PCRAFI

Pacific Catastrophe Risk Assessment & Financing Initiative

Annex 04:

Event Briefing Tropical Cyclone Pam

APRIL 14, 2015 // **COUNTRIES AFFECTED: VANUATU**

SPC Secretariat of the Pacific Community

ADB

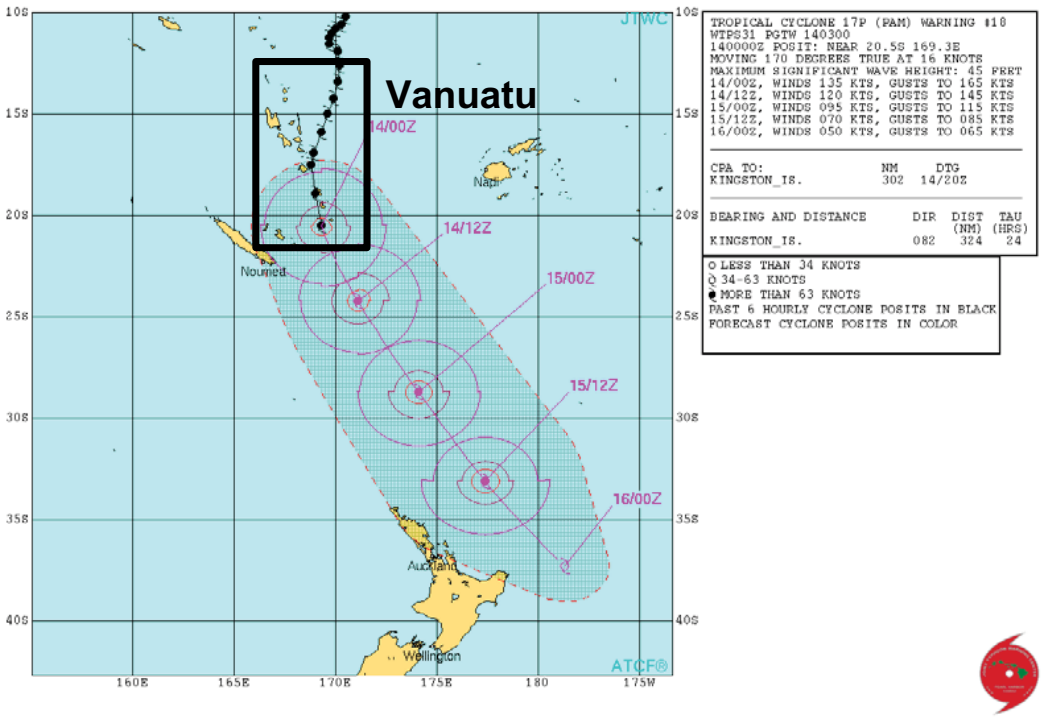
GFDRR Global Facility for Disaster Reduction and Recovery

