b; RWSS yearly work programs, 2013.

4.2.6 Government recovery initiatives

At the time of writing, no government initiatives have been confirmed. There have been informal reports of constituency funds being released and spent in Guadalcanal Province under the Guadalcanal Province

Figure 5: Breakdown of Damage and Loss for Water and Sanitation Sector



Sources: GP EHD 2014; Solomon Water 2014a, 2014b, 2014c; HCC 2014a 2014b; RWSS yearly work programs, 2013.

EHD. There are planned recovery initiatives being developed under the direction of the water, sanitation, and hygiene (WASH) cluster (chaired by director of the EHD) through the emergency response. There have also been confirmed reports of SI\$1 million taken out of the RWSS program and redistributed to an emergency fund administered by MHMS.

4.2.7 Proposed recovery plan

To help address the needs identified as part of this assessment, the following recovery and reconstruction activities should be considered. The estimates are based on the best information available at the time of writing, but further scoping work should be done before budgeting for these items.

Short-term recovery. The majority of damage to the rural water supply resulted directly from adoption of poor disaster risk reduction methodologies in the design and construction of infrastructure. For example, the short-term rehabilitation works intended to clean shallow wells will probably not restore the wells to their pre-disaster service level; the wells are poorly designed and upon cleaning they may collapse or become quickly recontaminated. Consideration should be given to decommissioning the existing wells and constructing a limited number of resilient shallow wells to meet basic water demand in the short term. This step could be complemented by replacement of all the damaged wells in the medium to long term.

Table 14 summarizes short-term needs in the water and sanitation sector.

Sanitation facilities also need to be upgraded. However, under the Solomon Islands RWASH Policy, no

subsidy can be applied to community sanitation. With the vast majority of the rural population practicing open defecation, accomplishing behavior change in sanitation is of paramount importance. New and innovative approaches to behavior change, such as community-led total sanitation (CLTS) or participatory hygiene and sanitation transformation, should be tried. There should be a strong push for CLTS programming in particular as a means of encouraging behavior that will improve sanitation.

All emergency repairs have been completed by Solomon Water in Honiara. Additional short-term recovery and rehabilitation plans have already been budgeted and planned for under existing programs.

Medium- to long-term recovery. Medium- to long-term recovery plans need to be underpinned by a detailed review of assessments. A gap analysis needs to be completed using existing data, and additional assessments then undertaken to address the gaps identified. At that point a detailed medium- to long-term reconstruction program should be developed.

Initial assessments have highlighted the lack of detailed baseline data and planning capacity for RWSS. Addressing these deficits is a strategic recommendation of the draft Strategic Plan for RWASH 2015–2020.

The initial damage assessments show that after basic access is restored, RWSS will need to complete installation of additional protected wells with SOLMARK hand pumps. This strategy is recommended under the “build back better” response; simply replacing the unprotected wells with more unprotected wells is no longer feasible. Gravity and rainwater harvesting systems will also need to be rehabilitated using BBB principles. A number of

Table 14: Short-Term Recovery Needs for Water and Sanitation Sector

Activity	Needs (US\$ million)
Rehabilitation of hand-dug wells damaged during the flooding	0.13
Development and dissemination of basic hygiene messages to affected rural communities and around Honiara	0.07
Additional water quality treatment, monitoring, and control	0.05
Replenishment of RWSS warehouse	0.49
Total	0.74

Source: Solomon Islands Government 2014.

Note: All short-term recovery needs shown here are for rural areas.

new population centers—created as people have moved to areas less prone to floods—will need new water and sanitation systems. An additional recommendation to reduce disaster risk, one that has already received partial donor funding, is the installation of a limited number of deep bores and solar pumps in high-risk communities.

Because the WASH sector has limited capacity, it will need support to assist with the implementation of the additional recovery and reconstruction activities. A significantly higher implementation cost is expected if additional technical capacity needs to be mobilized. At present, UNICEF is well positioned to support, and co-lead with, the RWSS/EHD in the overall emergency response. Through its partners, UNICEF can also contribute to delivery of the recovery plan in Guadalcanal Province and in the peri-urban areas in Honiara. Solomon Water will continue to extend the maintenance and repairs in Honiara.

The flood has identified a number of operational and reliability constraints in the current Solomon Water distribution network. A gravity main duplication (estimated at US\$1.75 million) has been proposed for the Kongulai water supply system; this would provide much-needed operational resilience. The flood has also highlighted the poor design and limited capacity of the existing sewage network and the need for Solomon Water to look at developing plans for a third independent water source.

Medium- to long-term recovery needs are summarized in table 15.

4.2.8 Potential funding options

Potential funding sources for short-, medium-, and long-term activities in the water and sanitation sector are shown in table 16.

Table 15: Medium- to Long-Term Recovery Needs for Water and Sanitation Sector

Activity	Needs (US\$ million)
Rural	
Drilling of boreholes in affected urban and rural communities	0.14
Repair of affected piped water supplies and rainwater harvesting systems in Guadalcanal Province	0.31
Supply of WASH services to new population centers	0.10
Rehabilitation of hand-dug shallow wells using BBB approach	1.92
Total	\$2.47
Urban	
Duplication of Kongulai gravity main	1.75
Development of municipal wastewater collection and treatment master plan	0.08
Development of water supply master plan	0.08
Development of Honiara drainage master plan	0.11
Total	2.02
Grand total	4.49

Sources: Solomon Islands Government 2014; Solomon Water 2013, 2014b.

Table 16: Potential Funding Sources for Water and Sanitation Sector

	Recovery Needs (US\$ million)	Potential Funding Sources		Financing Gap (US\$ million)
		Source (government or donors)	Amount (US\$ million)	
Short Term	\$0.74	World Vision Solomon Islands	0.02	0.44
		Department of Foreign Affairs and Trade Australia (warehouse losses)	0.28	
Medium-Long Term	\$4.49	World Vision Solomon Islands	0.08	4.41
Total	\$5.23		0.37	4.85

Sources: Solomon Islands Government 2014; Department of Foreign Affairs and Trade Australia.

4.3 Agriculture

Over 80 percent of Solomon Islanders live in rural areas. The agriculture, forestry, and fishery sector accounted for a total of 35.3 percent of GDP in the Solomon Islands in 2013, with 14.5 percent for agriculture (crops and livestock), 15 percent for forestry, and 5.8 percent for fishery.¹

Most rural residents derive their livelihoods from subsistence agriculture and small-scale income-generating activities, particularly the export of cash crops (coconut, oil palm, cocoa), traditional cash crops (sweet potato, cassava, banana, taro, yam, beans, cabbage), and other fresh products. The 2009 Population and Housing Census (Solomon Islands National Statistics Office 2009) indicates that 89 percent of all Solomon Islands households grow some of their own food; among rural residents the share is 96 percent.

Household gardening in rural areas is carried out on a shifting cultivation basis, generally using the slash and burn method, where an area is cultivated for a short period before being left fallow to allow natural regeneration. Increasing population pressure has combined with changes in crops, cropping methods, land use, and lifestyle to intensify the use of garden land areas on to more mountainous terrain. This trend has in turn increased soil erosion, landslides, and susceptibility to floods.

Livestock has a significant share in socioeconomic development in the Solomon Islands. Around 90 percent

of households keep between one and five pigs and between 10 and 12 scavenging chickens. Income from the sale of surplus production remains important for broader economic and social purposes. In the peri-urban Honiara area, livestock is reared in a more structured, formal system, but elsewhere in Guadalcanal Province, livestock is reared on unimproved, poorly managed pastures, fallow land, and crop residues. Table 17 below presents information on pre-disaster livestock in Guadalcanal Province and Honiara City.

Solomon Islands fisheries include subsistence, semi-commercial, and commercial fisheries, with most activity in the first two categories, especially among rural communities. About 60 percent of Solomon Islanders are involved in fishing activities for their own consumption, and about half of these also sell fish. According to the 2009 Population and Housing Census (Solomon Islands National Statistics Office 2009), only about 8 percent of the population in Honiara is involved in fishing activities.

The Ministry of Agriculture and Livestock Development (MAL) has numerous programs and projects devoted to helping smallholders; these take into consideration the smallholders' needs, motivations, capabilities, risks, and resources, as well as the effect of these factors on the production and marketing of products or their use within the household.

In order to address the national development priorities embodied in these programs and projects,

Table 17: Pre-disaster Livestock in Guadalcanal Province and Honiara City

Pre-disaster stock	Guadalcanal	Honiara	Total
Cattle, commercial	1,200	0	1,200
Cattle, smallholder	110	0	110
Poultry broiler, smallholder	7,300	7,700	15,000
Poultry layer, commercial	10,000	3,900	13,900
Poultry layer, smallholder	1,900	1,900	3,800
Pigs, commercial	900	2,000	2,900
Pigs, smallholder	12,670	460	13,130

Source: Ministry of Agriculture and Livestock Development, Department of Livestock and Veterinary Service.

¹ Figures are from the World Bank and the Central Bank of the Solomon Islands.

the government, through MAL, established numerous strategic activities to be implemented during the period 2010–2015. These activities included the following:

- Development of an oil palm plantation, with a target of developing 40,000 hectares over 10 years
- Establishment by 2020 of 3,000 hectares of rice projects across the country's nine provinces
- Rehabilitation and development of cocoa and coconut plantations
- Establishment of small livestock projects
- Revival of the cattle industry
- Development of exotic and indigenous crops, fruits, and nuts

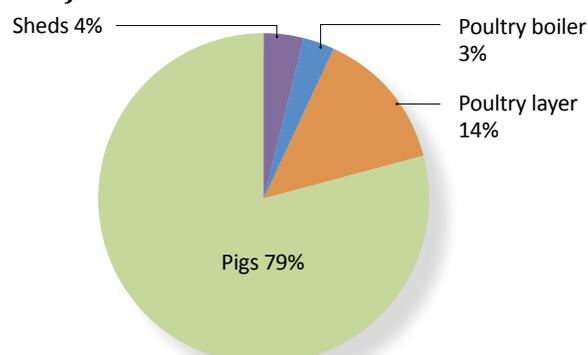
4.3.1 Description of the damages

Crops. The total damage to the crop subsector was assessed at SI\$5.47 million (US\$750,000). Most of the damage involved destruction of or damages to cocoa and copra driers and rural roads. Loss of livelihood assets such as farming tools was also considerable.

Livestock. The floods directly impacted the livestock subsector, with damage estimated at SI\$3.07 million (US\$420,000). There were significant losses of animals, mostly pigs (22 percent lost) and poultry (12 percent lost), along with damage to fences, chicken sheds (41 totally or partially damaged in Guadalcanal, 13 in Honiara), and pig structures (64 totally or partially damaged in Guadalcanal, 4 in Honiara).

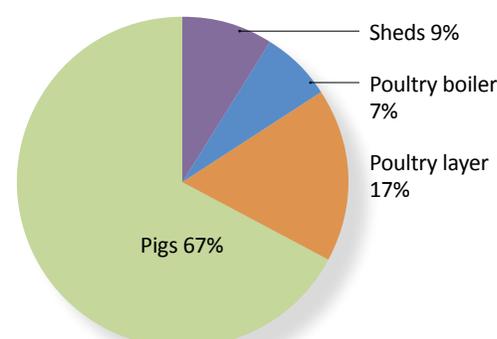
Table 18 presents the number of poultry and pigs washed away by the flash floods in Guadalcanal Province and Honiara City.

Figure 6: Damage to Livestock and Structures in Guadalcanal Province (as percentage of damage in sector)



Source: Based on official Solomon Island government data.

Figure 7: Damage to Livestock and Structures in Honiara (as percentage of damage in sector)



Source: Based on official Solomon Island government data.

Fisheries. The estimate of damage in the fishery subsector was SI\$2.19 million (US\$300,000). The flash floods impacted fishing communities living close to main rivers in Honiara City (Mataniko and Lungga Rivers) and East and West Guadalcanal. Damage in the fishery subsector mostly involved the loss of fishing equipment, canoes, and a few boats.

Table 18: Number of Livestock Lost in Guadalcanal Province and Honiara City

	Guadalcanal	Honiara	Total
Poultry broiler, smallholder	1,110	864	1,974
Poultry layer, commercial	1,520	438	1,958
Poultry layer, smallholder	289	213	502
Pigs, commercial	194	438	632
Pigs, smallholder	2,725	101	2,826

Source: MAL initial rapid assessment.

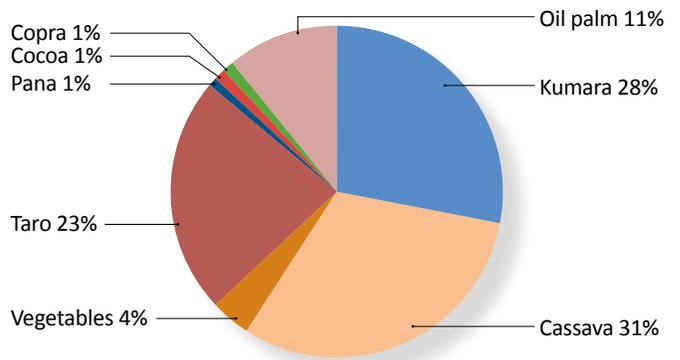
4.3.2 Description of the losses

Crops. The estimated loss to the crop subsector was SI\$112.69 million (US\$15.43 million). The flash floods caused significant damage to food gardens (affecting mostly kumara, cassava, taro, pana, and vegetables), export crops (cocoa, copra, palm oil), and fruit trees (banana). In total, 1,225 households in Honiara City and 7,335 households in Guadalcanal Province were directly affected. The numbers of households suffering total or partial damages to their food crops are shown in figure 8.

An estimation of loss was not part of the initial damage assessment. The loss in production and income has been assessed and estimated for the most affected crops (kumara, cassava, taro, pana, vegetables, cocoa, copra, and palm oil), taking into account the percentage of the crop damaged, the average area cultivated for each crop, the yield, and the farm gate price. A seasonal crop calendar (see annex 5) was developed in order to cross-reference the accuracy of the findings in terms of magnitude of production losses. The estimation of losses also included the cost for replanting vegetables. The cost for replanting root crops was not considered because most farmers will procure planting material at no cost (from undamaged crops, from neighbors, etc.).

In terms of economic loss, cassava accounted for 31 percent of total loss and kumara accounted for 28 percent, followed by taro (23 percent) and oil palm (11 percent). Details of distribution of loss in the crop subsector are shown in figure 9.

