Tropical Cyclones and Covid-19: How disaster managers can help prevent Covid-19 outbreaks after severe tropical cyclones in Oceania

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Abstract

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With the Covid-19 pandemic, there has been concern that outbreaks will follow tropical cyclones, based on the narrative that disaster managers will be hard-pressed to deal with multiple disasters at once. This narrative is particularly urgent for Island Nations in the South Pacific, where tropical cyclones are predicted to become more frequent and intense with climate change. Climate change also affects propagation of infectious diseases, so interactions like this are likely to continue with time. Previous disaster theory connected tropical cyclones with outbreaks of other airborne diseases via disruption of health care, poor sanitation, poor nutrition, and crowding. These risks occurred in real-time during April-August, 2020, when severe weather events affected parts of Vanuatu, the Philippines, and the United States. Ultimately, the question of preparedness for managing multiple stressors at once is rooted in policy, and a risk matrix revealed high scores for disaster plans in Fiji, Tonga, and Vanuatu. The adaptability present in pre-existing disaster plans for these Island Nations holds great potential for integrating Covid-19 measures into disaster management.

Acknowledgements

First and foremost, I would like to thank Yoshi Ota, for sitting with me in his office almost two years ago and asking me, if I were a superhero genius, what problem would I want to solve. His enthusiasm and guidance made this thesis possible.

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Early feedback and support came from the PAC-ISLEs research team of Luke Tornabene and Holly Barker, who also connected me with Lynette Finau. My conversation with Lynette was the first to lend a sense of place to this thesis. Thank you also to Kate Crosman, for early insights into methods and consistent support. I thank Astrid Vacchette, for sharing her knowledge with me about disaster management in Vanuatu, and I am especially grateful to Mosese Sikivou for sharing his extensive disaster management knowledge and expertise and providing me with access to policy documents.

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Chapter 1: Introduction

Disasters and their management within Pacific Islands

Covid-19 is a global pandemic that warrants disaster response in and of itself, yet it also functions as an additional risk factor in management of other disasters. Covid-19 complicates government response to extreme weather events because of the need to prevent outbreaks. Since the onset of the pandemic, several publications have warned that Covid-19 outbreaks may follow tropical cyclones.[1,2,3] Stuart Minchin, an Australian and part of the Pacific Community,[4] warned that Pacific Islands specifically were not prepared for Covid-19 outbreaks in the aftermath of tropical cyclones, with Dr. Collin Tuatonga calling the situation a 'double-whammy'.[5] So, how can disaster managers on Pacific Islands reduce the likelihood of Covid-19 outbreaks? And do they have policies in place already to do so?

This thesis relies on a four phase management framework that includes the following four phases: mitigation, preparation, response, and recovery.[6] While these phases blend together in practice, they are useful when comparing goals of management strategies. In the figure below, that "mitigation" and "preparation" occur before the disaster event, while "response" and "recovery" occur afterward. FEMA defines mitigation as "preventing future emergencies or minimizing their effects" (A.3-4),[7] which includes actions like constructing a seawall to reduce flood risk or buying insurance to cover unavoidable damages. Preparedness includes actions directly related to setting up an effective disaster response phase, which includes establishing evacuation procedures. The "response" phase generally includes the disaster event and its immediate repercussions (i.e. seeking shelter). Recovery includes activities from the response to a "return to normal or an even safer situation" (A 3-4), which can take months or even years.

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[1] Shultz, J., Kossin, J., Hertelendy, A., Burkle, F., Fugate, C., Sherman, R., . . . Galea, S. (2020). Mitigating the Twin Threats of Climate-Driven Atlantic Hurricanes and COVID-19 Transmission. Disaster Medicine and Public Health Preparedness, 14(4), 494-503. doi:10.1017/dmp.2020.243

[2] Phillips, C.A., Caldas, A., Cleetus, R. et al. Compound climate risks in the COVID-19 pandemic. Nat. Clim. Chang. 10, 586–588 (2020). https://doi.org/10.1038/s41558-020-0804-2

[3] Preprint of Pei, Sen, Dahl, Kristina A, Yamana, Teresa K, Licker, Rachel, & Shaman, Jeffrey. (2020). Compound Risks of Hurricane Evacuation Amid the COVID‐19 Pandemic in the United States. Geohealth, 4(12), E2020GH000319-N/a. Accessed at https://www.medrxiv.org/content/10.1101/2020.08.07.20170555v1

[4] Pacific Community. (n.d.) *Stuart Minchin.* https://www.spc.int/people/stuart-minchin

[5] By Georgina Hayes. (May 4, 2020 Monday). Cyclones and coronavirus: the 'double-whammy' catastrophe facing the Pacific Islands; Struggling through the aftermath of a devastating tropical cyclone, many Pacific nations would be overwhelmed by even a few Covid-19 cases. telegraph.co.uk. https://advance-lexis-

[6] Baird, M.E. (2010). The "Phases" of Emergency Management: Background Paper. Prepared for the Intermodal Freight Transportation Institute (IFTI), University of Memphis.

[7] FEMA. (n.d.). *Animals in Disasters: The Four Phases of Emergency Management*. Accessed at: https://training.fema.gov/emiweb/downloads/is10_unit3.doc