WORLD BANK GROUP

Event Description

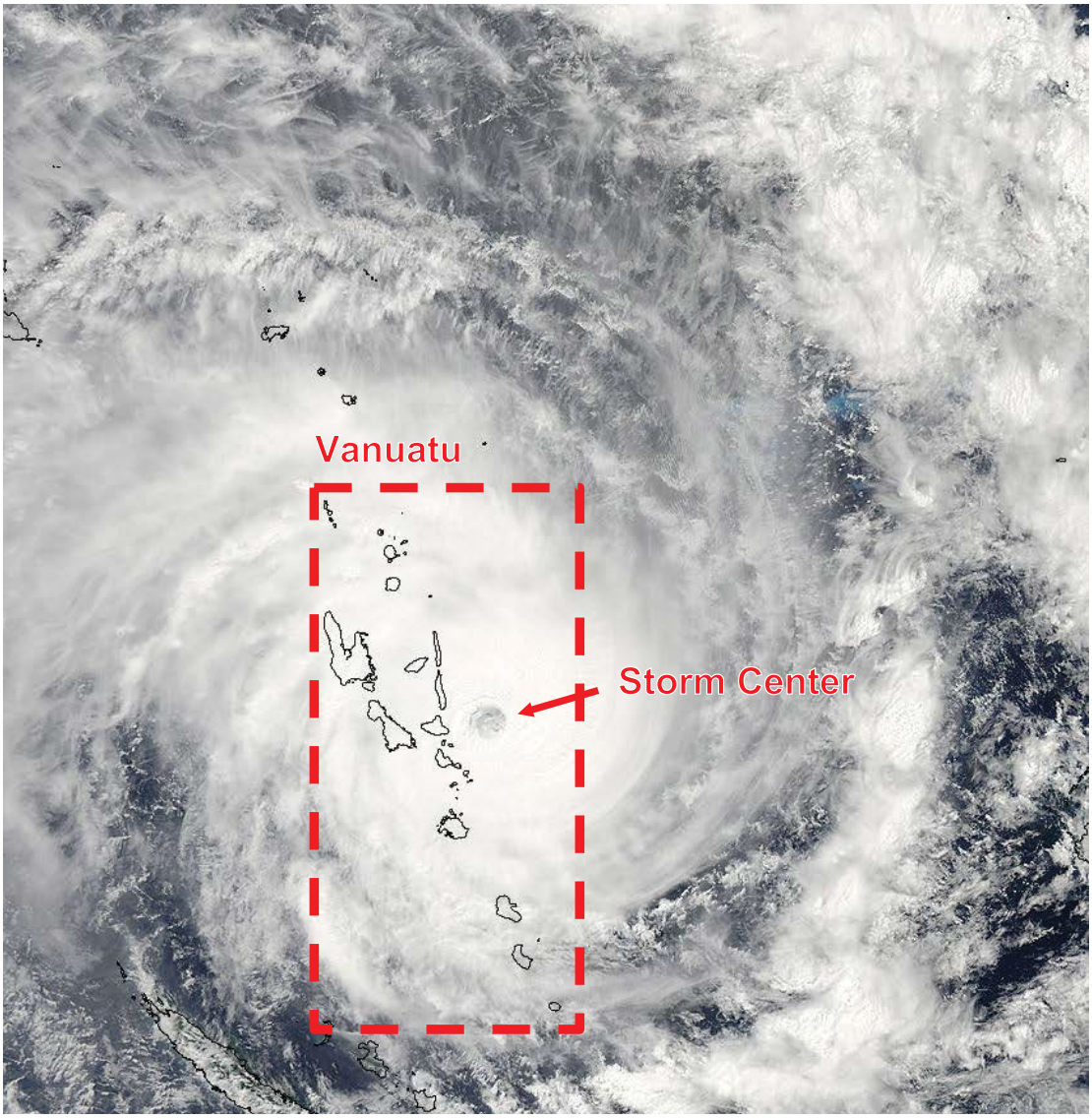
On March 6, 2015, the Fiji Meteorological Service's Regional Specialized Meteorological Centre in Nadi, Fiji (RSMC Nadi) reported that Tropical Disturbance 11F had developed about 1,140 km (710 mi) to the northwest of Nadi, Fiji. The system was located within an area of favorable environment for further development, which included low to moderate vertical wind shear and favorable sea surface temperatures. The disturbance slowly strengthened while foundering east of the Solomon Islands for two days before RSMC Nadi reported, on March 8, that the system had developed into a tropical depression. By the next day, the system further consolidated before the United States Joint Typhoon Warning Center (JTWC) initiated warnings and designated the depression as Tropical Cyclone 17P (Pam) later that day (see Figure 1 for an example warning advisory). Tropical Cyclone Pam continued south-southwest and rapidly intensified as it approached Vanuatu (see Figure 2 for a satellite image of Tropical Cyclone Pam on March 13 at 0220 UTC). On March 13 at 1200 UTC the storm reached its maximum intensity (with one minute maximum sustained surface winds of 145 knots) as the eye of the tropical cyclone passed by Vanuatu's capital approximately 45 km east of Port Vila. Based on the JTWC tropical cyclone warning advisories, the storm continued to track in the south-southeast direction, passing east of Efate and continuing in the southerly direction as its intensity weakened.

Figure 1– JTWC-Issued Warning Advisory for Tropical Cyclone Pam on 0000 UTC March 14, 2015



Source: JTWC

Figure 2– Satellite Image of Tropical Cyclone Pam on 0220 UTC March 13, 2015.



Source: NASA Goddard MODIS Rapid Response Team)

Post Event Loss Calculation Results

Under the Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI), a post event loss calculation (PELC) protocol has been developed, which determines modeled mean loss estimates for impacted countries based on the catastrophe loss models (earthquake, tsunami, and tropical cyclone) developed by AIR Worldwide Corporation (AIR) for 15 Pacific Island Countries (PICs1). These modeled mean loss estimates are currently used for the Pacific Catastrophe Risk Insurance Pilot Program for five countries (Samoa, Tonga, Marshall Islands, Vanuatu, and Cook Islands). This program aims to increase the financial resilience of PICs against natural disasters. The modeled loss calculation was conducted by AIR.