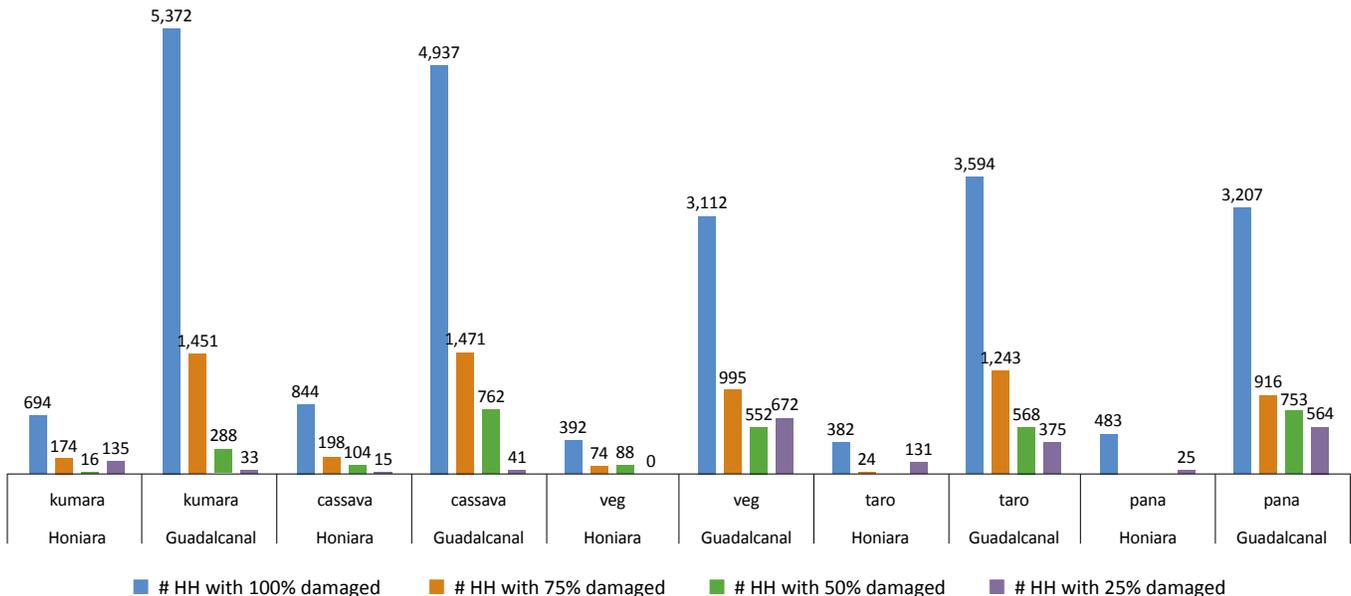
Figure 9: Distribution of Loss in the Crop Subsector



Source: Estimates based on official Solomon Island government data.

Livestock. The estimated loss to the livestock subsector was SI\$9.89 million (US\$1.35 million). Loss in production occurred mainly in the poultry and pig sectors. Farmers reported loss of animal feedstock as well as loss of livestock.

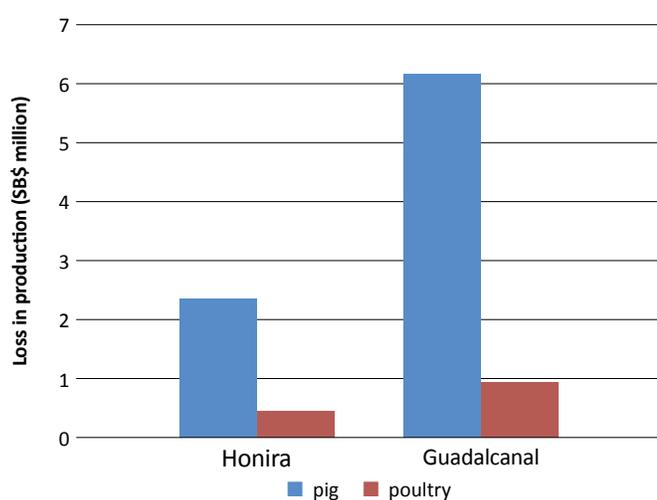
Figure 8: Number of Households Sustaining Damage to Food Gardens



Source: MAL initial rapid assessment.

Livestock is an important source of income for Honiara peri-urban households and for households in Guadalcanal Province. The loss of animals therefore has a direct economic impact because it means loss of revenue from the selling of eggs, pork, and chicken meat; it also means loss of production of offspring (especially pigs) for sale as weaners and finishers. Figure 10 illustrates the losses in production (SI\$) in Guadalcanal Province and Honiara City.

Figure 10: Loss in Livestock Production, by Commodity (SI\$)



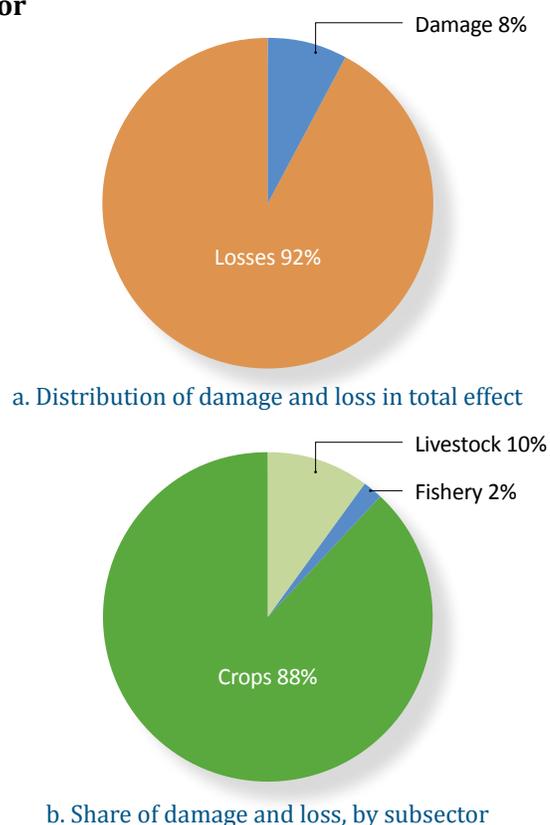
Fisheries. The estimated loss to the fishery subsector was SB\$ 1.1 million (US\$ 0.154 million). The loss of fishing equipment, canoes, and boats, along with reduced access to fishing grounds due to debris and sedimentation, resulted in reduction of daily catch.

Social dimension. The impact of the flooding on the agriculture sector in turn affected the availability and price of food. Recent market monitoring has shown a distinct decrease in the availability of fresh vegetables as well as an increase in their price—one that will likely have secondary impacts on the food security of a large portion of the population in Honiara and other areas of Guadalcanal Province. The majority of economically active women are engaged in agriculture; although their overall participation in cash generation is small, any disruption to agricultural activities is likely to have a disproportionate effect on women’s earning capacities.

4.3.3 Damage and loss summary

Of the total damage and loss for the three subsectors, 88 percent is attributable to crops, 10 percent to livestock, and 2 percent to fishery (figure 11, panel a). The total effect to the sector amounts to SI\$134.42 million (US\$18.41 million), of which SI\$10.73 million (US\$1.50 million)—8 percent—is damage and SI\$123.70 million (US\$16.94 million)—92 percent—is loss (figure 11, panel b). Of the total effect, 99.92 percent accrues to the private sector and 0.08 percent to the public sector.

Figure 11: Damage and Losses in the Agriculture Sector



Sources: MAL; Ministry of Fisheries and Marine Resources.

Table 19: Damage and Loss by Subsector (US\$ million)

	Damage	Losses	Total
Crops	0.75	15.43	16.18
Livestock	0.42	1.35	1.77
Fisheries	0.30	0.15	0.45
Total	1.47	16.83	18.20

Sources: MAL; Ministry of Fisheries and Marine Resources.

The assessment made clear that, with lost income and major food access issues, many small farmers will not be able to cope with the disaster. Access to high-quality agricultural inputs such as seeds should be immediately facilitated, and animal restocking and rehabilitation of the damaged infrastructure should be supported.

4.3.4 Government recovery initiatives

Although the details still need to be further developed, MAL is likely to support disaster recovery activities by drawing on funds available in recurrent budgets and/or redirecting development budget funds.

4.3.5 Proposed recovery plan

Farmers affected by the flash floods need to be supported to facilitate a quicker recovery and to help them reestablish their normal livelihoods. The longer

it takes to establish this support, the longer it will take for the Solomon Islands to attain full economic recovery. Table 20 and table 21 present the different activities to be undertaken in order to promote recovery in the short term as well as the medium to long term. The tables also seek to identify where government initiatives have already been implemented and where donor partner resources have been made available or may be necessary. Analysis suggests that the sum of SI\$21.18 million (US\$2.90 million) may be required for recovery and SI\$20.23 million (US\$2.77 million) for reconstruction.

4.3.6 Potential funding options

Table 22 shows potential funding sources for both short-term and medium- to long-term activities in the agriculture sector.

Table 20: Short-Term Recovery Needs for Agriculture

Activity	Needs (US\$ million)
Provide seeds, seedlings, suckers, cuttings, and other agricultural inputs for replanting of crops	1.90
Provide cash for work activities for community-level cleaning to enable affected families to meet food needs, purchase equipment, and/or rebuild animal housing and restock	1.00
Total	2.90

Sources: Livelihoods cluster; MAL.

Table 21: Medium- to Long-Term Recovery Needs for Agriculture

Activity	Needs (US\$ million)
CROPS	
Support promotion of resilient agriculture techniques (intercropping, fruit tree planting, integrated farming systems using permaculture technique); support community nurseries; improve resilience to floods (improve drainage systems, provide training in disaster risk reduction techniques, including traditional storage techniques)	1.60
Support MAL and Ministry of Fisheries and Marines Resources in developing damage and loss needs assessment tools, including development of accurate baseline information	0.01
LIVESTOCK	
Support restocking. Rehabilitate livestock structure with BBB techniques. Restore water facilities. Designate an area where household chickens and pigs can be safely evacuated during heavy floods. Ensure that community-level disaster plans factor in provisions for the suitable evacuation of livestock	0.60
Boost sustainable production through investing in both research and local capacity building by introducing lower cost, locally available ingredients into commercial feeds as the strategy to improve profit margins	0.05
FISHERY	
Provide fishing gear and equipment	0.24
Promote community fisheries-based management	0.27
Total	2.77

Sources: Livelihoods cluster; MAL; Solomon Islands Government 2014.



Farmers affected by the flash floods need to be supported to facilitate a quicker recovery and to help them reestablish their normal livelihoods. The longer it takes to establish this support, the longer it will take for the Solomon Islands to attain full economic recovery.

Table 22: Potential Funding Options for Agriculture

	Recovery Needs (US\$ million)	Potential Funding Sources		Financing Gap (US\$ million)
		Source (government or donors)	US\$ million	
Short term	2.90	MAL; ILO; DFAT; KGA; SEB; New Zealand MFAT; WSPA; ECHO	0.92	1.98
Medium- to long- term	2.77	Solomon Islands government; RDP/World Bank; EU; FAO, TTM/ROC, DFAT, New Zealand MFAT	0.21	2.56
Total	5.67	Solomon Islands government; PRRP; ILO, UNDP	1.13	4.54

Sources: Livelihoods cluster; MAL.

Note: ILO = International Labour Organization; DFAT = Department of Foreign Affairs and Trade; KGA = Kastom Gaden Association; SEB = Solo Enviro Beautification; MFAT = Ministry of Foreign Affairs and Trade; WSPA = World Society for the Protection of Animals; ECHO = European Community Humanitarian Office; RDP = Rural Development Program; EU = European Union; FAO = Food and Agriculture Organization; TTM/ROC = ; PRRP = Pacific Risk Resilience Program; UNDP = United Nations Development Programme.

4.4 Housing

Housing infrastructure in the Solomon Islands is highly vulnerable to natural disasters, as was demonstrated by the extensive damage inflicted during the 2014 flooding disaster. According to the 2009 Population and Housing Census (Solomon Islands National Statistics Office 2009), only 21 percent of houses in Honiara and 8 percent of houses in Guadalcanal are constructed with a concrete, cement, or brick floor, while the remaining houses have floors of corrugated iron, timber, or traditional or makeshift materials, making them more susceptible to flooding damage. The flooding along the Mataniko River was so destructive, however, that some houses constructed with cement brick walls were also badly damaged or destroyed.

The Solomon Islands National Building Code (Solomon Islands Government 1990) sets standards for building construction in the Solomon Islands, although in practice this standard is applied only to permanent structures. Buildings constructed of traditional materials are not built to any regulated standards and tend to be far less resilient to natural hazards such as flooding and cyclones.

Approximately 22 percent of houses in Honiara and 2 percent of houses in Guadalcanal Province are privately rented (Solomon Islands Government 2009). Rents are typically in the range of around SI\$1,500 to SI\$5,000 per month (approximately US\$200 to US\$700), depending on various factors but primarily the method of construction.

The Solomon Islands government provides housing for government employees, or alternatively contributes toward rental of private houses for employees.

4.4.1 Description of the damages

The Solomon Islands National Emergency Operations Centre (2014) states that the scope of the disaster is limited to Guadalcanal Island, and in particular those areas along the major river systems, the Guadalcanal Plains, and Northwest Guadalcanal. Thus assessments of housing damage have been or are intended to be limited to Honiara and to 11 affected wards of Guadalcanal Province.

Assessments carried out by the Ministry of Lands, Housing and Survey (MLHS) in Honiara and by World Vision International and Solomon Islands Red Cross in Guadalcanal Province show that the flooding has irreparably damaged or completely destroyed 243 houses in Honiara (2.7 percent of the city's total housing stock), and around 432 houses in Guadalcanal Province (3.6 percent of the total housing stock across 11 affected wards, and 2.5 percent of the total housing stock in the province). The Honiara assessment is complete, and the Guadalcanal figure is extrapolated from the assessments carried out in six wards to date.

The Honiara assessment shows that damage to houses was concentrated on the banks of the Mataniko River, and that most of these houses were entirely destroyed rather than partially damaged. In Guadalcanal Province, villages situated near major rivers on the

Guadalcanal Plains were the most affected, and the extent of damage was more varied than in Honiara. Damage at Burns Creek was minimal; only 17 of 712 assessed houses were destroyed.

A sample of the Honiara assessments shows that dwellings constructed of traditional materials comprised approximately 49 percent of the houses that were destroyed or suffered irreparable damage. This can be attributed to the lesser resiliency of traditional construction, as well as the tendency of squatters to build inexpensive temporary structures illegally on land that had not been subdivided for residential use, such as at Koa Hill adjacent to the Mataniko River. A total of eight government houses (allocated to Honiara City Council employees) constructed of permanent materials were completely destroyed in Honiara.

Figure 12: Location of Houses at Koa Hill Destroyed by Flooding



Sources: Ministry of Lands, Housing and Survey; Secretariat of the Pacific Community.

Note: Red dots indicate the location of houses.

Estimates of the cost of damage to the housing sector in Guadalcanal Province are based on assessments to date. They are also informed by census figures showing that approximately 70 percent of houses in Guadalcanal are constructed mainly of traditional materials, with the remainder constructed of more permanent materials (Solomon Islands Government 2009).

Though parts of Guadalcanal were not yet assessed at the time of writing, we project that in total, around 675 houses have been completely destroyed, 3,726 have suffered partial (repairable) damage, and 7,235 houses have suffered minimal or no damage.

4.4.2 Description of the losses

Privately rented houses account for 22.3 percent of houses in Honiara and 1.9 percent of houses in Guadalcanal (Solomon Islands Government 2009). A sample of the Honiara assessments shows that about one in four affected houses was privately rented, roughly matching the citywide figure. Rental values vary according to the construction materials, with monthly rentals around SI\$2,000 (approximately US\$275) for a house built of traditional materials, and around SI\$4,000 (approximately US\$550) for a house built of permanent materials. Assuming that houses that have been destroyed require an average of 18 months to reconstruct, and partially damaged houses require an average of 3 months to repair, the total losses resulting from loss of rental income will be approximately SI\$7.8 million (US\$1,066,000).

The Humanitarian Action Plan (Solomon Islands Government 2014) proposes that transitional shelter be provided for people whose houses have been destroyed and cannot be rebuilt. Based on the assessment carried out by MLHS in Honiara, the National Disaster Management Office estimates that there could be a need for approximately 260 transitional shelters (243 destroyed houses in Honiara, plus 17 destroyed houses at Burns Creek, which adjoins the Honiara City boundary). The NDMO has identified land owned by the Solomon Islands National University in Honiara—used for the 2012 Festival of Pacific Arts (and still identified as “FOPA”)—as a location for the shelters. The extent to which the remaining evacuation centers will also need to serve as transitional shelter is yet to be determined. The HAP estimates the cost of this transitional shelter project to be SI\$6 million (US\$822,000).