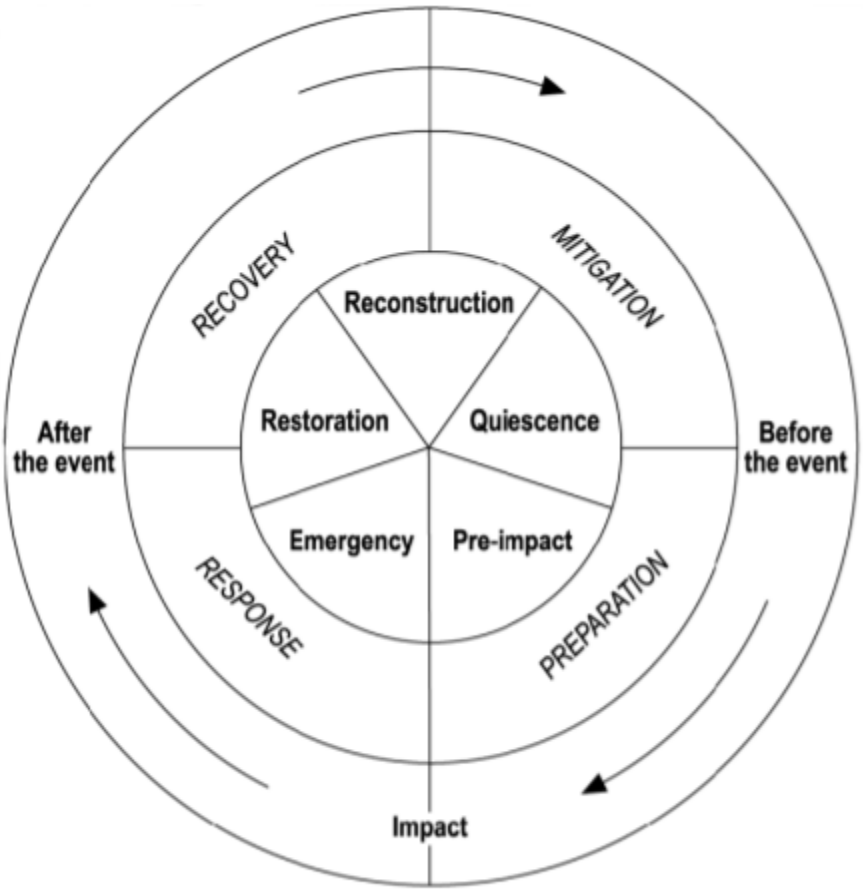

Figure 1. Phases of emergency management as presented by Baird (2010).

Relief aid traditionally has focused on the immediate aftermath of a disaster event[8] or the response phase, and thus has fallen short of normative goals to meet the "real needs of affected communities",[9] which persist well into the recovery phase. Aid has a complex role to play in disaster management on Pacific Islands, and lack of funds is something that people tend to mention when they say Pacific Islands are not prepared for one disaster or another.

From a global lens, there is demand for international ocean policy regarding disaster preparedness in Small Island Developing States (SIDS), which includes many Pacific Island nations.[10] During the 1990's International Decade for Natural Disaster Reduction, a call for

[8] Sakya, A., & Centre for Science Technology of the Non-Aligned Other Developing Countries. (2011). Natural disasters : Policy issues and mitigation strategies. New Delhi: Centre for Science & Technology of the Non-Aligned and Other Developing Countries (NAM S & T Centre) : Daya Publishing House

[9] Merriman, P., Browitt, C. W. A, & Royal Society. (1993). Natural disasters : Protecting vulnerable communities : Proceedings of the conference held in London, 13-15 October 1993. London : New York, NY: T. Telford ; Distributor for USA, American Society of Civil Engineers, Publications Sales Dept. pp. 432-446.

[10] Parks, John E. (Feb. 2017). "Issues and Opportunities in Global Ocean Policy; A Discussion Paper Prepared for the Ocean Policy Research Institute" *Sasakawa Peace Foundation*.

interdisciplinary disaster-focused work emphasized applying science and technology to reduce the societal impacts of natural disasters via forecasting or similar.[11] That was an important decade for technological innovation and progress, and the warning systems established have been integrated into Pacific Island disaster response.[12]

Pacific Islands have generally been viewed by other regions of the world as extremely vulnerable and of need of international assistance,[13] a thought perpetuated by the very definition of disasters as being locally incapacitating. However, the aid that this image encourages often comes with an agenda. Aid relationships with SIDS focus heavily on their 'development'; for example, Tonga's solar energy development over the past decade has been funded almost exclusively via grants from agencies like Asian Development Bank.[14] This example of a partnership fits Brinkerhoff's definition, where partnership is both voluntary and "rarely based on equal power relationships".[15] The nature of an unequal power dynamic means that true partnership should involve conscious power sharing, built into how the partnership forms, what the partners do, and where the outcomes or benefits feature. In one essay on how aid contributes to inequity, Gould argues that today's aid relationships feature a "subtler dynamic of alleged mutual complicity".[16] As such, it is important that aid relationships with Pacific Island nations do not contribute further to global inequality and that islander autonomy is recognized.

Residents of Oceania are most equipped to identify their own needs when facing hazards, and indeed, the benefits of locally driven disaster management have been identified in the literature.[17,18] Several island nations, including Fiji, Vanuatu, and Tonga, have come out with integrated disaster resiliency plans or statements, which simultaneously address climate change and natural hazards. Mosese Sikivou, a disaster resiliency expert in Suva, Fiji, believes that

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[11] Proceedings of the WMO/UNESCO Subforum on Science and Technology in Support of Natural Disaster Reduction. 1999. Geneva: World Meterological Organization and United Nations Educational, Scientific, and Cultural Organization.

[12] Tagata Pasifika. (2018, Feb. 25). TP+ Cyclone Gita aftermath. [Video]. YouTube. https://www.youtube.com/watch?v=LTcem_hcksU&t=2s

[13] Scandurra, G, Romano, A.A, Ronghi, M, & Carfora, A. (2018). On the vulnerability of Small Island Developing States: A dynamic analysis. Ecological Indicators, 84, 382-392.

[14] "Tonga Energy Road Map: A ten year road map to reduce Tonga's vulnerability to oil price shocks and achieve an increase in quality access to modern energy services in an environmentally sustainable manner". 2010. His Majesty's Government of the Kingdom of Tonga.

[15] Brinkerhoff, Jennifer. 2002. Partnership for International Development: Rhetoric or Results? Boulder: Lynne Rienner Publishers, Inc.

[16] Gould, Jeremy. 2005. "Timing, Scale, and Style: Capacity as Governmentality in Tanzania." In The Aid Effect, 61–84. Ann Arbor, MI: Pluto Press.