Under this protocol2, for a tropical cyclone event, country-wide modeled ground-up mean losses (defined as the estimated cost to repair or replace damaged assets, including residential, commercial, industrial, and public buildings, major cash crops, and major infrastructure) caused by tropical cyclone induced wind, flood from storm surge, and flood from tropical cyclone induced precipitation are calculated. In addition, estimates of emergency loss that national governments may sustain as a result of providing necessary relief and undertaking recovery efforts are calculated as a fraction (23percent) of the ground-up mean loss estimates. Tropical cyclone parameters are obtained from JTWC-issued tropical cyclone warning data archived by the Automated Tropical Cyclone Forecasting (ATCFTM) System (see Appendix C for track parameters).

Based on a strict application of the PELC protocol, the modeled ground-up mean loss for Vanuatu is calculated to be US$183.5 million with an associated modeled emergency loss of US$42.2 million (see Table 1).

It must be emphasized that these estimated mean losses are only one view of the potential loss as the losses are generated using a single representation of the storm track and intensity based on the JTWC parameters as required by the PELC protocol. These losses represent averages which have uncertainty associated with them. The uncertainty (or range) around the mean value can be significant due to multiple sources of uncertainty, such as observation uncertainty (in track location and reported wind speed) and uncertainty around damage functions used to derive the modeled mean value, among other sources of uncertainty in the calculations.

Additionally, it should be noted that the reported modeled mean loss values can differ from reported government estimates. This is due to many factors including those discussed above as well as differing definitions, methodologies, and sectors covered in the assessments and vice-versa (see Figure 7 for breakdown of modeled losses by sector). Thus, any comparison between modeled mean loss estimates and reported government estimates should be done with caution and with a full understanding of the limitations on both sets of loss estimates. It should also be noted that any payout resulting from the Pacific Catastrophe Risk Assessment and Financing Initiative is based on the results of the PELC, not the government assessments.

Table 1– Modeled Mean Losses from Post Event Loss Calculation (PELC)[3]

Country	Modeled Ground-up Losses (USD million)	Modeled Emergency Losses (USD million)
Vanuatu	183.5	42.2

1 Cook Islands (CK), Federated States of Micronesia (FM), Fiji (FJ), Kiribati (KI), Republic of the Marshall Islands (MH), Nauru (NR), Niue (NU), Palau (PW), Papua New Guinea (PG), Samoa (WS), Solomon Islands (SB), Timor–Leste (TL), Tonga (TO), Tuvalu (TV), and Vanuatu (VU).

2 The Post Event Loss Calculation (PELC) Process specified in the Calculation Agency Agreement.

3 Note that these modeled loss estimates are based on JTWC-issued storm parameters obtained from the ATCF on March 15, 2015 at 1800 UTC (refer to Appendix C) from **http://www.nrlmry.navy.mil/atcf_web/docs/warnings/2015/**. Estimated losses shown are rounded.

Event Impacts

Of the 15 PICs, Vanuatu is the only PIC that exhibited significant modeled mean loss estimates and damage (e.g., see Figure 3 for the track of TC Pam relative to the PICs). Other PICs, namely Solomon Islands, Kiribati, and Tuvalu, reported impacts from this event, but these nations do not participate in the PCRAFI PELC process and thus do not have modeled loss estimates. As such, the impact of TC Pam on Vanuatu is discussed further in the next section.

Figure 3– Track Data for Tropical Cyclone Pam from JTWC Advisories Overlaid on the PIC Domain (Pilot Countries Labeled in Red)