Damage and loss in the housing sector is summarized in table 23.

4.4.3 Government recovery initiatives

The MLHS has prepared a subdivision plan for an area known informally as April Hill, and it will shortly commence surveying and pegging for 264 urban lots, each with an area of at least 400m². These lots are to be allocated to people who lost their houses along the Mataniko River (so up to 260 lots may be required). The

Table 23: Damage and Loss Summary for Housing

	Damage (US\$ million)	Losses (US\$ million)	Total (US\$ million)
Fully destroyed houses	10.06	0.42	10.48
Partially damaged houses	14.47	0.35	14.83
Minimally damaged houses	4.67	–	4.67
Total	29.20	0.78	29.98

Sources: MLHS; Solomon Islands Red Cross; World Vision International; selected building quotes.

Note: – = negligible.

precise method of allocation will be determined either by the commissioner of lands or by a newly appointed Land Board.

4.4.4 Proposed recovery plan

To help address the needs identified as part of this assessment, the following recovery and reconstruction activities should be considered. The estimates are based on the best available information available at the time of writing, but further scoping work should be done to before budgeting for these items.

■ Short-term recovery

The NDMO is currently providing shelter for internally displaced persons in evacuation centers in Honiara and Guadalcanal Province, and further assistance is being provided by aid donors and nongovernmental organizations. NDMO is coordinating a “repatriation” program, which assists people in voluntarily returning either to their home in Honiara (if repairable) or to their province of origin. The HAP includes a program to repair and upgrade repairable houses in Honiara and to repair and reconstruct houses in Guadalcanal; Guadalcanal residents have alternative customary land upon which to resettle, but Honiara residents have limited or no access to alternative land, and are therefore considered as part of a separate resettlement program. Funding to support the repair/reconstruction program has yet to be identified.

NDMO expects that there may be around 1,000 to 2,000 people remaining in evacuation centers after the repatriation process, comprising Honiara residents who lost their homes and do not wish to return to their home province. These people will be provided with transitional shelter at the FOPA site; with an area of approximately

67,000m², the site can house around 2,000 people in transitional shelters. Structures used during the 2012 FOPA are still intact and have been used for immediate shelter needs. The Solomon Islands government will assess the suitability of these structures for transitional shelter.

Short-term recovery needs in the housing sector are summarized in table 24.

Table 24: Short-Term Recovery Needs for Housing

Activity	Needs (US\$ million)
Implementation of a house repair and upgrade program	1.8
Provision of transitional shelter	0.82
Total	2.00

Source: Solomon Islands Government 2014.

■ Medium- to long-term recovery

MLHS is preparing to subdivide and develop an area of land within the Honiara City boundary for the purpose of allocating land parcels to Honiara-based internally displaced persons. The preliminary subdivision plan includes 264 residential lots, which is sufficient to meet the anticipated needs. The precise layout of the subdivision needs to reflect constraints such as exposure to flood and landslide hazards; additional assessment may be required to determine this exposure. Early indications suggest that the indicative costs for the development of these plots—including the construction of roads and the servicing costs for water, electricity, housing, and sanitation—are approximately SI\$64 million (US\$8.7 million).

Given the high-level decisions that need to be made before any recovery program can be effectively designed, it has not been possible to include the costs in this report. At this stage it is unknown who will fund any resettlement and reconstruction activities or if repatriation of households will occur.

4.4.5 Potential funding options

The United Nations Development Programme will potentially provide up to US\$150,000 toward the cost of transitional shelters at FOPA. No donors have yet been identified to fund a house repair and upgrade program.

MLHS has a budget of SI\$6 million (US\$822,000) specifically for infrastructure costs associated with new subdivisions. The MLHS permanent secretary has allocated this Site Development Fund to be used at April Hill.² This will go some way toward paying for the infrastructure costs but will still leave a significant shortfall, particularly in light of the cost of new houses.

4.5 Health and Education

4.5.1 Health

A major priority for the Ministry of Health and Medical Services, and the driving force behind the development of health facilities in the Solomon Islands, is the Universal Health Coverage and Role Delineation Policy. This policy includes the upgrading of existing health facilities but also the establishment of new health clinics in selected areas.

Honiara and Guadalcanal Province—the areas that are the focus of this post-disaster rapid assessment—are home to 52 health facilities. Guadalcanal Province has 43 open health facilities and one hospital (Good Samaritan). Of the non-hospital facilities, 13 are nurse aid posts, 24 are rural health clinics, and 6 are area health centers. In Honiara, there are 8 clinics (thought to be in poor condition before the flooding) and the National Referral Hospital.

4.5.2 Education

The Solomon Islands education sector is currently guided by the 2013–2015 National Education Action Plan,

which in turn is organized around the five subsectors of the education system (early childhood education, primary education, secondary education, technical and vocational training, and tertiary education). The governments of New Zealand and Australia have actively supported the education sector over the past years through the joint Education Sector Support Program. The program provides budget support to mutually agreed-on targeted areas (e.g., teacher development, infrastructure, inspectorate). Despite ongoing support, however, the ministry has in recent years faced challenges in its capacity to expend existing resources, particularly on the development side. This difficulty has been due in part to limited human resources, to a lack of baseline data relating to the condition of existing assets (both buildings and curricula), and to delays in procurement processes.

4.5.3 Sector impacts

This assessment of sector impacts is based on the Australian Civil Corps Education & Health Assessment of April 24, 2014, and on assessment information provided by the Ministry of Education and Human Resource Development (MEHRD) and the MHMS. At the time of writing, further assessments were under way, so it should be understood that this account does not provide a complete picture of damaged schools and health clinics.

4.5.4 Description of the damages

Health clinics. In total eight health clinics suffered negative impacts from the floods: three in Honiara City Council and three in Guadalcanal Province.

No clinics were structurally damaged, and none needs to be relocated or completely reconstructed as a result of the floods. Three facilities in Honiara (Mataniko Area Health Center, White River Rural Health Clinic, and Pikinini Area Health Center) sustained varying levels of inundation and architectural damage to internal partition wall linings, electrical outlets, entrance doors, hollow core doors, external wall cladding, external landscaping, and septic tanks. The engineers who evaluated the facility believe that the clinics can commence operations while work proceeds. The Pikinini Area Health Center

² Based on personal communication with Stanley Waleanisia, May 5, 2014.

sustained similar types of damages, though these were more severe, and repair work is required before the clinic can operate effectively. A detailed breakdown of damage to health facilities is available in annex 6.

Three clinics in Guadalcanal (Selwyn Nurse Aid Post, Tinaghulu Nurse Aid Post, and New Tenabuti Rural Health Clinic) have sustained minor damage consequent to inundation of the premises; they will need new floors and repairs to inner lower walls, and some equipment and medical supplies will need to be replaced. Prior to the flooding, the quality and quantity of equipment of these facilities was already considered to be at a low level.

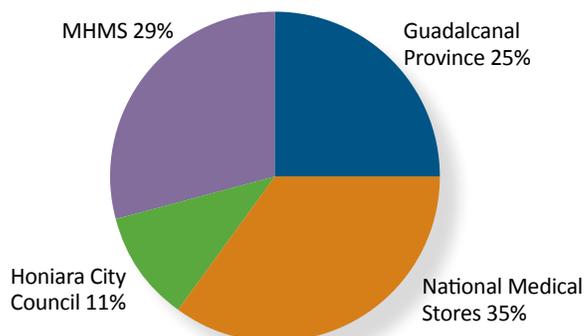
Education. According to the information collected to date, the damage reported to schools was minimal and requires only minor repairs. A full list of schools with reported damage is provided in annex 7. The key tasks to be carried out are repairs to school buildings, the pumping out of septic tanks, and the replenishment of curricular materials and furniture. It should be noted that there was no pre-disaster information on the condition of school infrastructure, which makes it difficult to ascertain the damage directly attributable to the disaster.

4.5.5 Description of the losses

Health. The Ministry of Public Service circular stipulated that staff working in the aftermath of the flooding would receive an extra allowance of SI\$150 (US\$20) per weekday and SI\$300 (US\$41) for weekends and public holidays. These amounts have been used as a proxy to estimate the level of loss incurred from the additional work required, but the final number of staff members who will be receiving this allowance is not yet final. The total loss for the health sector is estimated at SI\$4.7 million (or US\$649,000); losses are shown disaggregated by percentage in figure 13.

The impact on the National Environmental Health Division, which is part of the MHMS, has not been included here because water and sanitation have been assessed separately. It will be important to allocate National Environmental Health Division losses to the MHMS budget.

Figure 13: Health Losses by Source of Budget



Source: MEHRD.

Of the total damage, 36 percent is under the National Vector Borne Disease Control Division, 29 percent is under the National Reproductive & Child Health Division, 13 percent is under the National Referral Hospital, and the remaining 22 percent is under various MHMS national divisions.

Guadalcanal Province has been using its provincial health recurrent budget, which is funded by MHMS grants and Health Sector Support Programme grants, to conduct its emergency response throughout the province. It will do so until the end of May, so the weekly average of up-to-date costs is a forecast impact on their budget. The total amount expected to be spent for the flood is SI\$1.2 million (US\$164,484), representing 8 percent of the total grants for Guadalcanal Province for 2014 (total grants are equal to SI\$14.1 million or US\$57,000). This amount includes all expenses related to the flood, including mostly the per diems for staff working hard on the relief efforts (SI\$150 per weekday and SI\$300 for per day on weekends and public holidays), goods, equipment, rations, fuel, catering for the disaster team, and new computers for the team. The amount also includes the loss of one ambulance (washed away by flash floods) and the resulting interruption in service delivery.

Replacement of damaged stock and supplies for **National Medical Store** mobile teams is estimated at SI\$168,311 (US\$23,049). Overseas procurement, along with orders of new stock to replace what was lost and to meet increased needs arising from disease outbreaks, comes to SI\$1.5 million (US\$205,520). The replacement stock is to replenish supplies in Honiara City Council and

Guadalcanal Province clinics. Stocks in White River and Mataniko clinics have been replaced. The National Medical Store supply has returned to its pre-disaster level, but it is ready to accommodate spikes in usage arising from outbreaks of diarrhea, dengue, and other diseases.

Honiara City Council will spend SI\$490,000 (US\$67,000) of its recurrent budget (which is funded through MHMS and the Health Sector Support Programme) as a result of the floods.

Three Ministry of Health and Medical Services divisions were affected by the floods: (i) the National Vector Borne Disease Control division, which had to use its stock of long-lasting insecticide-treated nets and chemicals (which will have to be replaced) and order additional quantities; (ii) the National Reproductive and Child Health division, which will have to conduct an additional vaccination campaign; and (iii) the National Referral Hospital, which had to use its budget for MEOC and hospital expenses. In addition, various divisions' budgets were affected by the relief efforts. The total amount for losses for the MHMS is SI\$1.4 million (US\$192,000).

Education. The losses in the education sector have been derived by establishing a cost for the additional logistical support required to access the schools, overtime of the staff, and the school fees that were waived via the provision of school grants. Total loss for the sector is estimated at SI\$888,000 (US\$122,000).

4.5.6 Damage and loss summary

Table 25 summarizes damage and losses in the health and education sectors.

Table 25: Damage and Losses in Health and Education (US\$ million)

	Damage	Losses	Total
Public schools	1.24	0.10	1.24
Health facilities	0.19	0.65	0.80
Total	1.29	0.75	2.04

Source: Estimates based on official Solomon Islands government data.

4.5.7 Government recovery initiatives

Health. In the aftermath of the flooding, MHMS, with the support of its cluster partners, has been actively

responding to health sector needs, including preventative and curative services and disease surveillance. In response to the crisis, MHMS has strengthened its teams for risk communication, nutrition and food safety, WASH, and health cluster coordination.

A number of assessments, both rapid and ongoing, have been conducted to monitor health sector needs following the flooding. MHMS conducted an initial rapid assessment and is leading assessments of health facilities, with data analysis ongoing. People living in affected communities in Guadalcanal Province (currently 64 communities identified)—specifically the catchment area of the 21 affected health facilities—are at risk. The population of the catchment areas of the three health facilities in Honiara City Council, including affected communities in outer areas of Honiara, are also at risk.

Education. Community clean-up activities have helped to repair some of the damage and remove debris, and children were able to return to school following the Easter holiday. The MEHRD is conducting further assessments to determine the full extent of damage and the financial cost of replacing, repairing, and restoring essential services, resources, and physical environments in the affected schools. It has engaged an engineering company to begin this process.

4.5.8 Proposed recovery plan

To help address the needs identified as part of this assessment, the following recovery and reconstruction activities should be considered. The estimates are based on the best available information at the time of writing, but further scoping work should be done before budgeting for these items,

■ Short-term recovery

The short-term recovery of the health and education sectors requires the implementation of minor repair work. It is understood that for both MHMS and MEHRD, this work is already under way, and that the education sector has been able to leverage limited support via the Humanitarian Action Plan. The works suggested here focus on the minor repairs to school buildings, pumping out of septic tanks, and drainage; similar works are suggested for the health centers. Needs are summarized in table 26.

Table 26: Short-Term Recovery Needs for Health and Education

Activity	Needs (US\$ million)
Schools	
Minor repair of flood damage	0.69
Health Clinics	
Minor repair of flood damage	0.15
Recuperation of losses	0.65
Total	1.49

■ Medium- to long-term recovery

Health. The medium-term recovery activities were extracted from the HAP health section (excluding those that were considered part of short-term recovery and were undertaken by Guadalcanal Province, NHR, Honiara City Council, and various nongovernmental organizations, such as repairs to affected facilities, provision of health and nutrition services, supplementary immunization program, safe food handling to prevent food-borne diseases, provision of sexual reproductive health services, and provision of mental health and psychosocial services to affected communities).

Any medium- to long-term recovery efforts will need further assessment of the flood's effect on the health of the Solomon Islands population (for example, relating to nutrition and reproductive and child health). The referral system linking different facilities has been affected, and while it seems to be getting back on track, the disruption might have medium- or long-term consequences for the health sector.

In terms of medium- to long-term recovery, the floods have once again highlighted the precarious state of some of the health facilities in Honiara and Guadalcanal Province. Long-term efforts to improve infrastructure's resilience to natural hazards will need to be based on the MHMS Role Delineation Policy. Major infrastructure work has already been identified at the National Referral Hospital in Honiara, which has had to respond to natural hazard events by moving the pediatric, antenatal, gynecology, and postnatal wards to higher ground).

Education. The medium to long term activities identified for the education sector involve repairing the schools to their pre-disaster state. The activities identified are expected to take a longer time than those listed in table 27 and to involve activities such as repairs to access roads and the drainage system. The proposed build back better solution includes relocating four schools to sites not prone to flooding and carrying out various flood-proofing measures, such as elevating power points. Activities are summarized in table 27.

4.5.9 Potential funding options

Health. In preliminary discussions, UN agencies have expressed their interest in contributing to the relief effort for the health sector through the Central Emergency Response Fund. This would not cover the losses of MHMS, however, but only quick fixes to restore affected clinics to a functional level.