[17] Aru, Jill. (2021, April 9). "Covid closed our borders to international help after a cyclone, but showed us locals are the best first responders". *The Guardian.* https://www.theguardian.com/world/commentisfree/2021/apr/10/covid-closed-our-borders-to-international-help-after-a-cyclone-but-showed-us-locals-are-the-best-first-responders

[18] Paul Kadetz, Nancy B. Mock, "Chapter 9 - Problematizing vulnerability: Unpacking gender, intersectionality, and the normative disaster paradigm" Editor(s): Michael J. Zakour, Nancy B. Mock, Paul Kadetz, Creating Katrina, Rebuilding Resilience, Butterworth-Heinemann, 2018, Pages 215-230, ISBN 9780128095577, https://doi.org/10.1016/B978-0-12-809557-7.00009-0.

reducing the siloed approach to emergency management in favor of an approach that integrates risk reduction across all government sectors will improve resilience and ultimately save lives.[19] Efforts by the UN to improve natural disaster management in Small Island Developing States have recommended emphasis on increasing capabilities, empowering disaster mitigation initiatives (research, etc.), prioritizing citizen education and involvement, improving warning systems, strengthening existing disaster risk management frameworks, and supporting collaboration between sectors.[20] The emphasis on collaboration mirrors Sikivou's call for integrated disaster management and an end to siloed approaches.

In this thesis, I unpack the relationship between disasters and infectious diseases -- two frequently siloed stressors, discuss ways in which governments responded to tropical cyclones during the early stages of the Covid-19 pandemic, and make recommendations for disaster preparation based on existing policies. It is important to identify vulnerabilities to Covid-19 in current disaster management norms to enable disaster management under a 'new normal'.

The phrase 'new normal' was used as early as 1900 (i.e. as 'new normal forms' in various models) and emerged in popularity with the aftermath of the First World War.[21] It has origins in grief theory and has commonly been associated with events like 9/11,[22] the shooting at Columbine,[23] and the Great Recession,[24] as well as phenomena like globalization, technology,[25] and climate change.[26,27,28] The basic idea of a 'new normal' is that an event or phenomenon has fundamentally altered reality to the point that baselines of some parameter (safety, climate, financial stability, etc.) have shifted. Covid-19 affects a "new normal" because it has shifted baselines for acceptable inter-personal interactions, yielding far reaching impacts throughout the world.

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[19] USPMOOC on Climate Change and Pacific Islands. (2018, Dec. 2). *Mosese Sikivou, Regional Coordinator Pacific Resilience Program PREP Pacific Islands Forum Secretar*. [Video]. YouTube. https://www.youtube.com/watch?v=pOp3w00hW2A

[20] Shultz, J. M., Cohen, M. A., Hermosilla, S., Espinel, Z., & McLean, A. (2016). Disaster risk reduction and sustainable development for small island developing states. Disaster health, 3(1), 32–44. https://doi.org/10.1080/21665044.2016.1173443

[21] N.d. (n.d.) "Origin of 'the new normal' as a freestanding phrase". Stack Exchange: English Language & Usage. https://english.stackexchange.com/questions/215012/origin-of-the-new-normal-as-a-freestanding-phrase#:~:text=From%20an%20article%20in%20Psychology,promise%20you%20I%20will%20snarl.

[22] Jorgensen, T. (2016). The New "Normal". Health Physics : The Radiation Safety Journal., 111(2), 227-231.

[23] Ruddick, S. (2006). Abnormal, the "New Normal," and Destabilizing Discourses of Rights. Public Culture : Bulletin of the Project for Transnational Cultural Studies., 18(1), 53-78.

[24] Raber, L. (2009). A NEW NORMAL. C&EN Archives., 87(44), 45-58.

[25] Kirkpatrick, D. (2004). The new normal. Fortune., 150(12), 64.

[26] Hatchett, Benjamin J., Singletary, Loretta, Pohll, Greg, Sterle, Kelley, & Hatchett, Benjamin J. (2019). Hydroclimate Variability in Snow-Fed River Systems: Local Water Managers' Perspectives on Adapting to the New Normal. Bulletin of the American Meteorological Society., 100(6), 1031-1048.

[27] King, Andrew D., Perkins-Kirkpkpatrick, Sarah E., Lewis, Sophie C, King, Andrew D, & Perkins-Kirkpatrick, Sarah E. (2017). Defining a New Normal for Extremes in a Warming World. Bulletin of the American Meteorological Society., 98(6), 1139-1151.

[28] Stillman, J. (2019). Heat Waves, the New Normal: Summertime Temperature Extremes Will Impact Animals, Ecosystems, and Human Communities. Physiology., 34(2), 86-100.

The Pacific Islands of Oceania have not been spared from these impacts. Oceania characterizes a region of island nations and territories in the Pacific Ocean. Their archaeological history is one of expansion, from Asia eastward and outward to Hawai'i, Rapa Nui, and Aotearoa (New Zealand). Today, the Pacific Islands Forum is the major regional governing body, although the Micronesian sub-grouping walked out in February due to a leadership dispute.[29] Fishing and tourism industries are key economic sectors across the islands.

The ongoing COVID-19 pandemic has further complicated disaster management and transnational relations in Pacific Islands.[30] There are general economic impact and financial security concerns associated with COVID-19, particularly related to plummeting rates of tourism and seafood export demand.[31] Within fisheries themselves, operation can be tricky for international companies barred from island ports; in a piece for the Australian National University's Development Policy Blog, Aquorau has observed the benefit of being a locally-sourced fishing company in the present conditions.[32] Repatriation was also complicated, with many countries not even attempting repatriation until well into the pandemic.[33]

[29] Carreon, Bernadette and Ben Doherty. (2021, Feb. 8). "Pacific Islands Forum in crisis as one-third of member nations quit". *The Guardian.* https://www.theguardian.com/world/2021/feb/09/pacific-islands-forum-in-crisis-as-one-third-of-member-nations-quit

[30] Shultz, J., Kossin, J., Hertelendy, A., Burkle, F., Fugate, C., Sherman, R., . . . Galea, S. (2020). Mitigating the Twin Threats of Climate-Driven Atlantic Hurricanes and COVID-19 Transmission. Disaster Medicine and Public Health Preparedness, 14(4), 494-503. doi:10.1017/dmp.2020.243

[31] Reiley, L. "Commercial fishing industry in free fall as restaurants close, consumers hunker down and vessels tie up" . The Washington Post. April 8, 2020. https://www.washingtonpost.com/business/2020/04/08/commercial-fishing-coronavirus/

[32] Aquorau, T. "COVID-19 and its likely impact on the tuna industry in the Pacific Islands" DevPolicy Blog. Development Policy Centre, Australian National University. April 27, 2020. <https://devpolicy.org/covid-19-and-its-likely-impact-on-the-tuna-industry-in-the-pacific-islands-20200427-1/>