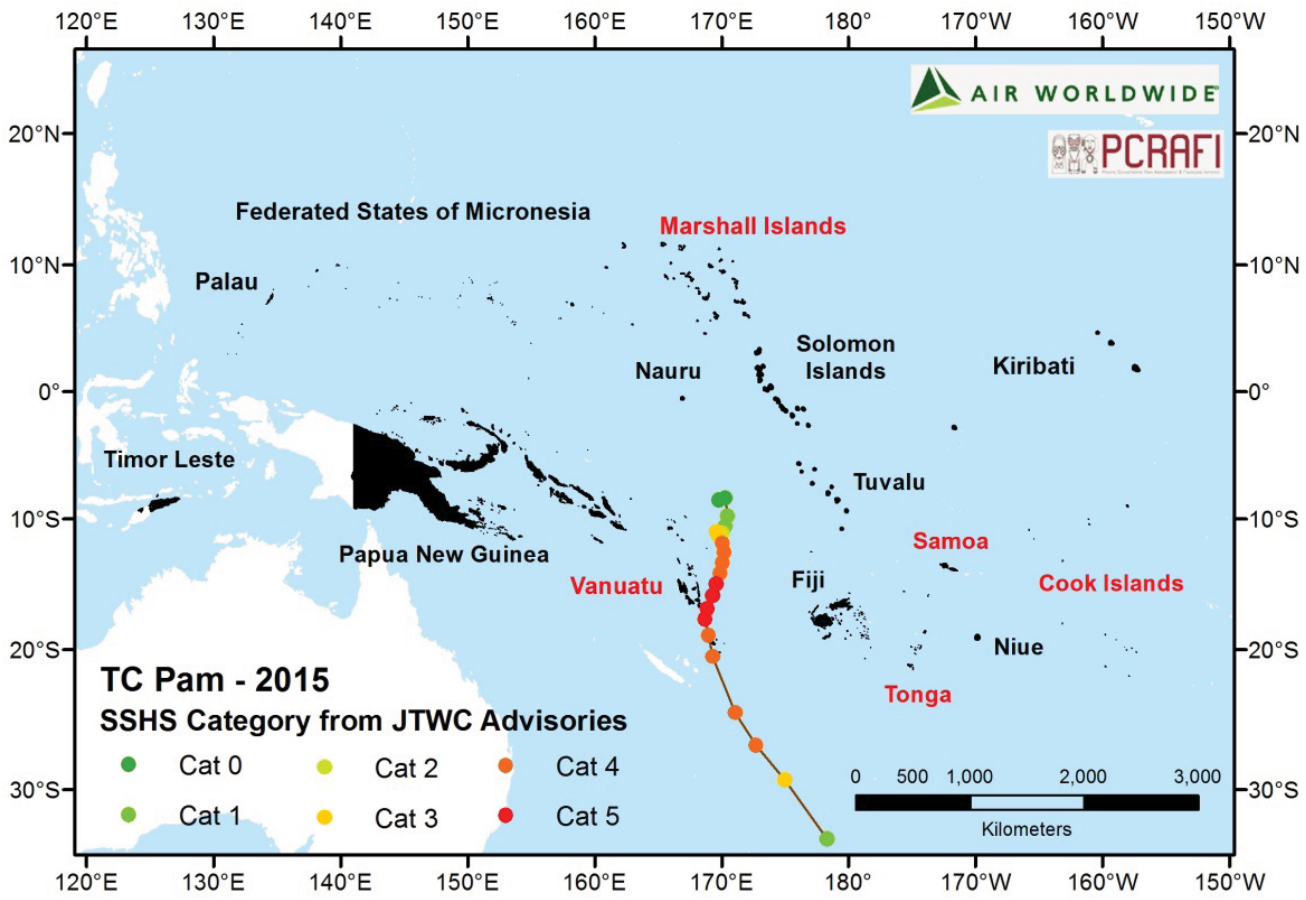


Figure 4– Homes destroyed by Tropical Cyclone Pam in Port Vila on March 16, 2015. (Photo: REUTERS/Dave Hunt/Pool)

Affected Countries: Vanuatu

On March 13, 2014, Tropical Cyclone Pam swept through the southern portion of Vanuatu's islands with reported maximum one-minute sustained wind speeds of 145 knots (equivalent to Category 5 strength on the Saffir-Simpson Hurricane Wind Scale), and tracked almost 15 km/hr in a south-southeast direction. At approximately 1200 UTC, the cyclone's western eyewall passed over the eastern side of Efate Island (population of approximately 66,000), which is home to the capital city of Port Vila. Port Vila is located on the southwest side of the island and was able to escape the strongest winds of the eyewall despite sustaining damage. Tropical Cyclone Pam continued in the southerly direction, passing just west of Erromango Island and Tanna Island by 1800 UTC March 13, with maximum one-minute sustained wind speed of 135 knots (equivalent to Category 4 strength on the Saffir-Simpson Hurricane Wind Scale). Note that the above information is based on reported parameters obtained from tropical cyclone warning advisories issued by the JTWC, which is a requirement of the PELC. Other agencies (e.g., Fiji Meteorological Service and Vanuatu Meteorological Service) may report different values for the parameters.