Table 28 gives an indication of potential funding sources for the recovery needs. At this stage, MHMS external support is being sought to fund these initiatives

Table 27: Medium- to Long-Term Recovery Needs for Health and Education

Activity	Medium- to Long-Term Recovery Needs (US\$ million)	Build Back Better Recovery Needs (US\$ million)
Schools		
Reconstruct schools	0.540	5.24
Health clinics		
Strengthen coordination mechanisms within and outside the health sector	0.068	
Establish early warning and response system	0.076	
Conduct nutrition assessment of affected population	0.008	
Carry out evidence-based nutritional interventions to protect young children	0.027	
Total	0.719	5.24

Table 28: Potential Funding Sources in Health and Education

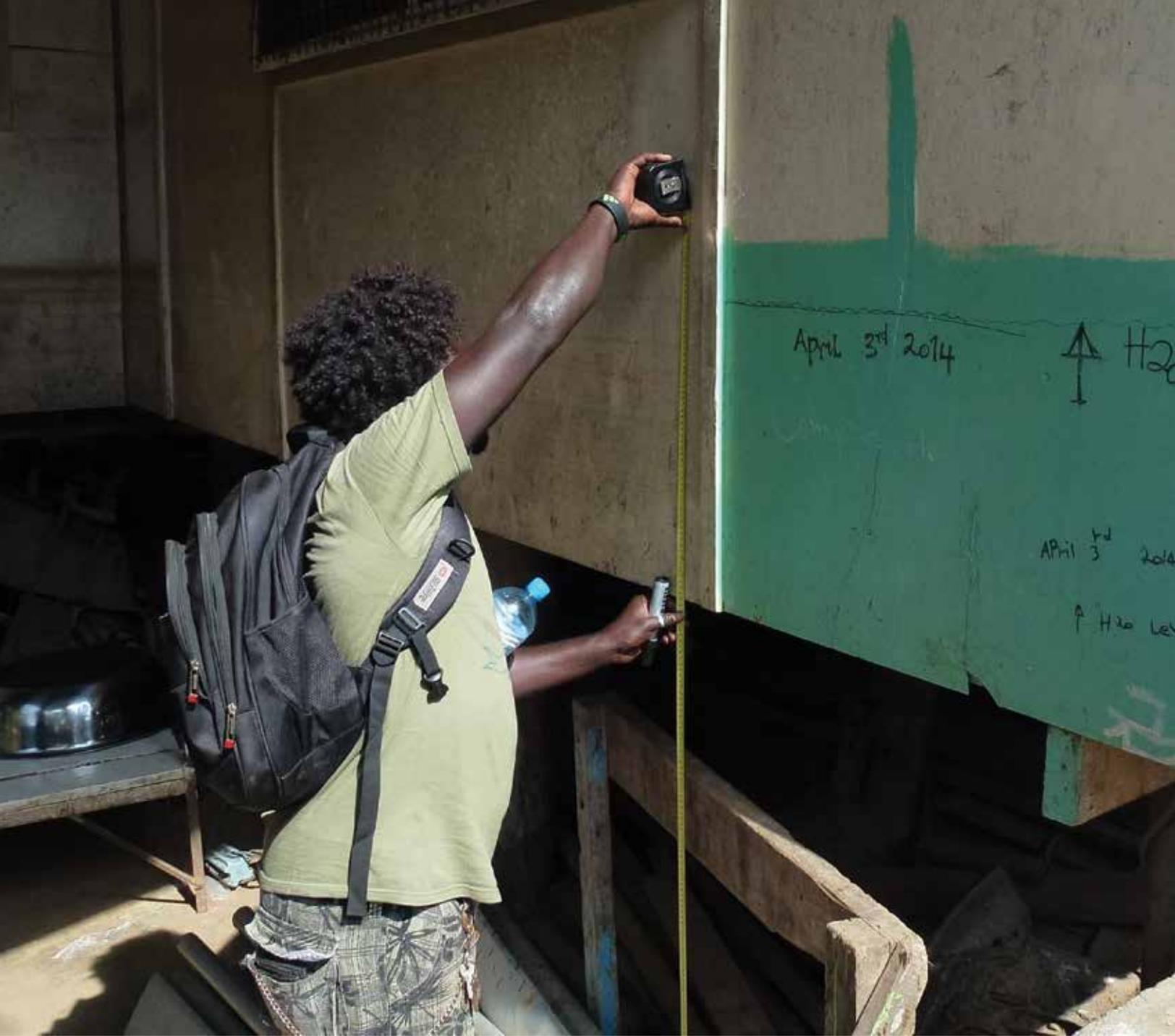
	Recovery Needs (US\$ million)	Potential Funding Sources		Financing Gap (US\$ million)
		Source (government or donors)	US\$ million	
Education short term	1.23	Government sector budget support	1.23	
Health short term	0.80			
Health medium- to long- term	0.12			
Total	2.15			0.92

so that additional funds need not be diverted from the core budget.

Education. Preliminary discussions with MEHRD suggest that the majority of repairs and restocking of curricular materials can be absorbed under its existing budget. The estimate given in table 28 is derived from combining the short-term and medium- to long-term repairs that would return the buildings to their pre-

disaster state. MEHRD has also indicated that the sector would benefit from additional technical assistance activities to help coordinate the works schedule with repairs that had already been planned. The cost of technical assistance has not been included in the recovery needs, as further scoping work would be required to ascertain the desired activities and to gauge interest from donors to in supporting the assistance.

Any medium- to long-term recovery efforts will need further assessment of the flood's effect on the health of the Solomon Islands population (for example, relating to nutrition and reproductive and child health). The referral system linking different facilities has been affected, and while it seems to be getting back on track, the disruption might have medium- or long-term consequences for the health sector.



Collecting flood level data at Koa Hill. Collection of accurate flood level data will support the BSURE approach.

5. Managing Flood Risk and Building Urban Risk Resilience

This section explores and seeks to understand the localized geographic impact of the April 2014 floods. It first provides an overview of the country's hazard setting and analyzes the urban/peri-urban risk setting. Indications are that urban vulnerability is increasing over time, likely with consequential drag on the national economy. This section then assesses the underlying causes of the flood and looks at the flood risk management measures in place at the time of the flood. It makes recommendations for more detailed mapping and modelling of the flood hazard, and for mapping and projections of settlement growth and land-use needs in different parts of Honiara, in particular the vulnerable areas. The resulting information will help in developing credible options for reducing flood risk. Finally, this section recommends an integrated program designed to break the urban risk cycle. The recommendations are clustered according to activities to modify (i) the flood hazard, (ii) human use of the floodplain, and (iii) the human responses to flooding.

5.1 Setting the context

5.1.1 National hazard setting

The Solomon Islands is one of the 20 countries most vulnerable to natural disasters, being subject to cyclones, floods, landslides, storm surges, earthquakes, tsunamis, and droughts. The Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI 2012) estimates that the Solomon Islands faces average annual losses of around US\$44 million due to tropical cyclones and earthquakes. Flooding has occurred with relentless frequency. Over and above the damage and losses suffered in April 2014, flood damage in Honiara and Guadalcanal had occurred as a result of Cyclone Angela (1966), Cyclone Glenda (1967), Cyclone Carlotta (1972), Cyclone Kerry (1979), Cyclone Bernie (1982), Cyclone Namu (1986), Cyclone Ului (2010), and Cyclone Yasi (2011), and as a result of excessively heavy rainfall in 2008, 2009, 2010, and 2012.

5.1.2 Urban and peri-urban risk setting

The global trend toward urbanization³ is evident in the Solomon Islands. According to national census reports, urban growth rates have been higher than rural growth rates for the last 30 years. Extrapolating from the 2009 national census figures, it is estimated that at least 129,000 people, or 22.2 percent of the total population, live in urban areas in 2014, an increase of 27,000 people over the past five years. The figure would be higher if the population of Honiara's peri-urban settlements located within Guadalcanal Province were included (figure 14).

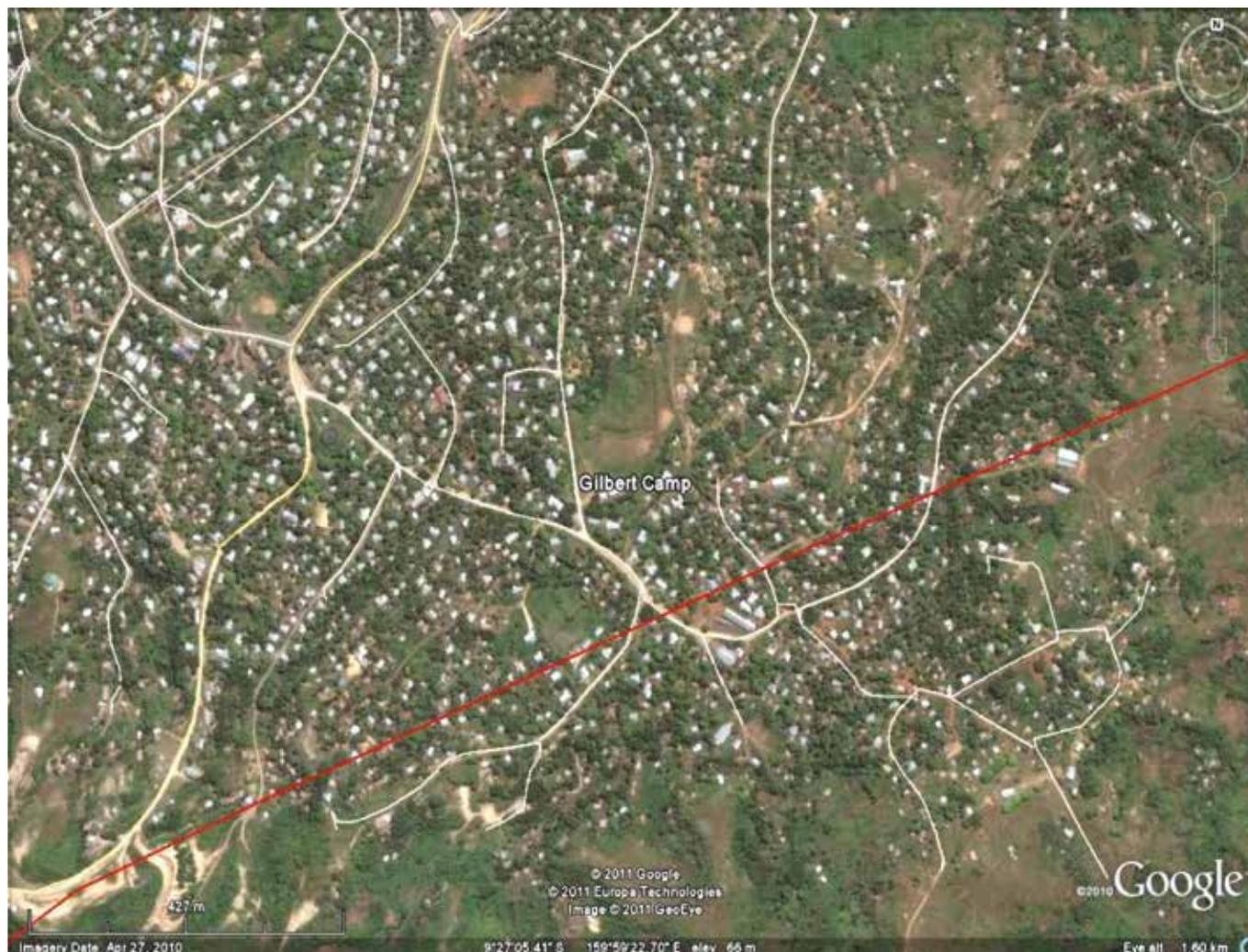
In-migration to urban centers is typically driven by employment and livelihood opportunities or prospects. In 2005, the urban product (i.e., the level of economic activity in urban areas) was 37 percent, although only 16.3 percent of the country's total population lived in urban areas at that time. Similarly, in 2010 the urban contribution to GDP was 66 percent (although this figure also includes mining activities).⁴ The 2005–2006 Household Income and Expenditure Survey (Solomon Islands Statistics Office 2006) found that the median annual per capita expenditure of urban households was 3.5 times greater than that of rural households.

The urban areas and Honiara in particular function as important engines of economic growth. The growth in urban population is positively correlated with growth in GDP per capita and decline in poverty levels over the past 10 years. It would be economically rational for the Solomon Islands to take full advantage of urbanization and the economic opportunities it presents.

On the supply side, urban management systems, land use, and service delivery have failed to keep pace with this rapid growth. For the past 30 years or so, little in the way of new subdivisions or serviced land has been available for low- or lower-middle-income groups. As a result, both new migrants into the city and new households that have grown naturally out of existing

³ By mid-2010, for the first time in history, more of the world's population lived in urban rather than rural areas (UN-Habitat 2011).

⁴ Urban contribution to GDP was derived from national accounts; see Soubbotina (2004).

Figure 14: Informal Settlement Straddling Guadalcanal Province/Honiara City Council

households have had to find their own land and housing solutions. UN-Habitat (2012) reports that 35 percent of Greater Honiara's population lives in 30 informal squatter settlements. Growth rates in these informal settlements are high—around 6 percent a year—and there are reports that middle-income as well as low-income households build in these areas, given the overall shortage of serviced land. An estimated 4,000 people live in areas well located for employment, such as the highly vulnerable informal settlements of Koa Hill, Vara Creek, Lord Howe, and Burns Creek.

Key national and strategic infrastructure and facilities are also located in areas of risk. These include the Honiara International Airport, the Point Cruz port

and fuel depot, the Marine Training School, and a number of bridges and land transport routes linking Honiara to the Guadalcanal agricultural hinterland.

All these factors combine to trap Honiara (and to some extent other secondary towns) in a cycle of worsening risk (illustrated in annex 8), though some of the risk could be mitigated or prevented through improved urban and risk management.

5.1.3 Anatomy of a disaster: Underlying causes of the April 2014 flash floods

The causes of the April 2014 disaster involve the intersection of a severe flood hazard and a highly vulnerable population. To build flood resilience, it is

useful to analyze the causes of the disaster, and to focus in particular on the Mataniko River and the communities of Vara Creek and Koa Hill, where the loss of life was concentrated (figure 15).