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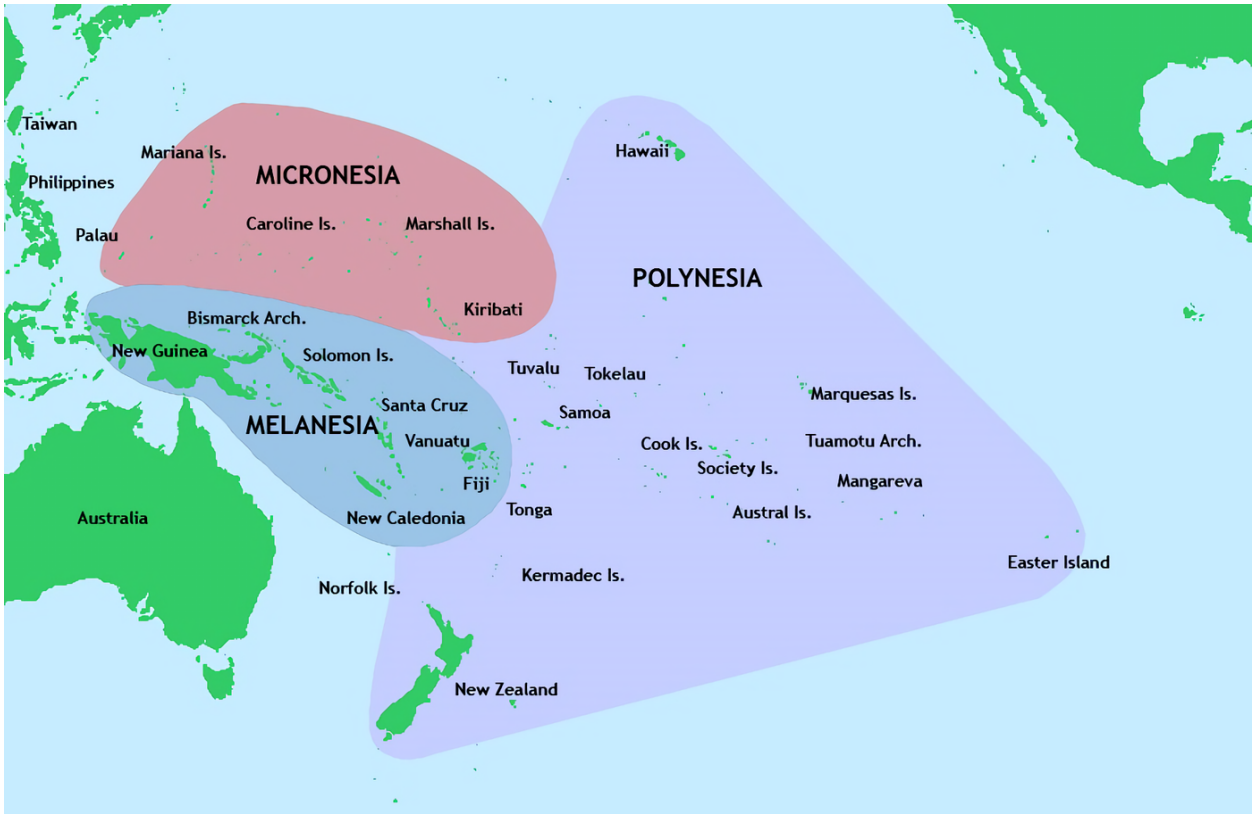

Figure 2. Map of Pacific Islands / Oceania region, depicting Micronesia, Polynesia, and Melanesia. Courtesy of Howe (2008).[34]

While the islands referred to as Small Island Developing States (SIDS) are indeed small from a land-based perspective, their Exclusive Economic Zones (which many are in process of claiming)[35] are collectively immense. The region is culturally and ecologically diverse,[36] with a history of inter-island and international exchange.[37] To borrow from famed anthropologist Epeli Hau'ofa:

> "Oceania is vast, Oceania is expanding, Oceania is hospitable and generous, Oceania is humanity rising from the depths of brine and regions of fire deeper still, Oceania is us." (p. 39)[38]

Islanders are accustomed to natural hazards. As Lynette Finau told me in a conversation about Tonga and the Kingdom's people, 'they are immune to it'. Individuals have traditional practices

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[34] Vaka Moana: Voyages of the Ancestors - the discovery and settlement of the Pacific, ed K.R. Howe, 2008, p57.
[35] N.d. (2021, March 11). "Pacific small islands fear rising seas will distort their claims to EEZs". MercoPress. https://en.mercopress.com/2021/03/11/pacific-small-islands-fear-rising-seas-will-distort-their-claims-to-eezs
[36] Jupiter Stacy , Mangubhai Sangeeta Kingsford Richard T (2014) Conservation of Biodiversity in the Pacific Islands of Oceania: Challenges and Opportunities. Pacific Conservation Biology 20, 206-220.
[37] Fitzpatrick, Scott M, & Anderson, Atholl. (2008). Islands of Isolation: Archaeology and the Power of Aquatic Perimeters. Journal of Island and Coastal Archaeology, 3(1), 4-16.
[38] Epeli Hau'ofa. (1998). The Ocean in Us. The Contemporary Pacific, 10(2), 392-410.

of identifying and securing themselves against hazards,[39] since they have been dealing with them for the history of habitation. However, one projected effect of climate change is increased frequency and severity of tropical cyclones in the South Pacific, particularly in El Niño years[40].