After the tropical cyclone passed Vanuatu, there were reports of damage (e.g., see Figure 4), and by March 25, there were 11 confirmed fatalities, 15,000 buildings damaged or destroyed, and an estimated 3,370 people in 48 evacuation centers. Reconnaissance flights by Australia and France found severe and widespread damage to the larger islands of Tanna, Erromango, and Efate, while less damage was assessed on the smaller islands of Aneityum, Aniwa, and Futuna in the southern region. Islands in Tafea Province and the outer islands of Shefa Province were deemed high priority areas for water, food, shelter, and health assistance. Root crops, which constitute approximately 80% of the local food source for the entire population, have been significantly damaged across all affected islands (Data collected primarily from OCHA Situation Report No. 3-11).

Countrywide, Vanuatu's building stock consists mainly of single story masonry/concrete buildings, traditional style dwellings (typically constructed of woven bamboo walls and thatch roofs), and single story timber frame homes. However, the distribution of construction types may vary between urban and rural communities across the islands (e.g. Port Vila has a higher percentage of masonry/concrete buildings and lower percentage of traditional-style dwellings when compared to the country-wide average). Overall, the PELC estimates that TC Pam resulted in a loss cost of 5.5% (which is defined as the total modeled damage normalized by the associated replacement value) for the entire country of Vanuatu. Table A (see Appendix A) summarizes the modeled assets for Vanuatu in the year 2010. Figure 5 illustrates the modeled physical exposure of Vanuatu (in terms of value) and how it differs across the islands. For example, Port Vila, Vanuatu's capital city, is highlighted as a concentration of exposure; however, there is also a large concentration center, Luganville, in the northern islands. Damaging effects from the storm (wind and flooding from precipitation and storm surge) are primarily concentrated in the southern part of the country, as these areas experienced the highest hazard intensities (see Appendix B for a modeled wind speed map and modeled accumulated precipitation map).

Figure 6 shows the modeled ground-up mean loss, by Area Council, resulting from TC Pam. It is estimated that Shefa Province sustained the highest value of ground-up mean losses, estimated to be US$98.9 million. Losses have been calculated using the PELC methodology outlined above. The highest level of modeled losses was attributable to residential buildings, which account for about 60% of the total modeled mean ground-up loss. This was followed by the classification of "Commercial, industrial, and other building" losses, which accounted for approximately 18% of the total modeled mean ground-up loss. The classification of "Public buildings and infrastructure" accounted for approximately 18% of the total mean ground-up losses. Crops constituted the smallest proportion of modeled losses at approximately 5% (see Figure 7).

While Tropical Cyclone Pam has caused substantial damage to Port Vila and the southern islands of Vanuatu, there are other plausible storm scenarios that have the potential to cause greater loss. Vanuatu's exposure value is dispersed throughout the island chain and is not exclusively concentrated in the capital of Port Vila. While 60% of the exposure value is located in the provinces of Shefa and Tafea, approximately 30% of the value is located in the provinces of Sanma and Malampa, where Pam is expected to have caused less damage. Figure 5 shows that Pam's track passes closely to the southern provinces of Shefa and Tafea, where most of the damage is being reported. The northern provinces – particularly Sanma and Malampa – are much further from the centerline of the track, and the maximum modeled wind speeds in these regions are much lower than those in the south (see Appendix B).

If Pam's path had significantly impacted the northern provinces of Sanma and Malampa or passed closer to the capital city of Port Vila, the damage and associated loss incurred by Vanuatu would have been much higher. It is possible for other tropical cyclones to have tracks that pass close enough to affect all the islands of Vanuatu, causing significant damage throughout the entire country.

The estimated return period of the tropical cyclone hazard at West Tanna, where tropical cyclone Pam imposed some of the highest wind speeds on populated areas, was greater than 500 years. However, the return period of the modeled loss is approximately 40 years and the wind speed hazard at Port Vila is approximately 50 years because the center of the storm remained offshore of the capital by approximately 45km. Should Pam's central path have passed closer to Port Vila, the damage and associated losses incurred would have been substantially greater than the modeled losses caused the by Pam's track, corresponding to a modelled loss return period of more than 150 years.

Figure 5– Modeled Physical Exposure of Vanuatu. Track Data for Tropical Cyclone Pam taken from JTWC Advisories