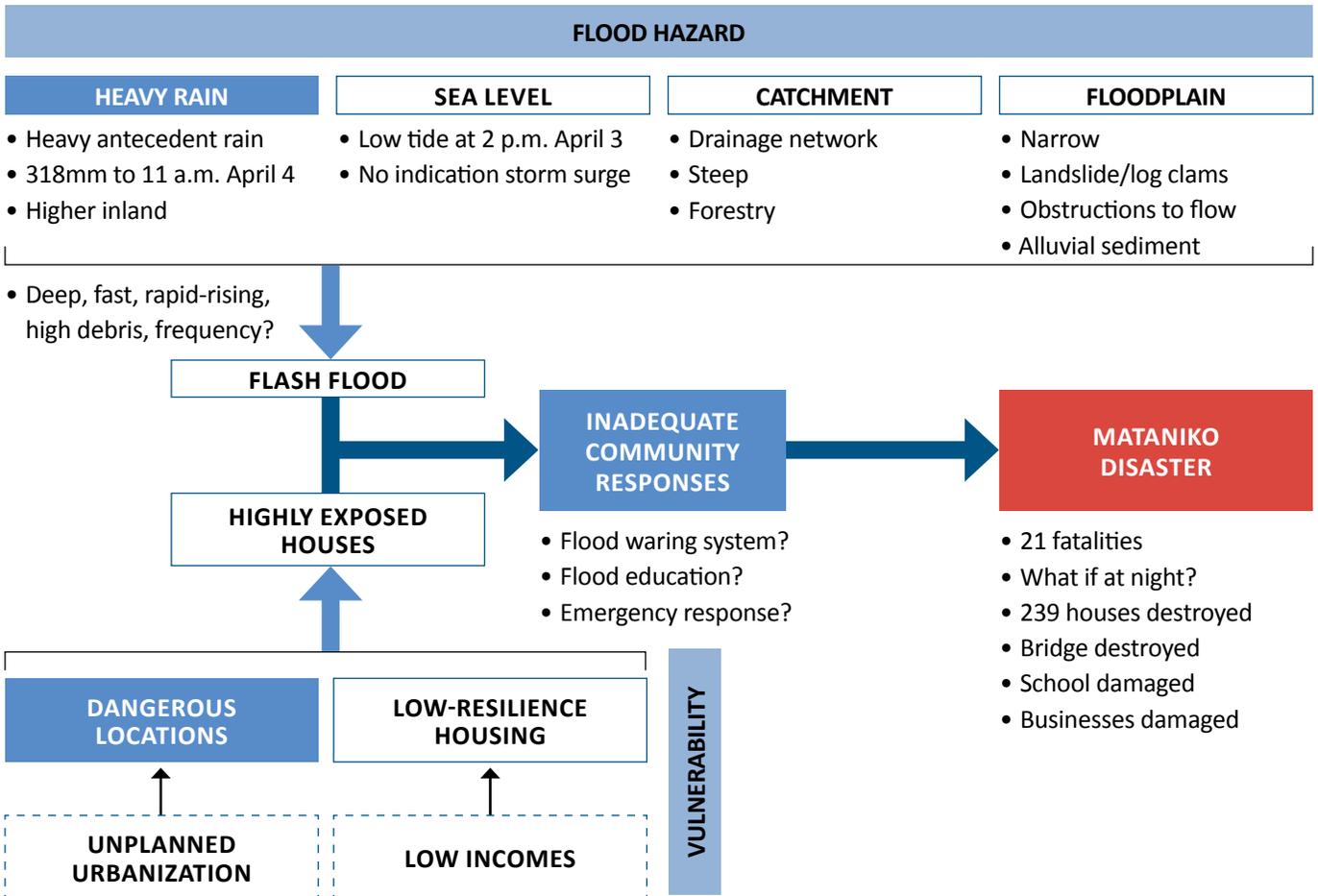
On the hazard side of the disaster equation, the flood may be attributed primarily to a slow-moving tropical depression that brought very heavy rain—a record 318mm was recorded at Honiara for the 24 hours ending 11 a.m. on April 4. Peaking at about 2 p.m. on Thursday April 3, the flash flood was very deep in some places (e.g., 4.35m over the floor of St. John the Baptist church at Koa Hill). The flow was reportedly fast and carried a great deal of debris, including whole trees and houses.

A lack of hydrological data makes it difficult to estimate an average return period for the flood with any confidence. The daily rainfall measured at Honiara

is associated with events having return periods greater than 100 years (Lal and Thurairajah 2011). But the critical time period to produce the largest flows for the 57km² Mataniko catchment would likely be much less than 24 hours. Further, the annual recurrence frequency of rainfall at a location is not the equivalent of flood frequency. Anecdotal evidence suggests about a 50- to 100-year return period for the flood. (This doesn't mean that a flood of this size will not return for 50 or 100 years, but rather that such a flood has a 1–2 percent chance of occurring in any given year).

On the vulnerability side of the disaster equation, the immediate cause of the disaster was the highly exposed houses, located on dangerously low ground, especially at Koa Hill, where residents say the land was once a swamp. The low-resilience housing styles also contributed to vulnerability. Traditional leaf houses were

Figure 15: Analysis of Causes of the April 2014 Mataniko River Flood Disaster



disproportionately damaged in the flood, though at Koa Hill the flood depths, velocities, and debris load were such that even block concrete houses were destroyed.

A severe flash flood and a highly exposed population were ingredients for a disaster on the afternoon of April 3, 2014. Only an appropriate response from those in danger’s way might have saved lives, but anecdotal reports suggest that many people responded inadequately. Consideration should be given to whether the flood warning system, flood education initiatives, or emergency response operations could be improved.

Some 22 people lost their lives in the Mataniko River flood disaster of April 2014. A number of near misses were also reported: several people held on to the apex of the church roof, and a boy survived despite being washed downriver from Koa Hill to the sea. Had the flood occurred at night, with fully occupied houses and rescues more difficult to carry out, there might well have been hundreds of fatalities. The flooding also destroyed 235 houses along the valley, washed away the old Mataniko Bridge, inundated classrooms at Honiara High School, and affected many businesses in Chinatown, partly because of extensive riverbank erosion.

5.2 Breaking the cycle of increasing risk

Every natural hazard does not have to result in a disaster. With better policy, planning, and coordination, urbanization could become a positive force for economic growth and poverty reduction rather than a factor increasing natural hazard risk. To be sure, building back better at the city level will require an integrated strategy, such as the Building and Strengthening Urban Resilience (BSURE) approach summarized in Figure 16 and described in more detail in section 5.6.

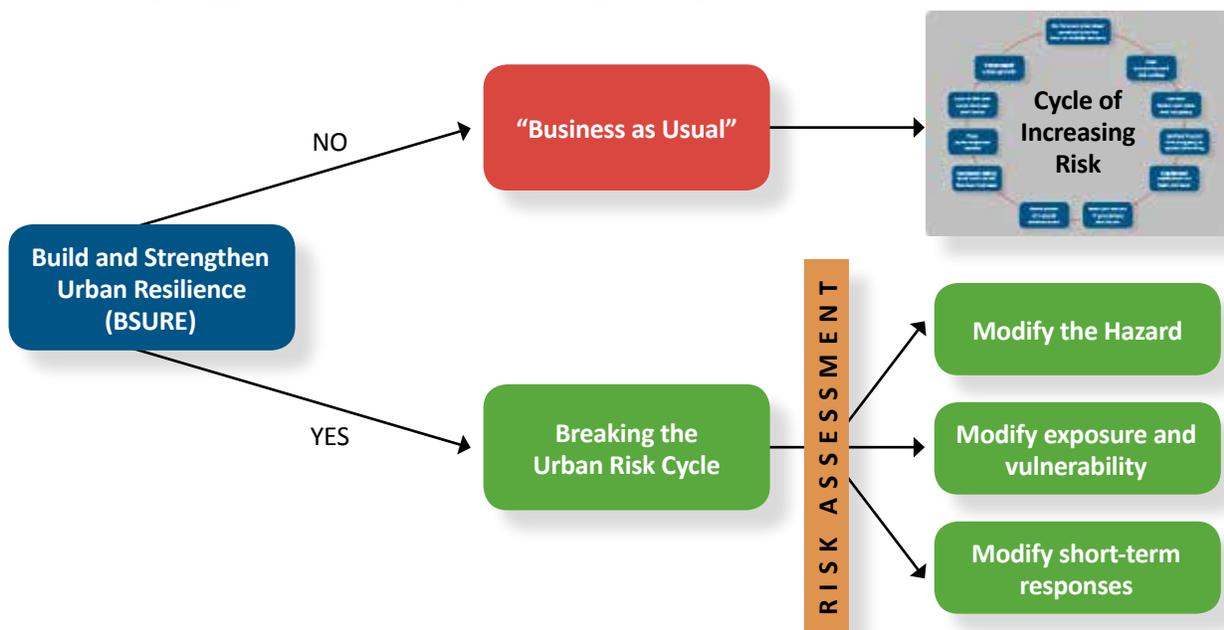
As the figure shows, managing flood risk requires assessment of the risk, followed by interventions to reduce the risk by modifying the hazard, modifying exposure and vulnerability, and modifying short term responses.

5.3 Better understanding the risk

5.3.1 Flood hazard assessment

Flood hazards in the Solomon Islands are in general poorly understood; annex 9, which measures flood risk management practices in the Solomon Islands against best-practice benchmarks, makes this clear. The following measures are proposed to improve this situation.

Figure 16: Strategic Approach to Building and Strengthening Urban Resilience



Note: The box at the upper right is included as annex 8, where it can be read more easily.



Had the Mataniko River flood disaster of April 2014 occurred at night, with fully occupied houses and rescues more difficult to carry out, there might well have been hundreds of fatalities.

- a. *Collect flood data for the April 2014 event.* There is an urgent need to collect flood data from the April 2014 event before it is lost in the course of time. In addition to mapping the extent of flooding, there is a need to record flood depths and survey peak flood levels. These are vital data for the calibration of any flood modelling that is conducted.
- b. *Devise options to sustainably improve the hydrological monitoring network.* Considerable investment has been made in improving hydrological monitoring in the Solomon Islands. Unfortunately, minimal data on rainfall and river levels were captured for the April 2014 flood, which appears to reflect the Hydrology Unit's lack of capacity or funding to maintain the hydrological infrastructure—as well as occasional vandalism (see SPC 2012, 122–38). The current lack of data constrains both assessment of flood risks through modelling and delivery of timely flood warnings. The current network must be restored and expanded, while simultaneously increasing the capacity of the Hydrology Unit and committing to ongoing maintenance of the gauge infrastructure. Careful consideration of gauge locations and security will be required to minimize the risk of vandalism.
- c. *Carry out flood modelling to inform an urban flood risk management master plan.* Some flood mapping based on historical events is available, but it does not demonstrate best practice. The importance of Honiara as the capital and economic hub of the Solomon Islands, and the pressure placed by urban growth on floodplains, commend a more comprehensive investigation.
- d. *Assessments need to take account of multiple hazards.* Flooding from rivers and creeks is just one hazard affecting greater Honiara. Ultimately there is a need for a multi-hazard assessment that includes storm surge associated with tropical cyclones as well as landslides and riverbank erosion.

5.3.2 Vulnerable areas

Important first steps in addressing risk in vulnerable areas have been taken, but the interventions are not large enough to make an impact on the cycle of deterioration described above. The government has recently completed descriptive “urban profiles” for the three main urban areas. It also is embarking on a number

of measures to carry out land tenure regularization in four “temporary housing” informal settlements within Honiara City, and to lay out and service a middle-income residential subdivision on greenfield, government-owned land at some distance from business areas of the city. It intends to review and update the Honiara Local Planning Scheme (2006), to carry out an organizational review and restructuring of the key units of Ministry of Lands, Housing and Survey, and to review all land-related legislation.

It is critical that basic data be collected regarding household incomes and expenditures (we are awaiting results of the 2013 survey) and that a business and enterprise survey be undertaken. These data would (i) inform the government's direction of growth to secondary towns; (ii) make it possible from a risk perspective to predict the direction and pace of growth in urban villages/settlements and the associated land-use needs; and (iii) help the government direct growth to particular lower-risk parts of the city.

5.4 Risk-reducing options

5.4.1 Modify the hazard

The following steps could be taken to reduce risk by modifying the flood hazard;

- a. *Watershed management.* Given the intensity of the rain and the steep watershed, the land surface cover probably had little effect on the resultant flood in the Mataniko catchment. Nevertheless, a prudent “no regrets” measure is best practice for watershed management. Better understanding the extent of forestry operations is required, along with positive land management practices such as reforestation to increase rainfall interception and slope stability. Similarly, agricultural practices such as planting along the contour would be beneficial.
- b. *Riverbank protection/rehabilitation.* In some places, riverbank erosion is threatening important facilities and infrastructure, and engineering measures such as rock gabion walls may be required to contain the erosion. The naturally dynamic nature of river channels in the Solomon Islands also needs to be acknowledged. Recognizing the likelihood of rivers shifting, Roy (1990) mapped wide flood channel

zones for rivers on the Guadalcanal Plains. Aerial photography of the Lungga River delta shows substantial changes from 1949 to 2013. In such an area, the large-scale investment that would be required to stabilize the river could well be in vain. But the planting of deep-rooted trees, grasses, and reeds might be used to slow down the rate of change.

- c. *Bridge protection.* Much damage was done by the debris carried along in the floodwater in April 2014. The resilience of bridges would be enhanced by building back structures with higher decks and larger spans, with fewer piers presenting an obstacle to flow. Any piers could be protected by deflectors (though some deflectors used in the past have been stolen).
- d. *Maintenance of flow conveyance.* An inspection of culverts around Honiara suggests that many are partly blocked by debris. There is also a large quantity of rubbish in watercourses. In a flood, this means that the culverts may be entirely blocked, diverting flow into areas that might not otherwise have flooded.

A key requirement to facilitate the conveyance of flow is to maintain the creeks and drainage infrastructure. It is understood that this would be a Ministry of Infrastructure Development function for road culverts, but which if any organization is responsible for cleaning creeks within the city is unclear. More broadly, extending the provision of waste collection services and seeking to shift the culture of using the creeks for solid waste disposal would be advantageous.

Conveyance can also be affected by obstructions on the floodplain, and the flood effect of developments should be assessed in the approvals process.

- e. *Structural works to increase flood immunity of Henderson Airport.* Henderson Airport experienced flooding on several occasions before 2014, including in 1967, 1972, and 1986. One proposal put forward by Trustrum, Whitehouse, and Blaschke (1989) was for “stop banks” to prevent overflow channels of the Lungga River from inundating the airport. A formalized flood diversion channel could direct overflows around the southern side of the runway toward Alligator Creek. A full assessment would be required to evaluate the economic, social, and environmental feasibility of the works. Detailed

flood modelling would likely be required, because withdrawing so much of the flood storage area is expected to increase flood levels elsewhere. Local decision makers will need to determine whether the increase is acceptable.

- f. *Drainage master plan.* Every wet season, Honiara is beset by routine drainage problems that include surface water on roads and inundation of some buildings. Preparation of a detailed drainage master plan would make it possible to calculate flows, identify current assets, determine the need for new or expanded assets, identify overland flow paths and opportunities for retention basins, and consider drainage design standards and detailing. A drainage master plan would need to link up with the proposed flood hazard mapping. There is also a need for legislative review to help delineate and strengthen the ability of MID and Honiara City Council to control new developments and remove encroachments into watercourses.

5.4.2 Modify exposure and vulnerability

The following measures are proposed for modifying exposure and vulnerability:

- a. *Best-practice hazard mapping should inform city and local planning as well as building design in existing and new settlements.*
- b. Use of low-hazard land should be maximized.
- c. *For residential serviced land, a twin-track approach should be implemented.* The first track would involve phased area/settlement upgrading with tenure regularization. Following negotiations with the community, a package of services to meet the community’s identified needs would be provided; the package would be based on community members’ ability and willingness to pay for land and services (and would thus discourage in-migration). The pilot areas would be in Honiara City, peri-urban settlements, and Gizo, based on the hazard risk profile of each area and on the willingness of the communities to participate. The second track would involve designing and building phased new serviced subdivisions that target low- and middle-income groups. The project would seek full recovery of land (opportunity) costs and maintenance of service levels (which could require utility agencies to use sinking funds for transparen-

- cy). The pilot would be located in a low-hazard area in Honiara City, peri-urban settlements, and Gizo, according to the identified demand (based on market surveys) for land in that particular area.
- d. Ways of promoting voluntary resettlement from very dangerous locations should be considered.
 - e. Involuntary resettlement should be a last resort, and populations should be relocated as close as possible to their original location.
 - f. *Guidelines for hazard-resilient housing, including for low-income groups, should be reviewed and updated.* Some good information is available for designing and building hazard-resistant houses in the Solomon Islands. Some useful papers were presented at the National Disaster Preparedness Workshop in 1990. However, an inspection of damaged houses after the April 2014 floods suggests that building standards—even for concrete dwellings presumably belonging to middle-income residents—are wanting. In particular, at some sites the uprooted foundations were seen to be very shallow, and the floor and walls were seen to be inadequately fixed to the columns. A review and update of available guidelines, and possible promulgation of the guidelines through the Solomon Islands Built Environment Professionals Association (SIBEPA), is recommended. Options for low-income groups should be considered.