The island nations of Vanuatu, Fiji, and Tonga are among the most frequently affected by tropical cyclones and other hazards, due to their location on the Ring of Fire and the South Pacific Tropical Cyclone Basin. The region has seen the worst storms in living history within the past ten years, evidencing the present impacts of climate change. Tonga's National Emergency Management Office (NEMO) reports that numbers of cyclones per decade have increased since monitoring began in 1960[41]. Cyclone Gita in 2018 was particularly intense, with an estimated T$356.1 million (US$164.1 million) in damages (Natural Disaster Risk Reduction Program), as well as over 40 injuries and 2 deaths[42]. This cyclone also destroyed Tonga's parliamentary building, which had withstood storms for 126 years.[43] Ni-Vanuatu president Baldwin Lonsdale described 2015 Cyclone Pam, which according to UNICEF affected 132,000 people,[44] as a "monster".[45] Cyclone Pam remains the second most severe tropical cyclone to date,[46] tied with last year's TC Yasa. In 2016, however, TC Winston set the record.[47] Per Fiji's National Disaster Management Office's website, TC Winston killed 44 people, damaged or destroyed 40,000 homes, and impacted 350,000 people.[48] One of these people was Kalesi Vavakiwaqa, from Namacu village on Koro Island. She described her experience to a reporter, translated as such: "It was the first time for me to experience violent winds that lifted rooftops. It destroyed everything in the house from our belongings to cooking utensils which lay shattered and smashed".[49]

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[39] Johnston, Ingrid. (2015). Traditional warning signs of cyclones on remote islands in Fiji and Tonga. Environmental Hazards, 14(3), 210-223.
[40] Chand, Savin S, Kevin J. Tory, Hua Ye, and J.E. Walsh. 2017. "Projected Increase in El Niño-Driven Tropical Cyclone Frequency in the Pacific." Nature Climate Change 7 (December): 123–27.
[41] n.d. (2011). "Cyclone". The Ministry of Works: The National Emergency Management Office in Tonga. Accessed at: https://tonganemo.wordpress.com/hazards-in-tonga/cyclone/
[42] Government of Tonga. (2018). POST DISASTER RAPID ASSESSMENT. The Government of Tonga. https://www.gfdrr.org/sites/default/files/publication/WB_Tonga_Report_FA02_Medium_0.pdf
[43]Tagata Pasifika. (2018, Feb. 25). TP+ Cyclone Gita aftermath. [Video]. YouTube. https://www.youtube.com/watch?v=LTcem_hcksU&t=2s
[44] UNICEF. (n.d.) *Vanuatu Emergency Appeal.* https://web.archive.org/web/20150403093543/https://www.unicef.org.nz/vanuatu
[45] BBC News. (2015, March 15). Vanuatu: Cyclone Pam leaves thousands homeless - BBC News. [Video]. YouTube. https://www.youtube.com/watch?v=N6j7Rfjy5kk
[46] Joshua Robertson (15 March 2015). "Cyclone Pam: Vanuatu awaits first wave of relief and news from worst-hit islands". The Guardian. Retrieved 15 March 2015.
[47] Diamond, Howard (5 July 2017). "Southwest Pacific Enhanced Archive for Tropical Cyclones (SPEArTC)". Retrieved 6 July 2017.
[48] "What Is a Tropical Cyclone?" n.d. National Disaster Management Office. <http://www.ndmo.gov.fj/images/Hazards/Pull-up-banner_tropical-cycclone.pdf.>
[49] Fijian Government. (2017, Feb. 19). *TROPICAL CYCLONE WINSTON COMMEMORATION VIDEO.* [Video]. YouTube. https://www.youtube.com/watch?v=APtKgTRwWSA

The increasing frequency and severity of these tropical cyclones is critical. The value of traditional ecological knowledge holds only so long as the ecosystem remains stable, and in the 'new normal' of climate change, islanders will need to adapt to more than they have dealt with previously. Add the Covid-19 pandemic to this issue, and it is clear we need to pull from multiple disciplines and knowledge sources to mitigate the suffering that is possible. Pacific Islands have taken a lead for climate action, exemplified by integrated disaster policies[50,51,52] and the Talanoa climate dialogue sessions,[53] and dealing with Covid-19 is yet another way in which they will have to adapt their existing disaster management policies.

Infectious diseases themselves are related to climate change, with infectious disease specialists projecting more frequent epidemics as climate change continues.[54] Authors predict changing climate and habitat will improve vector viability,[55] for example, via longer summers and a spread of tropical climate toward higher latitude. The tropics currently boast a diversity of hosts (mosquitos, etc.), and climate change provides potential for these hosts to expand their distributional range.[56] Additionally, more frequent crop failures will increase malnourishment, associated with weakening the immune system.[54] There is also concern that water scarcity will make handwashing and sanitation more challenging, since droughts are projected in many regions related to global climate change, and that the decline in sanitation levels will facilitate spread of pathogens.[57] Increasing global connectivity also increases the opportunity for pathogens to travel long distances; because we can disperse far across the globe, pathogens can as well.

A serious pathogen that has emerged in recent years is the novel coronavirus (SARS-CoV-2), hereafter referred to as Covid-19. The first case of Covid-19 was recorded in December 2019 in

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[50] Ministry of Disaster Management and Meteorological Services. (2018). *National Disaster Risk Reduction Policy*. The Republic of Fiji. https://www.rcrc-resilience-southeastasia.org/wp-content/uploads/2020/04/Natural-Disaster-Risk-Reduction-Policy-2018%E2%80%932030.pdf

[51] Kingdom of Tonga. (2010). JOINT NATIONAL ACTION PLAN ON CLIMATE CHANGE ADAPTATION AND DISASTER RISK MANAGEMENT 2010–2015. https://sustainabledevelopment.un.org/content/documents/1335tongaDisaster%20Management%20Strategy.pdf

[52] Government of the Republic of Vanuatu. (2015). Vanuatu Climate Change and Disaster Risk Reduction Policy 2016-2030. Secretariat of the Pacific Community (SPC). https://policy.asiapacificenergy.org/sites/default/files/vanuatu_cc_drr_policy_minus_att4v4.pdf

[53] N.d. (n.d.). *2018 Talanoa Dialogue Platform.* United Nations Climate Change. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement/2018-talanoa-dialogue-platform

[54] Patz, J. A. (1996). Global climate change and emerging infectious diseases. JAMA : The Journal of the American Medical Association, 275(3), 217-223.

[55] Thomas, Matthew B. (2020). Epidemics on the move: Climate change and infectious disease. PLoS Biology, 18(11), E3001013.

[56] Kevin D. Lafferty. (2009). The Ecology of Climate Change and Infectious Diseases. Ecology (Durham), 90(4), 888-900.

[57] Shuman, Emily K. (2010). Global Climate Change and Infectious Diseases. The New England Journal of Medicine, 362(12), 1061-1063.

Wuhan City, China.[58] Since then, the virus has effectively shut down the world, with far reaching effects on human health, economy, society, and politics. At the time of writing, the Moderna, Pfizer, and Johnson & Johnson vaccines are being distributed in the United States.