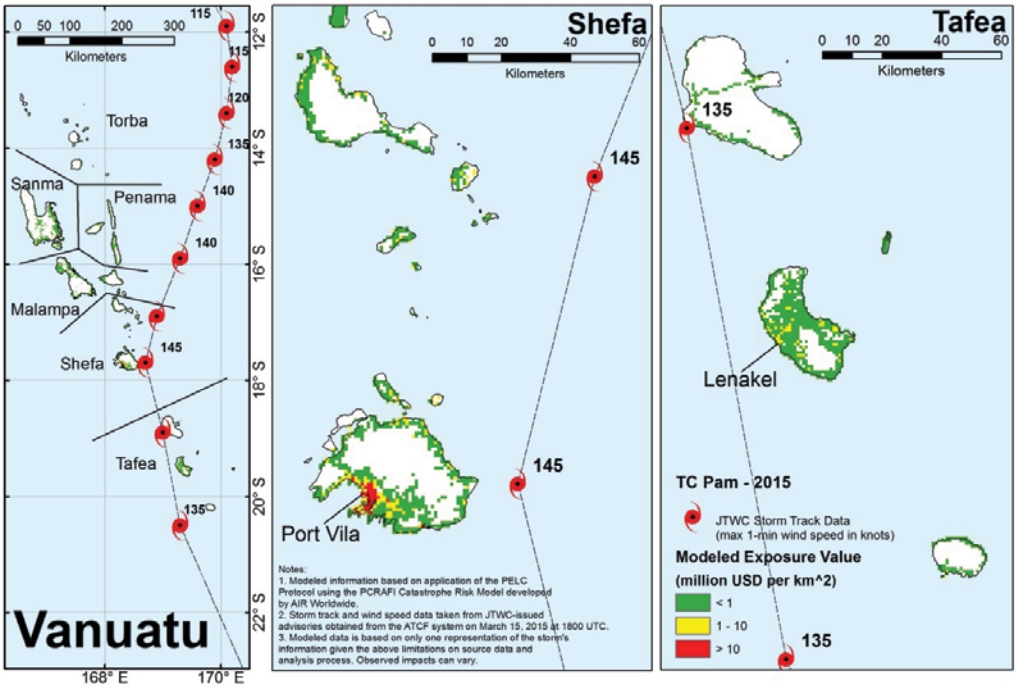


Figure 7– Breakdown of Total Modeled Ground-up Mean Loss by Sector for Tropical Cyclone Pam in Vanuatu

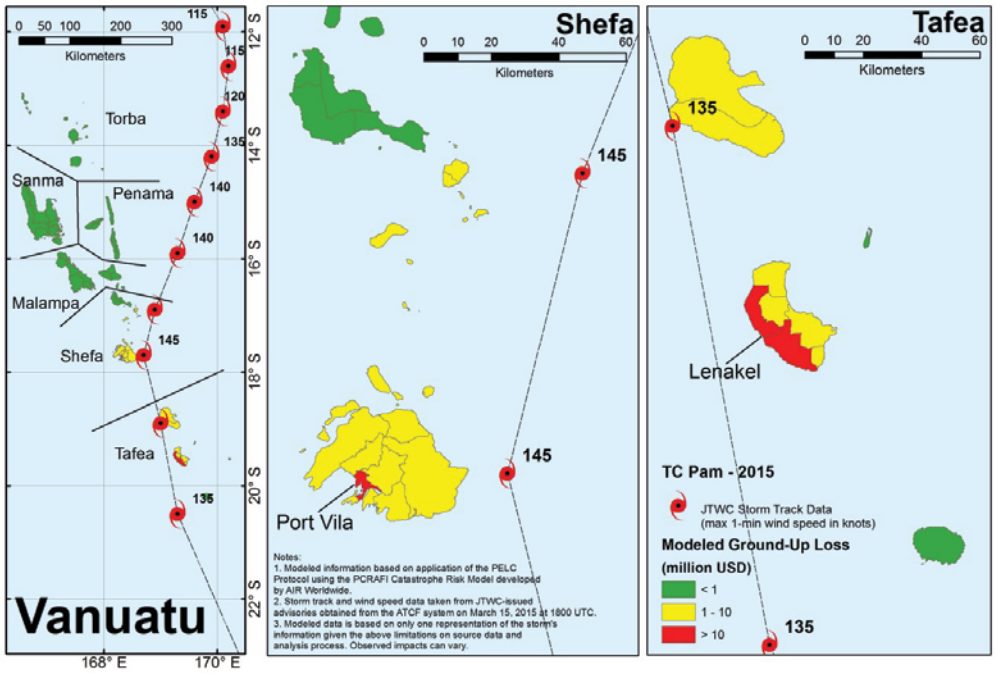
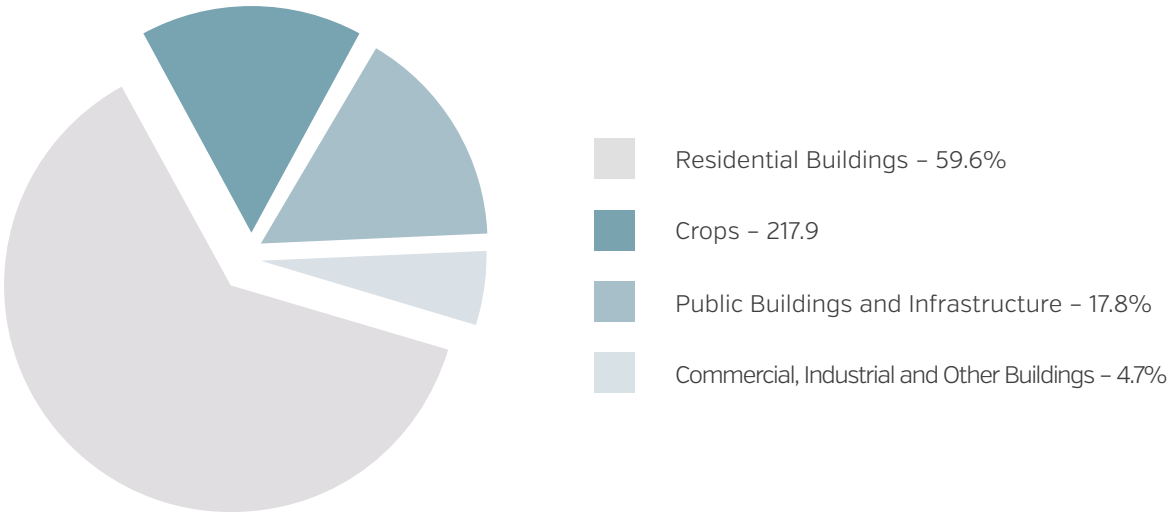