5.4.3 Modify short-term responses

The following measures are proposed for modifying short-term responses:

- a. *Review and strengthen flood warning systems.* After every severe flood, a review of the performance of the total flood warning system is appropriate. This will help to identify how the system can be improved. A preliminary analysis suggests that more clearly differentiating heavy rain alerts from heavy rain warnings would be helpful, given the heightened threat of flood associated with the latter. There also appears to be scope for greater spatial precision in these messages.

In addition to a review of overall system performance, there is a need for an early warning system for the Mataniko River. While ideally the most severely affected land would not be resettled, resettlement cannot be ruled out, and there must be a

system in place to ensure that those living in low-lying areas have time to escape to higher ground. A warning system would also benefit businesses in Chinatown. Several simple community-based systems have been introduced in Guadalcanal. An ideal warning system could be designed so that when a water-level recorder reaches predetermined thresholds, an SMS is sent to the appropriate government ministries (including one with 24-hour capability, such as the police) and to wardens for each community located along the river.

- b. *Review and strengthen flood education initiatives to promote safer behavior during flooding.* For flood warnings to be effective, the communities exposed to flooding need to be aware of their risk and ready to respond in good time. The experience of the April 2014 flood suggests that further work is needed to ensure communities are ready for flooding. Guidelines could be developed to help businesses, communities, and key organizations (including Honiara International Airport) prepare their own flood emergency response plans. One salient message is that future floods will be bigger than those experienced in the past.
- c. *Provide hazard-proof evacuation shelters where gaps were identified.* A preliminary assessment following the April 2014 flood indicates that some communities are located a long way from evacuation centers. There were reports from the Burns Creek community, for example, of women and children evacuating through waist-deep water over a distance of more than 2km. In such circumstances, one misstep into a drain could result in tragedy. A detailed analysis of evacuation risks is needed; and where the risk is judged to be intolerable, resilient evacuation shelters should be built.

5.5 Intervention to address risk: Next steps for Building and Strengthening Urban Resilience (BSURE) strategy

Table 29 describes the BSURE program for strengthening flood risk management and urban resilience. Early discussions indicate a need for greater coordination between the various stakeholders to implement the program (details of institutional aspects are described in annex 10).

Table 29: Building and Strengthening Urban Resilience Strategy

Activity	Agency	Short-Term (3–6 months)	Medium- to Long-Term (> 6 months)
INSTITUTIONAL COORDINATION			
Enhance coordination between existing institutions and clarify arrangements and responsibilities for flood risk management	Solomon Islands government, NDMO	✓	✓
Nominate lead agencies for BSURE	Solomon Islands government	✓	✓
RISK ASSESSMENT			
<i>Flood hazard</i>			
Flood hazard mapping Collect flood data (high priority) Survey flood peak levels Conduct LIDAR survey and digital elevation modelling Carry out flood modelling Identify high-risk areas in citywide plans	Donors, MECDM, Division of Water Resources, MLHS, Honiara City Council	✓	✓
Devise options to sustainably improve the hydrological monitoring network	Donors, Division of Water Resources		✓
Conduct a multi-hazard assessment for Honiara including storm surge, landslide, and riverbank erosion	Donors		✓
<i>Vulnerable areas</i>			
Collect data on household income and expenditures and conduct a businesses and enterprise survey		✓	
Project urban growth direction, pace, and land-use needs within greater Honiara, Auki, and Gizo (high priority)	MLHS	✓	
RISK REDUCTION MEASURES			
<i>Modify the flood hazard</i>			
Manage watersheds	Forestry, Agriculture		✓
Protect/rehabilitate riverbanks	MID, To be confirmed		✓
Protect bridges from debris impact	MID		✓
Maintain flow conveyance	MID, Honiara City Council		✓
Construct a ring levee to increase flood immunity of Henderson Airport	MID		✓
Prepare a drainage master plan	MID		✓
<i>Modify exposure and vulnerability</i>			
Implement twin-track approach for residential serviced land: Upgrade informal settlements, including security of tenure and user-pays-for-services approach Identify service and allocate new residential and business land (lease/sale prices to include cost recovery)	MLHS	✓	✓
Promote voluntary resettlement from very dangerous locations	MLHS	✓	✓
Review and update guidelines for hazard-resilient housing, including for low-income groups	SIBEPA		✓
<i>Modify short-term responses to flooding</i>			
Review and strengthen flood warning systems	MECDM; Division of Water Resources	✓	
Review and strengthen flood education initiatives	MECDM	✓	
Provide hazard-proof evacuation shelters where gaps have been identified	MECDM		✓

Note: MECDM = Ministry of Environment Climate Change, Disaster Management and Meteorology; SIBEPA = Solomon Islands Built Environment Professionals Association



The flooding has irreparably damaged or completely destroyed 243 houses in Honiara, and around 432 houses in Guadalcanal Province.

6. Summary of Recovery and Reconstruction Needs

The following tables present the needs for recovery and reconstruction, prioritized as short-, medium-, and long-term activities. The time frames for these interventions are purely indicative, since timing will depend in part on institutional arrangements and both domestic and external financial support. For further information on these requirements, see the discussion of individual sectors in chapter 4.

Table 30 summarizes the estimated costs for recovery and reconstruction. Total recovery and reconstruction is estimated at SI\$401 million (US\$56.03 million). Of this amount, SI\$99 million (US\$14.59 million) is required in the short term (three to six months), with the remaining activities intended for the medium to long term (beyond six months) and expected to include some build back better initiatives.

6.1 Recovery and reconstruction needs

Table 31 details the recovery and reconstruction activities to be commenced in the short, medium, and

long term in order to restore livelihood and services in the various sectors. The majority of activities are to be completed in the medium to long term. Funding priorities should be established in consultation with the government and its development partners.

6.2 Future funding requirements

Preliminary discussions among sectors and development partners indicate that some US\$13.58 million may be available to assist with recovery and reconstruction; this would reduce the bill to US\$41.5 million. Similarly, some sectors—e.g., health and education, water and sanitation—may be able to bear some of the costs of damage repair from their sector budget support. A donor pledging conference should be co-convened by the Ministry of Development Planning and Aid Coordination (MDPAC) and MoFT to establish the full potential of donor contributions. Equally, internal discussions with line ministries should be held to establish the level of financial costs that can be absorbed from sector budget support.

Table 30: Total Recovery and Reconstruction Needs (US\$ million)

Sector	Short-Term	Medium- to Long-Term	Total
Transport	5.84	28.81	34.65 ^a
Water and sanitation	0.74	4.50	5.24 ^b
Agriculture	2.90	2.73	5.63 ^c
Housing	2.62		2.62
Health and education	1.49	5.42	6.91
Total	13.59	41.46	55.03

Source: Estimates based on official data from the Solomon Islands government.

- Early indications suggest that US\$12.08 million of this has already been sourced. Please refer to the discussion of transport (section 4.1).
- Around US\$370,000 has been received from Department of Foreign Affairs and Trade Australia and World Vision. Please refer to the discussion of water and sanitation (section 4.2).
- Approximately US\$1.13 million indicated; see section 4.3 on the agriculture sector.

Table 31: Recovery and Reconstruction Needs

Sector	Activity	US\$	Short-Term	Medium-Term	Long-Term
Transport	Repair to unpaved roads	50,000	x		
	Repair to paved roads	1,828,000	x		
	Repair to bridges	2,361,000	x		
	Repair to culverts and road-related drainage	206,000	x		
	Repairs to Henderson Airport	1,393,000	x		
	Repair to unpaved roads	229,000		x	
	Repair to paved roads	522,000		x	
	Repair to bridges	2,655,000		x	
	Repair to culverts and road-related drainage	639,000		x	
	Improvements to bridges including climate proofing	23,888,000			x
	Improvements to culverts including climate proofing	878,000			x
Water & sanitation	Rehabilitation of hand-dug wells	130,000	x		
	Development and dissemination of basic hygiene messages to communities	70,000	x		
	Additional water quality treatment, monitoring, and control	50,000	x		
	Replenishment of RWSS warehouse	490,000	x		
	Drilling of boreholes in affected communities to be fitted with hand/solar pumps	140,000		x	
	Repair of affected piped water supplies and rainwater harvesting systems in Guadalcanal Province	310,000		x	
	Supply of WASH services to new population centers	100,000		x	
	Use of BBB/disaster risk reduction approach in hand-dug shallow wells	1,920,000			x
	Duplication of Kongulai gravity main	1,750,000		x	x
	Development of municipal wastewater collection and treatment master plan	80,000		x	x
	Development of water supply master plan	80,000		x	x
Development of Honiara drainage master plan	110,000		x	x	
Agriculture	Provision of seeds, seedlings, suckers, cuttings, and other agricultural inputs for replanting of crops	1,900,000	x		
	Cash for work activities for community-level cleaning to enable affected families to meet food needs, purchase equipment, and/or rebuild animal housing and restock	1,000,000	x		
	Support for promotion of resilient agriculture techniques (intercropping, fruit tree planting, integrated farming systems using permaculture technique); support for community nurseries, techniques for improved resilience against floods (e.g., improved drainage systems, training in disaster risk reduction techniques—including traditional storage techniques)	1,600,000		x	x
	Support for MAL and Ministry of Fisheries and Marine Resources in developing tools for assessing damage and loss needs, including support for the development of accurate baseline information.	10,000		x	x
	Support for restocking, rehabilitation of livestock structure with BBB technique, restoration of water facilities for household chickens and pigs, and designation of an area where they can be safely evacuated during heavy floods.	600,000		x	x
	Boosting of sustainable production through investing in both research and local capacity building by introducing lower-cost, locally available ingredients into commercial feeds as a way to improve profit margins.	5,000		x	x
	Provision of fishing gears and equipment	240,000		x	x
	Promotion of community fisheries-based management	270,000		x	x

Table 31: Recovery and Reconstruction Needs (cont.)

Sector	Activity	US\$	Short-Term	Medium-Term	Long-Term
Housing	Repair and upgrade program	1,800,000	x		
	Provision of transitional shelter	820,000	x		
Health & education	Minor repair of flood damage to health centers	148,000	x		
	Recuperation of losses to health sector	649,000	x		
	Strengthening of coordination mechanisms within and outside the health sector	68,000		x	x
	Establishment of early warning and response system	76,000		x	x
	Carrying out of nutrition assessment of affected population	7,874		x	x
	Carrying out of evidence-based nutritional interventions to protect young children	27,000		x	x
	Minor repair of flood damage to schools	690,000	x		
	Reconstruction of schools	5,240,000			x
Flood risk management	Flood risk management and urban resilience	1,000,000	x		
Total needs		56,029,874	14,585,000	41,444,874	



The flooding has irreparably damaged or completely destroyed 243 houses in Honiara, and around 432 houses in Guadalcanal Province.

Annex 1: List of People Consulted

Ishmael Alulu, Ministry of Infrastructure Development

Ronald Amigo, Deputy City Clerk, Honiara City Council

Kent Asagolomo, Guadalcanal Province

Hearly Atupule, Deputy Director Livestock, Technical Services, Ministry of Agriculture and Livestock Development

Audrey Aumua, World Health Organization

Simon Baete, Deputy Director Livestock, Research and Information, Ministry of Agriculture and Livestock Development

Jay Bartlett, Hatanga

Dr. Chris Becha, Ministry of Health and Medical Services

Roger Benzie, New Britain Palm Oil, Guadalcanal Plains

Kerryn Bouyer, NPH

Lance Cash, Media Relations Adviser, Honiara City Council

Samantha Chapman, World Health Organization

Lucinda Coates, Risk Frontiers, Macquarie University

Frank Daukalia, Solomon Water

Dr. Joel Denty, Guadalcanal Province

Nick Dutta, World Health Organization

Brian Halisanau, Ministry of Civil Aviation

Tim Harris, Acting Director, Solomon Islands Maritime Safety Administration

Leon Hickie, Provincial Fisheries Division, Ministry of Fisheries and Marine Resources

Michael Ho'ota, Director Agriculture Extension, Ministry of Agriculture and Livestock Development

John Hughes, Transport Policy and Coordination Adviser, Ministry of Infrastructure Development

Ridha Jebeniani, World Health Organization

Salvador Jiao, Project Manager, Rapid Employment Project

Don Johnston, International Federation of Red Cross

Moses Karuni, Honiara City Council

Charles Kelly, City Clerk, Honiara City Council

Luke Kiddle, Senior Development Officer, New Zealand High Commission

Douglas Kimie, Government Statistician, Ministry of Finance and Treasury

Mathew Korinihona, Solomon Islands Electricity Authority

Gus Kraus, Operation Manager, Solomon Airlines

Louisa Laekeni, National Archives Solomon Islands

Naoko Laka, Japan International Cooperation Agency

Peter Lawther, International Federation of Red Cross

Isaac Lekelalu, Division of Water Resources, Ministry of Mines, Energy and Rural Electrification

Nicholas Leleu, Ministry of Civil Aviation

Francis Lomo, Permanent Secretary, Ministry of Civil Aviation

Max Lua, Guadalcanal Provincial Government

Eric Lui, First Secretary, Development, Australian High Commission

Esmu Magu, Ministry of Health and Medical Services

Simon McGree, Australian Bureau of Meteorology

Scott McNamara, First Secretary, Economic Infrastructure, Australian High Commission

Sarah Mecartney, UN-Habitat

Charles Meke, Crisis Response Intervention Support Program

John Norton, Norton Consulting

Jimmy Nuake, Under Secretary, Ministry of Infrastructure Development

Divi Ogaoga, Ministry of Health and Medical Services

Moses Pelomo, Chairperson, Kastom Garden Association

Hamptan Pitu, Crisis Response Intervention Support Program

Alex Rilifia, Solomon Islands Meteorological Service

Harry Rini, Director, Central Project Implementing Unit, Ministry of Infrastructure Development

Carol Robertson, Risk Frontiers, Macquarie University

Emma Rooke, Chief Veterinary Officer, Ministry of Agriculture and Livestock Development

Jimmy Saelea, Permanent Secretary, Ministry of Agriculture and Livestock Development

Matt Shortus, World Health Organization

Adrian Simbe, Honiara City Council

David Spring, Team Leader, Transport Sector Development Project, Ministry of Infrastructure Development

Peter Spring, SKM

Francis Tofuakalo, Director, Provincial Fisheries Division, Ministry of Fisheries and Marine Resources

Lily Wane, Women in Agriculture, Department Agriculture Extension, Ministry of Agriculture and Livestock Development