Research statement

For this thesis, I look at how Covid-19 functions as a risk factor for disaster management, with a particular emphasis on Pacific Islands. I attempt to answer the question: What can disaster managers do to prevent Covid-19 outbreaks after severe tropical cyclones in Pacific Islands?

In this chapter, I have presented background information on disaster management, Oceania, and how climate change affects tropical cyclones and infectious diseases. I have set up information about Covid-19 and tropical cyclones in Fiji, Vanuatu, and Tonga to position this thesis at their intersection.

In Chapter 2, I will present the theory behind the relationship between natural disasters and infectious disease outbreaks, in order to answer the question: What relates tropical cyclones and Covid-19? Informed by a literature review, I construct a flow chart diagram to track previously studied connections between hazards and factors that promote outbreaks, generating a robust list of risks that disaster managers can look out for.

In Chapter 3, I ground this theory in a Covid-19 reality, examining 3 cases where countries dealt with tropical cyclones against a backdrop of Covid-19. This chapter looks at the question, What have people done to prevent Covid-19 when dealing with a tropical cyclone/typhoon/hurricane? I discuss policy actions, apparent risks, and observed impacts, and I compare these observations with the list of risks generated in Chapter 2.

In Chapter 4, I create my main thesis product: a matrix to analyze disaster management policies for how Covid-19 resilient they are. This risk assessment matrix is based on a list of risks informed by public health literature, guidelines from the World Health Organization, and what I found from my flowchart in Chapter 2 and example cases in Chapter 3. I then apply the matrix to disaster plan documents from Fiji, Tonga, and Vanuatu, to answer the question: Do these plans address the risks that I have identified?

Fundamentally, Covid-19 prevention is an important component of disaster management right now, and the lessons learned from its integration into disaster management will be vital for future epidemics

[58] Liu YC, Kuo RL, Shih SR. COVID-19: The first documented coronavirus pandemic in history. Biomed J. 2020 Aug;43(4):328-333. doi: 10.1016/j.bj.2020.04.007. Epub 2020 May 5. PMID: 32387617; PMCID: PMC7199674.

Chapter 2: Theory

Why do experts worry about outbreaks when natural disasters happen?

There is some debate about whether or not events like tropical cyclones and earthquakes lead to outbreaks of infectious diseases. Some authors argue the risk is negligible compared to deaths caused by warfare[59] or the disaster event itself,[60] while others stress the need for vigilance to guard against more suffering.[61,62,63] Much of the interest in this topic stems from the 2004 earthquake and tsunami in Indonesia, when a variety of outbreaks in diseases like tetanus and measles in affected regions perhaps inspired the narrative that disease outbreaks are inevitable in the aftermath of disasters, especially in 'developing' countries.[64,65,66,67,68,69] A handful of authors combat this narrative to the extreme, arguing there is no evidence of a relationship between disasters and diseases. Their conclusion is based on sheer numbers of natural disasters where no outbreaks were recorded.[59] However, Floret et al.'s argument that natural disasters do not import diseases actually agrees with most of the other literature. The majority of writers take a nuanced approach, arguing that while natural disasters do not directly cause infectious

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[59] Floret, N., Viel, J. F., Mauny, F., Hoen, B., & Piarroux, R. (2006). Negligible risk for epidemics after geophysical disasters. Emerging infectious diseases, 12(4), 543–548. https://doi.org/10.3201/eid1204.051569

[60] Lemonick DM. Epidemics after natural disasters. Am J Clin Med. 2011;8(3):144–152

[61] World Health Organization. (2005). Epidemic-prone disease surveillance and response after the tsunami in Aceh Province, Indonesia = Surveillance des maladies à caractère épidémique et action après le tsunami dans la Province d'Aceh, Indonésie. Weekly Epidemiological Record = Relevé épidémiologique hebdomadaire, 80 (18), 160 - 164. https://apps.who.int/iris/handle/10665/232787

[62] Magloire, Roc et al. "Launching a National Surveillance System after an earthquake --- Haiti, 2010." MMWR. Morbidity and mortality weekly report 59 30 (2010): 933-8 .https://www.cdc.gov/mmwr/PDF/wk/mm5930.pdf

[63] Sheel, Meru, Collins, Julie, Kama, Mike, Nand, Devina, Faktaufon, Daniel, Samuel, Josaia, . . . Nilles, Eric. (2019). Evaluation of the early warning, alert and response system after Cyclone Winston, Fiji, 2016/Evaluation du systeme d'alerte et d'intervention rapides apres le passage du cyclone Winston--Fidji, 2016/Evaluacion del sistema de alerta temprana, alerta y respuesta tras el ciclon Winston, Fiji, 2016. Bulletin of the World Health Organization, 97(3), 178.

[64] Aceh Epidemiology Group (2006) Outbreak of tetanus cases following the tsunami in Aceh province, Indonesia, Global Public Health, 1:2, 173-177, DOI: 10.1080/17441690600652803

[65] Balaraman, K, Sabesan, S, Jambulingam, P, Gunasekaran, K, & Doss, PS Boopathi. (2005). Risk of outbreak of vector-borne diseases in the tsunami hit areas of southern India. The Lancet Infectious Diseases, 5(3), 128-129.

[66] Guha-Sapir, D., & Van Panhuis, W. (2009). Health Impact of the 2004 Andaman Nicobar Earthquake and Tsunami in Indonesia. Prehospital and Disaster Medicine, 24(6), 493-499. doi:10.1017/S1049023X00007391

[67] Morgan O, Ahern M, Cairncross S (2005) Revisiting the Tsunami: Health Consequences of Flooding. PLoS Med 2(6): e184. https://doi.org/10.1371/journal.pmed.0020184

[68] Murakami, Aya, Chagan-Yasutan, Haorile, Hattori, Toshio, Sasaki, Hiroyuki, Pascapurnama, Dyshelly Nurkartika, & Egawa, Shinichi. (2016). Prevention of Tetanus Outbreak Following Natural Disaster in Indonesia: Lessons Learned from Previous Disasters. The Tohoku Journal of Experimental Medicine., 238(3), 219-227.