Figure 8– Breakdown of Total Modeled Ground-up Mean Loss by Sector for Tropical Cyclone Pam in Vanuatu



Appendix A

Table A.1– Summary of Modeled Exposure in Vanuatu (2010)

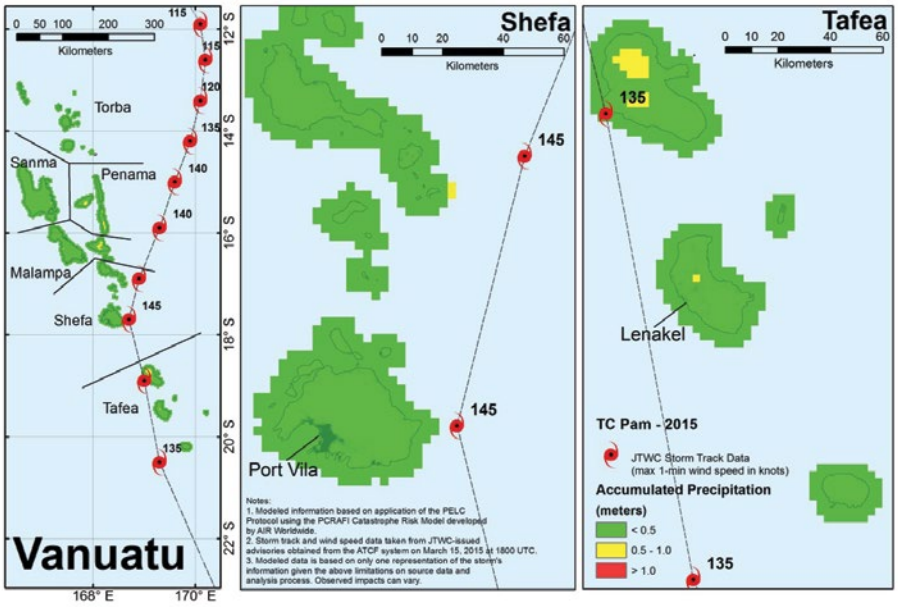
General Information:	
Total Population:	246,000
GDP Per Capita (USD):	2,960
Total GDP (million USD):	729.0
Asset Counts:	
Residential Buildings:	90,699
Public Buildings:	3,280
Commercial, Industrial, and Other Buildings:	6,767
All Buildings:	100,746
Hectares of Major Crops:	78,434
Cost of Replacing Assets (million USD):	
Buildings:	2,858
Infrastructure:	420
Crops:	56
Total:	3,334
Government Revenue and Expenditure:	
Total Government Revenue:	
(Million USD):	173.7
(% GDP):	23.80%
Total Government Expenditure:	
(Million USD):	178.8
(% GDP):	24.50%

Table A.2– Summary of Modeled Ground-up Mean Loss Estimates in Vanuatu from TC Pam