Peter Weston, World Vision International

Michael Wyatt, Ministry of Health and Medical Services

Loti Yates, National Disaster Management Office



Traffic chaos following loss of bridges. Photo: Solomon Star

Annex 2: Estimation of Damage to Transport Infrastructure

Type of Damage	Location	Emergency Repairs (US\$)	Restoration Cost, Medium-Term (US\$)	Estimated Cost of Building Back Better (US\$)	Estimated Short-Term Cost (US\$)	Estimated Medium- to Long-Term Cost (US\$)
Rural roads		49,259.80	228,564.39	-	49,259.80	-
Unpaved roads						
	Total network					
	Landslide	4,450.77	68,473.45		4,450.77	-
	Shoulder erosion		58,750.22		-	-
	Savaui Village					
	Verahue	4,450.77	68,473.45		4,450.77	-
	Verahue Village (central east)	7,121.24			7,121.24	-
	Verahue Village (central west)	21,363.72			21,363.72	-
	Verahue Village (Western End)	6,231.08			6,231.08	-
	Nuhu River	9,791.70			9,791.70	-
	Damaged roads					
	Lambi School (Western End)		19,583.41		-	-
	Lambi School (Eastern End)		17,803.10		-	-
	North Malaita		53,409.29		-	-
	Haevo Road	301.28	10,544.91		301.28	-
Urban roads		1,827,830.35	521,973.13	-	1,827,830.35	-
	Highway adjacent to Henderson airport	80,113.94			80,113.94	-
East Guadalcanal						
	Damaged roads					
	1km after Metabona Bridge	26,704.65	3,560.62		26,704.65	-
	Vara Creek road to Tuvaruhu Road	256,090.71			256,090.71	-
	Lio Creek (Panatina) Road	9,038.50	53,409.29		9,038.50	-
	East Honiara Highway — Lawson Tama to KGIV	106,202.33			106,202.33	-
	Damaged roads					
	St. Martyn's Road	167,212.17			167,212.17	-
	Damaged roads					
	Tuvaruhu Road	406,732.31			406,732.31	-
	Damaged roads					
	Kola Ridge Road (Honiara Highway to Tanuli Road)	301.28	11,298.12		301.28	-
Honiara						
	Damaged roads					
	Zion Road	35,400.78			35,400.78	-
	Damaged roads					
	Langakiki-Mbokona Loop		256,090.71		-	-
	Damaged roads					
	Tasahe B Road	632,694.70			632,694.70	-
	Damaged roads					
	Rifle Range Road	11,448.76			11,448.76	-
	Damaged roads					
	Skyline-Mbokonavera Road		195,834.08		-	-
	Damaged roads					
	Independence Valley	71,856.04			71,856.04	-
	Damaged roads					
	Turtle Beach Culvert 2	24,034.18			24,034.18	-
West Guadalcanal						
	Fallen trees		1,780.31		-	-

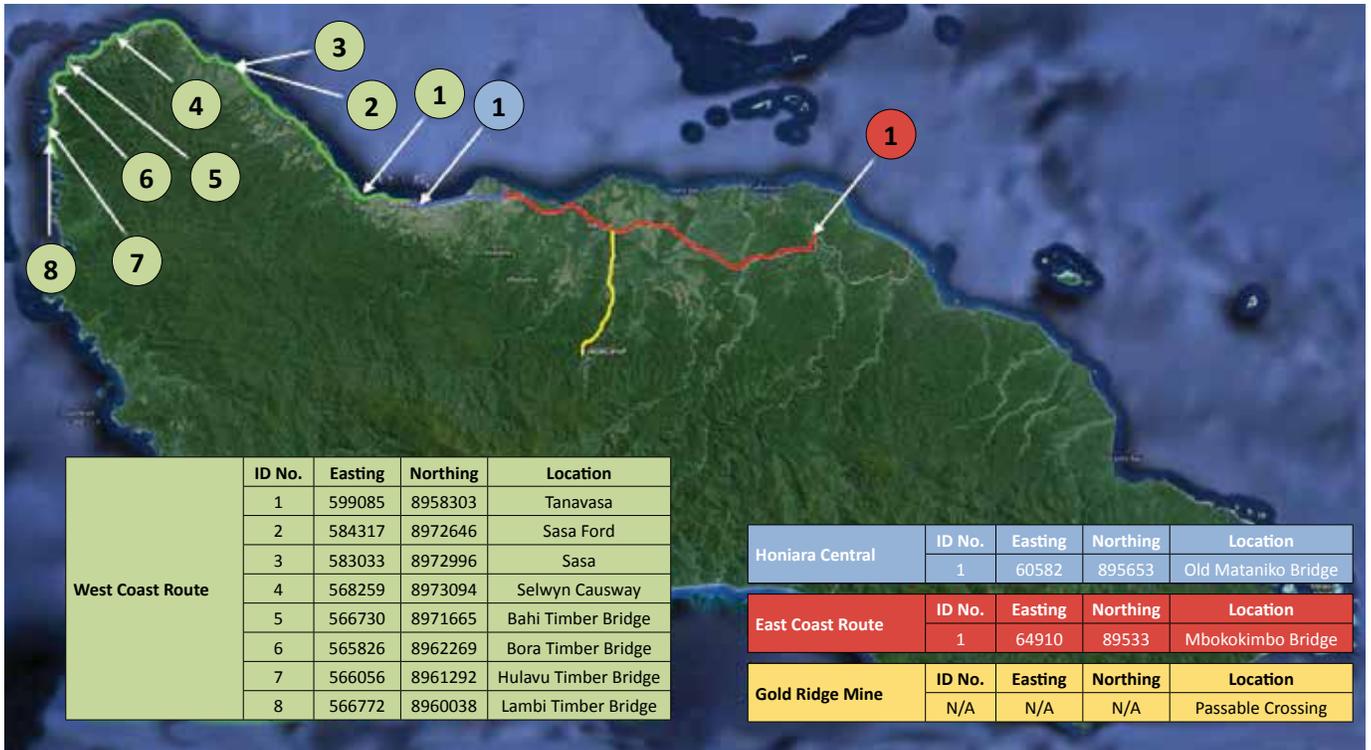
	Type of Damage	Location	Emergency Repairs (US\$)	Restoration Cost, Medium-Term (US\$)	Estimated Cost of Building Back Better (US\$)	Estimated Short-Term Cost (US\$)	Estimated Medium- to Long-Term Cost (US\$)
Bridges	West approach washed away	Mbalasuna Bridge	2,360,197.75	2,654,387.09	23,887,610.93	2,360,197.75	23,887,610.93
	2 upstream piers damaged	Mberande Bridge	20,542.04	249,243.37	2,054,203.59	20,542.04	2,054,203.59
	Debris	Ngalanimbui Bridge	1,780.31	267,046.47	2,054,203.59	1,780.31	2,054,203.59
	Debris	Youza Bridge (Mberande bridge)	4,450.77			4,450.77	-
	Damage to western abutment	Kovelau Bridge	2,738.94	34,236.73	136,946.91	2,738.94	-
	Damaged bridge	Mbokikimbo Bridge	4,450.77		6,847,345.28	4,450.77	6,847,345.28
	Scouring to embankment of western abutment	Gold Ridge Bridge	68,473.45		205,420.36	68,473.45	205,420.36
	Eastern abutment washed out	Lungga Bridge	512,181.43			512,181.43	-
	Bridge washed away, removal of sunk bridge	New Mataniko Bridge	602,566.39		5,287,500.00	602,566.39	5,287,500.00
	Debris removal	Old Mataniko Bridge	684,734.53	30,128.32	4,700,000.00	684,734.53	4,700,000.00
	Approach slabs collapsed	White River bailey Bridge	150.64			150.64	-
	Collapsed gabion on eastern abutment	Tomba Bridge	227,879.65	35,606.20	205,420.36	227,879.65	205,420.36
	Bridge approaches washed away	Poha Bridge		356,061.95			-
Bridge approaches washed away	Tanavasa	72,992.70	356,061.95		72,992.70	-	
Edge slip on approach slab	Sasa—low-level bridge	35,606.20	121,061.06	410,840.72	35,606.20	410,840.72	
Gabions washed away	Tanemba Causeway approach		3,026.53			-	
Erosion of the western abutment	Tanemba Causeway		27,594.80			-	
Eroded batter slopes	Tanemba (Kohi Bridge)		32,935.73			-	
Western abutment and approach slab collapsed	Veravahu ford		15,132.63			-	
Western abutment eroded	Selwyn Causeway		534,092.93		35,606.20	-	
1 span washed away	Bahi Timber Bridge		29,375.11	301,283.19	29,375.11	301,283.19	
Erosion to western approach	Bora Timber Bridge		35,606.20	493,008.86	35,606.20	493,008.86	
Western abutment washed away (partial)	Hulavu Timber bridge		5,340.93	369,756.65	5,340.93	369,756.65	
Scouring to eastern abutment	Lambi Timber Bridge		6,231.08	273,893.81	6,231.08	273,893.81	
	Mbonege Bridge		26,704.65			-	

West Guadalcanal

Bridges (cont.)		Type of Damage	Location	Emergency Repairs (US\$)	Restoration Cost, Medium-Term (US\$)	Estimated Cost of Building Back Better (US\$)	Estimated Short-Term Cost (US\$)	Estimated Medium- to Long-Term Cost (US\$)
West Guadalcanal	Collapsed gabion on western abutment	Belamatanga Bridge		213,637.17			-	-
	Debris	Tamboko Bridge		5,340.93			-	-
	Eastern approach slab collapsed	Waihauru causeway		1,958.34	105,449.12	547,787.62	1,958.34	547,787.62
	Collapsed log bridge	Buala-Garanga		7,532.08	241,026.55		7,532.08	-
Culverts and other road drainage works				203,503.10	638,788.84	876,460.20	203,503.10	876,460.20
	Clogged culvert	Ngalirauga—cross drainage		9,942.35			9,942.35	-
	Scoured culvert	Tasahe Drive intersection			210,898.23		-	-
	Insufficient culvert	Highway in Rove area (St. John's School)		10,544.91	158,173.68		10,544.91	-
	Damaged culvert	CBSI culvert		3,204.56			3,204.56	-
	Collapsed gabion wall	Mbonege Box culvert		12,462.17	8,901.55		12,462.17	-
	Scoured culvert	Turtle Beach culvert 1		14,242.48	53,409.29	205,420.36	14,242.48	205,420.36
	Buried culvert	Tabea Market culvert			14,242.48		-	-
	Insufficient culvert	Kakabona culvert		53,409.29			53,409.29	-
	Bridge approaches washed away	Arulugo 6 cell culvert (Sasa ford)		67,651.77	106,818.59	205,420.36	67,651.77	205,420.36
West Guadalcanal	Culvert washed away	Lambi (Aloha Village)		23,144.03		123,252.22	23,144.03	123,252.22
	Downstream washed away	Tanaghai Arc culvert			51,628.98	273,893.81	-	273,893.81
	Insufficient culvert	Tanaghai School culvert			10,681.86		-	-
	Insufficient culvert	Tanaghai reinforced concrete box culvert			10,681.86		-	-
	Outlet scoured	Mbonege pipe culvert-1		8,901.55			8,901.55	-
	Damaged culvert	Belamatanga culvert 1			1,068.19		-	-
	Damaged culvert	Belamatanga culvert 2			356.06		-	-
	Scoured outlet	Tamboko reinforced concrete box			4,450.77		-	-
	Scoured wing wall	Ngatu 8 cell culvert			7,121.24		-	-
	Damaged culvert	Aroligo culvert			356.06	68,473.45	-	68,473.45

	Type of Damage	Location	Emergency Repairs (US\$)	Restoration Cost, Medium-Term (US\$)	Estimated Cost of Building Back Better (US\$)	Estimated Short-Term Cost (US\$)	Estimated Medium- to Long-Term Cost (US\$)
Airport							
	Perimeter fence (500 metres)	Henderson Airport	639,164.04	753,207.98	–	1,392,372.02	–
	Drainage culvert outlet runway	Henderson Airport	205,420.36			205,420.36	–
	Domestic terminal and offices	Henderson Airport	89,015.49			89,015.49	–
		Henderson Airport	22,218.23			22,218.23	–
	Runway markings	Henderson Airport	205,420.36			205,420.36	–
	Runway lighting system	Henderson Airport	117,089.60			117,089.60	–
	Perimeter road reconstruction	Henderson Airport		191,725.67		191,725.67	–
	Back road reconstruction	Henderson Airport		314,977.88		314,977.88	–
	Outer drainage reconstruction	Henderson Airport		109,557.52		109,557.52	–
	Domestic car park reconstruction	Henderson Airport		136,946.91		136,946.91	–
Maritime	None						
TOTAL			\$5,079,955.04	\$4,796,921.43	\$24,764,071.12	\$5,833,163.02	\$24,764,071.12

Annex 3: Location of Cuts to Road Access



Annex 4: List of Build Back Better Structures in Transport Sector

Location	Existing Structure and State of Damage	Preliminary Assessed Option	Preliminary Cost Estimate (US\$ million)
Mbalasuna Bridge, East Guadalcanal	Low-level bridge; road cut off due to debris accumulation; approaches washed away	High-level bridge including climate proofing	2.10
Mberande Bridge, East Guadalcanal	Low-level bridge; 2 piers damaged; road cut off due to debris accumulation and washed away structures	High-level bridge including climate proofing	2.10
Mbokokimbo Bridge, East Guadalcanal	Existing engineered ford damaged	High-level bridge	7.00
Gold Ridge Bridge East Guadalcanal		Upgrade	0.21
New Mataniko Bridge, Honiara		Upstream 2-lane bridge (financed by JICA)	5.30
Old Mataniko Bridge, Honiara	Bailey bridge washed away; new Bailey bridge was completed in June 2014	New bridge (financed by JICA)	4.70
Tomba Bridge, West Guadalcanal		Climate proofing and river training	0.21
Sasa Bridge	Low-level bridge	Climate proofing and river training	0.42
Bahi Timber Bridge, West Guadalcanal	Timber bridge	Low-level bridge	0.31
Bora Timber Bridge, West Guadalcanal	Timber bridge	Low-level bridge	0.50
Hulavu Timber bridge, West Guadalcanal	Timber bridge	Low-level bridge	0.38
Lambi Timber Bridge, West Guadalcanal	Timber bridge	Low-level bridge	0.28
Waihauru, Makira	Causeway	Low-level bridge	0.56
Turtle Beach culvert	Culvert	Single-span bridge	0.21
Aruligo (Sasa Ford)	6-cell culvert	Climate proofing and river training	0.21
Lambi (Aloha Village)	Culvert	Single-span bridge	0.13
Tanaghai Arch culvert	Culvert	Single-span bridge	0.28
Total			24.90

Note: JICA = Japan International Cooperation Agency.