[69] Roy, S., Bhattacharya, D., Ghoshal, S., Thanasekaran, K., Bharadwaj, A., Singhania, M....Sugunan, A. (2009). Acute Diarrhea in Children after 2004 Tsunami, Andaman Islands. Emerging Infectious Diseases, 15(5), 849-850. https://dx.doi.org/10.3201/eid1505.081096.

disease outbreaks, they tend to create circumstances that are amenable to disease propagation by a variety of pathways.[70,71,72]

If a direct connection exists between tropical cyclones and infectious disease outbreaks, an increase in infectious disease outbreaks will be inevitable for Pacific Islanders, as tropical cyclones become more frequent. Under the assumptions that a) climate change increases tropical cyclones and b) infectious diseases inevitably follow tropical cyclones, little action could be taken besides extreme climate change mitigation. However, assuming that the majority of experts are correct, and disasters do not import diseases but rather promote diseases indirectly, the issue is more easily addressed. By acting on the factors that connect disasters to diseases, disease outbreaks may be prevented.

Constructing a typology of disasters, diseases, and linking factors

Hazards common to Fiji, Tonga, and Vanuatu include cyclones, earthquakes, floods, landslides, tsunamis, volcanoes, drought, coastal erosion, and storm surges. Shared hazards (i.e. hazards identified by multiple Island States' disaster management offices) include cyclones, earthquakes, floods, tsunamis, and volcanos. These five hazards were used to construct a typology of disasters, diseases, and connecting factors that would be applicable to multiple Pacific Island countries.

A search in Google Scholar with search terms "disease outbreak after [cyclone/earthquake/flood/tsunami/volcano]" yielded a variety of research and information about outbreaks of various diseases associated with these different disaster events. The information below is based on cited papers that were within the first two results pages and had titles and abstracts related to infectious disease(s) and disaster event(s).

Many of these papers described relationships between hazards and outbreaks, with authors identifying specific factors they thought contributed to disease outbreaks in the aftermath of certain hazards. For example, the 2016 earthquake off the coast of Ecuador resulted in massive population displacement due to the destruction of homes.[73] In evacuation centers and temporary shelters, displaced persons were more exposed to the elements than under normal circumstances, which meant they were more exposed to Zika-ridden mosquitos. Authors think that this exposure, along with more standing water facilitating mosquito breeding, promoted a Zika outbreak along the Ecuadorian coast in the aftermath of this

[70] Isidore K Kouadio, Syed Aljunid, Taro Kamigaki, Karen Hammad & Hitoshi Oshitani (2012) Infectious diseases following natural disasters: prevention and control measures, Expert Review of Anti-infective Therapy, 10:1, 95-104, DOI: 10.1586/eri.11.155

[71] Watson JT, Gayer M, Connolly MA. Epidemics after natural disasters. Emerg Infect Dis [serial on the Internet]. 2007 Jan [date cited]. Available from http://www.cdc.gov/ncidod/EID/13/1/1.html

[72] Keim, M.E. 2006. Cyclones, tsunamis, and human health: The key role of preparedness. Oceanography 19(2):40–49, https://doi.org/10.5670/oceanog.2006.62.

[73] Reina Ortiz, M., Le, N.K., Sharma, V. et al. Post-earthquake Zika virus surge: Disaster and public health threat amid climatic conduciveness. Sci Rep 7, 15408 (2017). https://doi.org/10.1038/s41598-017-15706-w

earthquake.[74,75] To represent this relationship in a typology, there are three components: 1) the disaster, in this case an "earthquake"; 2) factors connecting the disaster to disease outbreaks, which would be "increased exposure" and "modified vector habitat; and 3) the disease, which was "Zika" in this case.

There were many relationships like 'earthquake → increased exposure AND modified vector habitat→ Zika' throughout the literature, revealing a wide array of intermediary factors. Tropical cyclones, which include hurricanes and typhoons, were associated with increased exposure, changed vector habitat, population displacement, lack or disruption of health services, crowding (i.e. in an evacuation center), contaminated water, and poor nutrition.[76,77] Flooding events were related to near-drowning, poor sanitation, and exacerbating underlying health conditions (ex. Lack of immunization) in addition to the factors shared in the literature with cyclones.[78,79,80,81] Tsunamis [76,77,78,79,80] confirmed many similar factors (lack/disruption of health services, crowding, etc.) and added injuries to the mix, which specifically related to a tetanus outbreak after the 2004 tsunami in Aceh Province, Indonesia.[82,83,84,85,86]

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[74] Vasquez, D., Palacio, A., Nuñez, J., Briones, W., Beier, J. C., Pareja, D. C., & Tamariz, L. (2017). Impact of the 2016 Ecuador Earthquake on Zika Virus Cases. American journal of public health, 107(7), 1137–1142. https://doi.org/10.2105/AJPH.2017.303769

[75] Sorensen, C. J., Borbor-Cordova, M. J., Calvello-Hynes, E., Diaz, A., Lemery, J., & Stewart-Ibarra, A. M. (2017). Climate variability, vulnerability and natural disasters: A case study of Zika virus in Manabi, Ecuador following the 2016 earthquake. GeoHealth, 1, 298–304. https://doi.org/10.1002/2017GH000104

[76] Isidore K Kouadio, Syed Aljunid, Taro Kamigaki, Karen Hammad & Hitoshi Oshitani (2012) Infectious diseases following natural disasters: prevention and control measures, Expert Review of Anti-infective Therapy, 10:1, 95-104, DOI: 10.1586/eri.11.155

[77] Keim, M.E. 2006. Cyclones, tsunamis, and human health: The key role of preparedness. Oceanography 19(2):40–49, https://doi.org/10.5670/oceanog.2006.62.

[78] Watson JT, Gayer M, Connolly MA. Epidemics after natural disasters. Emerg Infect Dis [serial on the Internet]. 2007 Jan [date cited]. Available from http://www.cdc.gov/ncidod/EID/13/1/1.html

[79] Lemonick DM. Epidemics after natural disasters. Am J Clin Med. 2011;8(3):144–152

[80] Dyshelly Nurkartika Pascapurnama, Aya Murakami, Haorile Chagan-Yasutan, Toshio Hattori, Hiroyuki Sasaki, Shinichi Egawa. 2018. Integrated health education in disaster risk reduction: Lesson learned from disease outbreak following natural disasters in Indonesia. International Journal of Disaster Risk Reduction. Volume 29, Pages 94-102, https://doi.org/10.1016/j.ijdrr.2017.07.013

[81] Manuel J Loayza-Alarico, Andres G Lescano, Luis A Suarez-Ognio, Gladys M Ramirez-Prada & David L Blazes (2013) Epidemic activity after natural disasters without high mortality in developing settings, Disaster Health, 1:2, 102-109, DOI: 10.4161/dish.27283.