Area Council	*Province*	*Loss Cost (Modeled Loss Normalized by Exposure Value)*
Emau	Shefa	> 50%
South West Tanna	Tafea	25% - 50%
South Tanna	Tafea	25% - 50%
West Tanna	Tafea	25% - 50%
Tongariki	Shefa	25% - 50%
North Tanna	Tafea	25% - 50%
North Tongoa	Shefa	25% - 50%
Aniwa	Tafea	25% - 50%
Middle Bush Tanna	Tafea	25% - 50%
Whitesands	Tafea	10% - 25%
North Efate	Shefa	10% - 25%
Nguna	Shefa	10% - 25%
South Erromango	Tafea	10% - 25%
Eton	Shefa	10% - 25%
Makimae	Shefa	10% - 25%
North Erromango	Tafea	10% - 25%
All Others		< 1%

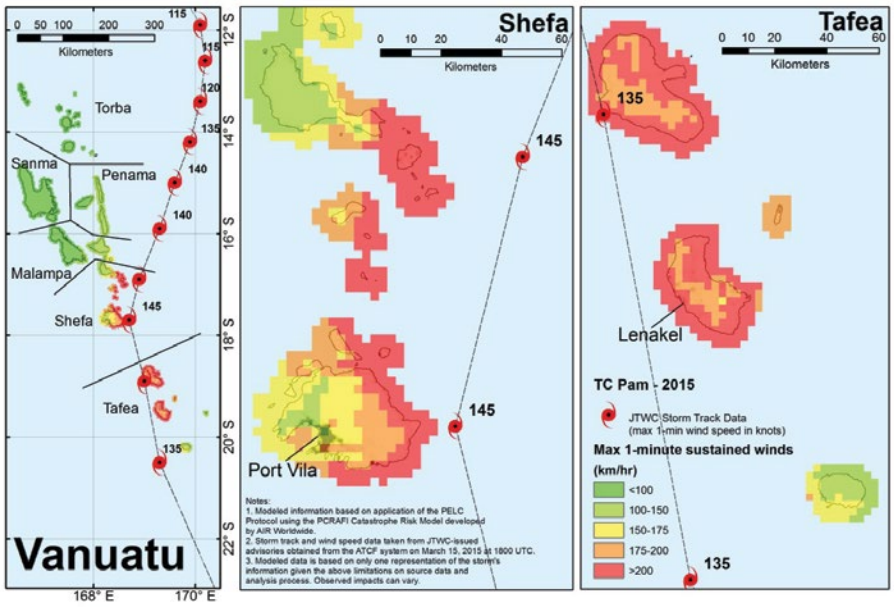
Appendix B: Modeled physical hazard from Tropical Cyclone Pam

Figure A.1– Modeled Accumulated Precipitation from Tropical Cyclone Pam over Vanuatu[4]



4 The JTWC issues wind speed data in knots, while the modeled wind speed is presented in km/hr. 1 knot = 1.852 km/hr

Figure A.2– Modeled Maximum Wind Speed from Tropical Cyclone Pam over Vanuatu[5]



5 The JTWC issues wind speed data in knots, while the modeled wind speed is presented in km/hr. 1 knot = 1.852 km/hr

Appendix C

Table C.1– Summary of TC Pam Storm Parameters Obtained from the JTWC

						One-Minute Maximum Sustained Surface Winds	
Year	Month	Day	Hour	Lat	Long	knots	km/hr
2015	3	9	6	-8.5	169.8	35	64.8
2015	3	9	12	-8.4	170.3	45	83.3
2015	3	10	0	-9.8	170.5	65	120.4
2015	3	10	12	-10.6	170.3	80	148.2
2015	3	10	18	-11.1	170.1	90	166.7
2015	3	11	0	-11	169.6	100	185.2
2015	3	11	6	-11.2	169.7	105	194.5
2015	3	11	18	-11.9	170.1	115	213
2015	3	12	0	-12.6	170.2	115	213
2015	3	12	6	-13.4	170.1	120	222.2
2015	3	12	12	-14.2	169.9	135	250
2015	3	12	18	-15	169.6	140	259.3
2015	3	13	0	-15.9	169.3	140	259.3
2015	3	13	6	-16.9	168.9	145	268.5
2015	3	13	12	-17.7	168.7	145	268.5
2015	3	13	18	-18.9	169	135	250
2015	3	14	0	-20.5	169.3	135	250
2015	3	14	12	-24.6	171.1	130	240.8
2015	3	14	18	-26.9	172.7	115	213
2015	3	15	0	-29.3	175	100	185.2
2015	3	15	12	-33.3	178.3	65	120.4