Annex 5: Seasonal Crop Calendar, Guadalcanal Province

Crops	Planting to Harvest Season (months)											
	J	F	M	A	M	J	J	A	S	O	N	D
	Wet season					Dry season				Wet season		
Cocoa				High yield	High yield	High yield	High yield					
Coconut (copra)	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round
Palm oil	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round
Taro		Planting	Planting						High yield	High yield		
Cassava	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round
Yam	Planting	Planting	Planting	High yield	High yield	High yield						
Sweet potato	Planting				Low yield	Planting						High yield
Pineapple	Planting	Planting						High yield				
Pawpaw	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round
Banana	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round
Leafy vegetables	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round	Year round
Slippery cabbage			Planting						High yield	High yield	High yield	High yield
Pana	High yield	High yield	High yield	Year round	Planting	Year round						

Planting	= planting
Low yield	= low yield
High yield	= high yield
Year round	= year round

Annex 6: Damage and Loss to Health Facilities (US\$)

Facilities	Damage	Loss	Total
Large damage			99,971
Pikinini	27,389	27,389	
White River	31,498	13,695	
Smaller damage		-	20,541
Mataniko	6,847		
New Tenabuti	13,694		
Nurse aid posts			27,388
Selwyn	6,847	6,847	
Tinaghulu	6,847	6,847	
Total	US\$ 93,122	US\$ 54,778	US \$147,900

Annex 7: List of Schools with Reported Damage

Ruavatu Provincial Secondary School (PSS)

Kaotave Community High School (CHS)

Ngalibiu Primary

Kelyn Primary

White River CHS

Tuvaruhu CHS

Lunga CHS

Tumurora Primary

Mbalasuna Primary

St Joseph's Tenaru National Secondary School (NSS)

Burns Creek CHS

Mbokonavera CHS

King George VI NSS

Sali Primary School

Honiara High PSS

Turarana CHS

Naha CHS

Coronation CHS

Koloale CHS

Mbokona CHS

Bishop Epalle CHS

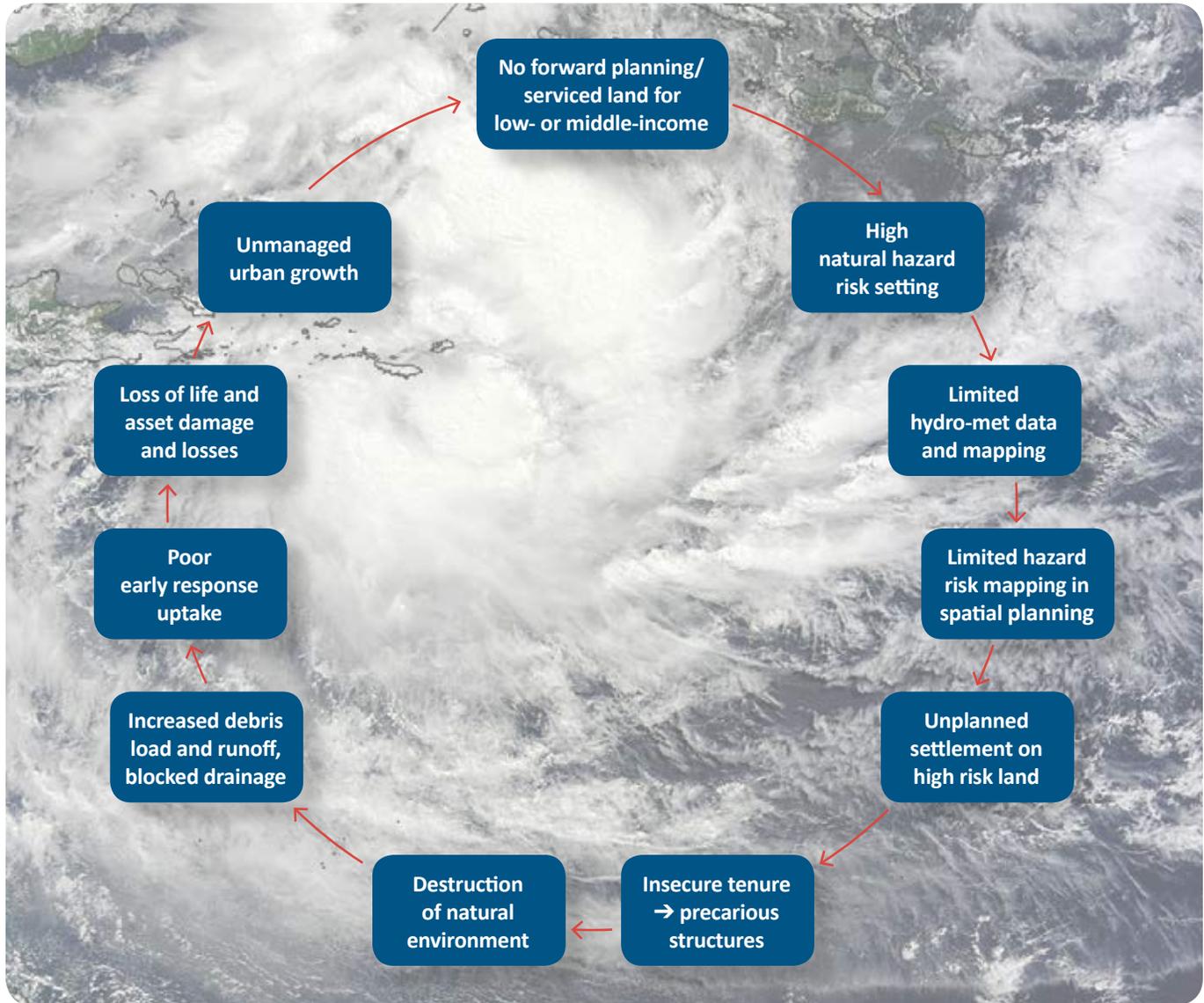
Mbua Valley CHS

Komukama

Pitukoli

Ghaobata CHS

Annex 8: Cycle of Increasing Risk



Source: Stephen Yeo.

Annex 9: Benchmarking Current Flood Risk Management Practice

A forensic examination of the recent disaster suggests steps for reducing the risk of loss of life (and other impacts) in future flooding events, but a broader review of flood risk management practice in the Solomon Islands is also valuable. This review adapts some of the measures used by Babister and Retallick (2013) to assess current practice against best practice.

Hazard assessment (mapping)

Mapping of floods and floodplains is foundational for understanding and managing flood risk. To date, mapping in the Solomon Islands has been confined to historical flood extents and/or to geomorphic assessments. Notable is the work of Trustrum, Whitehouse, and Blaschke (1989), which mapped the extent of flooding associated with Tropical Cyclone Namu in 1986 as far west as the Lungga floodplain, but did not extend to Honiara.

A challenge for developing the more sophisticated mapping products derived from hydrologic and hydraulic models is the fragmented and poor nature of hydrological records in the Solomon Islands (SPC 2012, 122–38).

Risk assessment

A risk assessment considering both the likelihood and consequences of flooding is essential for quantifying flood risk and comparing the merits of alternative flood risk management options. No evidence for this approach has been uncovered in the Solomon Islands.

Floodplain management measures

Flooding problems in the Solomon Islands appear to have been managed largely on an ad hoc and informal basis. Some villages have relocated after floods, such as Sasa in northwestern Guadalcanal after the 2009 disaster (Lal and Thurairajah 2011). Many houses are raised well above the ground, and while this design

may reflect traditional building styles, there is little doubt that many floors have been deliberately raised in flood-prone locations. Over recent years, development partners have supported the installation of community-based early warning systems (see below). However, a considered, integrated application of the full suite of flood risk management measures—both structural and nonstructural—over the full range of flood risk has yet to find expression in the Solomon Islands.

Integrating hazard knowledge into spatial plans

Land-use planning is one component of best-practice floodplain risk management, particularly to contain future flood risk. Used in association with appropriate incentives such as property taxes (rates), long-term infrastructure investments, and siting of commercial, health, and education facilities, it is a useful tool for guiding future urban growth away from flood-prone areas. But in Honiara, flood risk constraints seem to have been given little consideration in urban planning, and efforts to curb the growth of informal settlements on highly flood-prone land, and to make serviced land available for sale or lease to homeowners of all income groups, have been inadequate or ineffective.

Warning/education

The Solomon Islands Meteorological Service issues heavy rain alerts and warnings, and the National Disaster Management Office adds information, broadcast via the Solomon Islands Broadcasting Corporation and FM radio stations, about what residents should do in response. During the April 2014 flood, the director of NDMO was on the air encouraging people to evacuate during the day. It is understood that these broadcasts had been undergirded by various flood education messages, such as “Flooding: Find out about the worst flood in your area—would it reach your home?” and “Risky or not? You make up your mind.”

In recent years there has been significant investment in community-based early warning systems in rural Guadalcanal, including at Tamboko Village. Three out of four of these systems are said to have been operational and effective in the April 2014 flood.

Strategic management

Flood risk management initiatives in the Solomon Islands have typically been reactive, taking place in response to

damaging flooding rather than in advance of it. A UN-Habitat (2012) report identified the acute vulnerability of the Koa Hill community—even including it on a map—but evidently no substantive measures were introduced to reduce its exposure to flash flooding prior to the April 2014 disaster. Only now, after the flood, does there seem to be a determination to address the risk.



Cleanup near mouth of the Mataniko River. Photo: Solomon Star

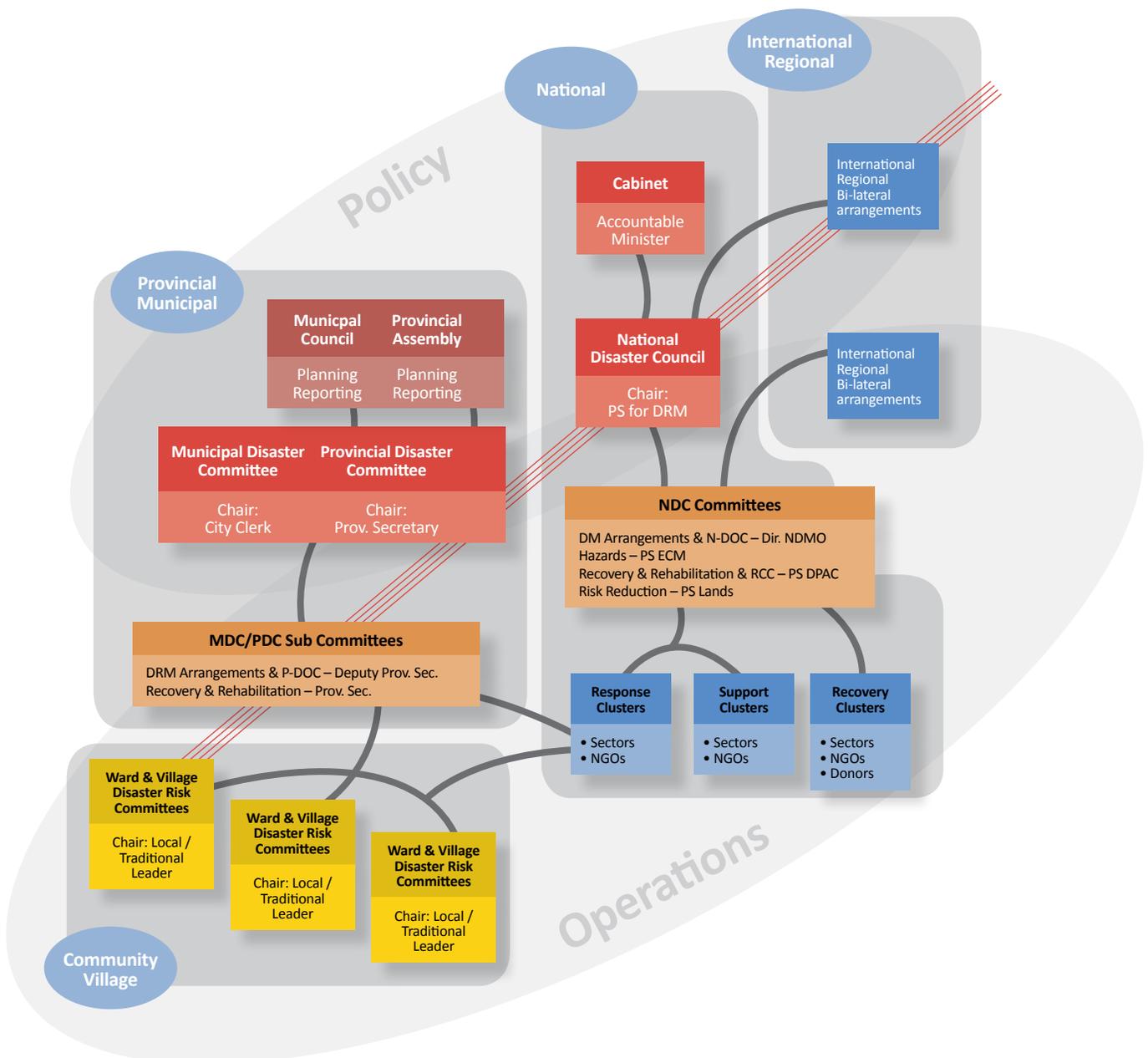
Annex 10: Institutional Aspects

General arrangements

The National Disaster Risk Management Plan of the Solomon Islands government (2009) specifies institutional arrangements for disaster risk management

(DRM) throughout the country (see figure 17). It includes arrangements for preparing for, managing, and recovering from disaster events and establishes institutional mechanisms for addressing disaster risk reduction, including climate change adaptation.

Figure 17: Disaster Risk Management Organizational Arrangements



The National Disaster Council is the strategic decision-making body for mobilizing resources, setting priorities, and advising the cabinet during a disaster. It is also responsible for the overview of disaster events and the management of international, regional, and bilateral support arrangements for DRM through the National Disaster Coordinating Committee's cluster groups. The Recovery and Rehabilitation Committee of the Council is chaired by the permanent secretary of MDPAC, the Risk Reduction Committee is chaired by the permanent secretary of MLHS, and the Hazard Committee is chaired by the permanent secretary of Ministry of Environment Climate Change, Disaster Management and Meteorology (MECDM). The National Disaster Council ideally would task the three committees with forming a working group to provide direction and oversight to any build back better/BSURE strategy.⁵

The National Disaster Management Office functions as the Secretariat of the National Disaster Council and is responsible for coordinating, developing, and implementing DRM. Provincial/municipal governments—including Honiara City Council—are required to establish provincial disaster committees (PDCs) or municipal disaster committees (MDCs), and must also make ward-level and local-level arrangements for disaster management and risk reduction. PDCs/MDCs are responsible to their executive for arrangements and planning for DRM, consistent with the national plan. They are also responsible to the council for managing and coordinating the response to disaster events within their jurisdiction.

Each PDC/MDC is supposed to prepare its own DRM plan. Honiara City Council prepared a DRM plan in 2013. During the April 2014 floods, the council was

able to quickly make schools available as short-term evacuation centers, raise food relief from the business community, and clear debris in some areas.⁶ Learning from its emergency response procedures, the Honiara City Council has made a number of changes to its plan and to DRM organizational arrangements in order to improve communications between key departments.

Village disaster risk committees are to be established at the village and associated settlement level or where appropriate. Villages, families, and individuals within a village disaster risk committee are to provide for a local disaster planning network, including local arrangements for early warning, management of disaster response, and handling of hazard and risk reduction issues (including climate change).

Flood risk management

Part 1, section 18 of the National Disaster Risk Management Plan refers to the need for hazard-specific contingency plans. It is understood that these, along with standard operating procedures for the National Disaster Council and its committees, have yet to be prepared. Table 32 presents a preliminary assessment of the key players involved (whether intentionally or unknowingly) in flood risk management in Honiara. Early discussions indicate there may be a need for greater coordination between the Physical Planning Division of MLHS and Honiara City Council so as to avoid duplication, as well as between the Meteorological Division of MECDM and the Hydrology Unit of the Ministry of Mines, Energy and Rural Electrification so as to ensure delivery of an integrated hydrometeorological warning service.

⁵ The working group would include representatives from Guadalcanal Provincial Council, Honiara City Council, Malaita Provincial Council, and Western Provincial Council.

⁶ The Honiara City Council has prohibited the disposal of construction and demolition waste in the registered landfill site. The safe disposal of such waste is not currently catered for.

Table 32: Key Government Organizations Involved in Flood Risk Management in Honiara

	Modify the Hazard	Modify Exposure and Vulnerability	Modify Short-Term Responses
Ministry of Infrastructure Development	Road drainage, bridge design		
Ministry of Forests	Watershed management		
Ministry of Agriculture and Livestock	Watershed management		
Ministry of Development Planning and Aid Coordination		National planning	
Commissioner of Lands, Ministry of Lands, Housing and Survey		Land approvals	
Honiara Town and Country Planning Board		Planning approvals	
Honiara City Council	Waste removal	Building approvals	
Ministry of Environment, Climate Change, Disaster Management and Meteorology			Weather warnings, community education
Division of Water Resources, Ministry of Mines, Energy and Rural Electrification			River level monitoring



Village disaster risk committees are to be established at the village and associated settlement level or where appropriate. Villages, families, and individuals within a village disaster risk committee are to provide for a local disaster planning network, including local arrangements for early warning, management of disaster response, and handling of hazard and risk reduction issues (including climate change).

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Silt deposits and flood mark inside St. John the Baptist Church, Koa Hill. Photo: Stephen Yeo



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