[82] World Health Organization. (2005). Epidemic-prone disease surveillance and response after the tsunami in Aceh Province, Indonesia = Surveillance des maladies à caractère épidémique et action après le tsunami dans la Province d'Aceh, Indonésie. Weekly Epidemiological Record = Relevé épidémiologique hebdomadaire, 80 (18), 160 - 164.

[83] Aceh Epidemiology Group (2006) Outbreak of tetanus cases following the tsunami in Aceh province, Indonesia, Global Public Health, 1:2, 173-177, DOI: 10.1080/17441690600652803

[84] Morgan O, Ahern M, Cairncross S (2005) Revisiting the Tsunami: Health Consequences of Flooding. PLoS Med 2(6): e184. https://doi.org/10.1371/journal.pmed.0020184

[85] Murakami, Aya, Chagan-Yasutan, Haorile, Hattori, Toshio, Sasaki, Hiroyuki, Pascapurnama, Dyshelly Nurkartika, & Egawa, Shinichi. (2016). Prevention of Tetanus Outbreak Following Natural Disaster in Indonesia: Lessons Learned from Previous Disasters. The Tohoku Journal of Experimental Medicine., 238(3), 219-227.

[86] Guha-Sapir, D., & Van Panhuis, W. (2009). Health Impact of the 2004 Andaman Nicobar Earthquake and Tsunami in Indonesia. Prehospital and Disaster Medicine, 24(6), 493-499. doi:10.1017/S1049023X00007391

Earthquakes[87,88,89,90,91,92] and volcanoes were the only hazards associated with the intermediary factor airborne dust or ash, which were associated with acute respiratory infections (ARIs) and coccidiomycosis in the literature.

These hazards, intermediary factors, and associated diseases were assembled into a flow chart, with lines representing connections identified by authors. Collectively, these five natural hazards (cyclones, floods, tsunamis, earthquakes, and volcanoes) have been connected to 15 infectious diseases via 13 intermediary factors, with many factors shared between hazards and diseases.

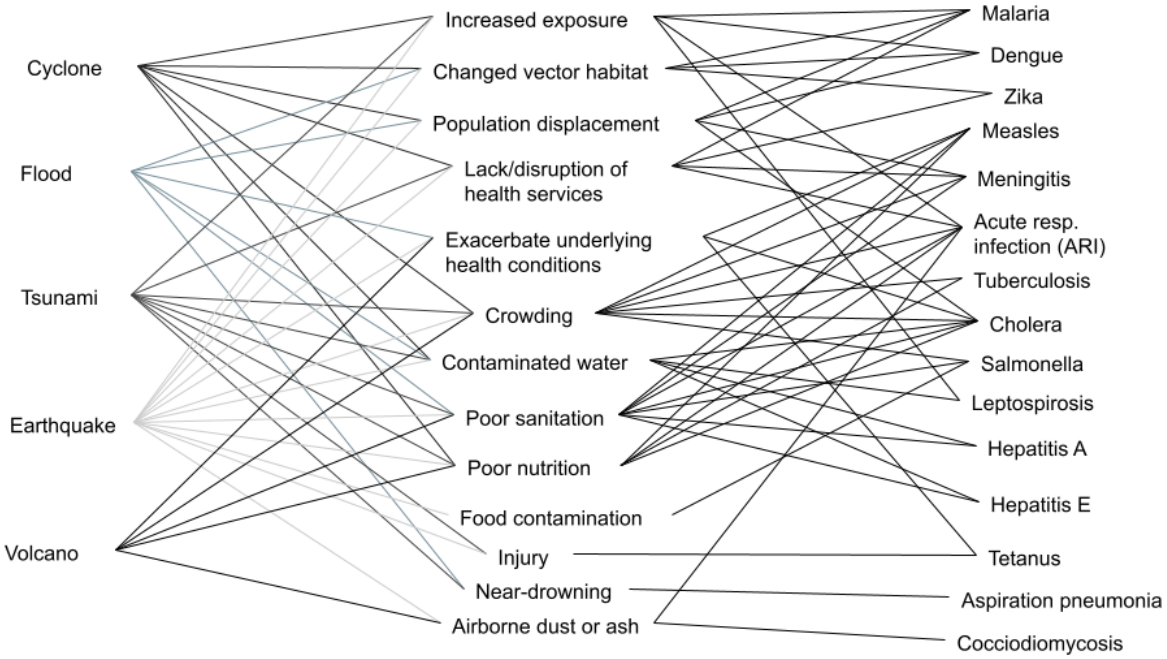

Figure 3. Flow chart typology depicting links between natural hazards, factors promoting outbreaks of infectious diseases, and infectious diseases, as identified in the literature.

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[87] Kawano T, Hasegawa K, Watase H, Morita H, Yamamura O. Infectious disease frequency among evacuees at shelters after the great eastern Japan earthquake and tsunami: a retrospective study. Disaster Med Public Health Prep. 2014;8(1):58-64. doi:10.1017/dmp.2014.15

[88] Isidore K Kouadio, Syed Aljunid, Taro Kamigaki, Karen Hammad & Hitoshi Oshitani (2012) Infectious diseases following natural disasters: prevention and control measures, Expert Review of Anti-infective Therapy, 10:1, 95-104, DOI: 10.1586/eri.11.155

[89] Watson JT, Gayer M, Connolly MA. Epidemics after natural disasters. Emerg Infect Dis [serial on the Internet]. 2007 Jan [date cited]. Available from http://www.cdc.gov/ncidod/EID/13/1/1.html

[90] Lemonick DM. Epidemics after natural disasters. Am J Clin Med. 2011;8(3):144–152

[91] Dyshelly Nurkartika Pascapurnama, Aya Murakami, Haorile Chagan-Yasutan, Toshio Hattori, Hiroyuki Sasaki, Shinichi Egawa. 2018. Integrated health education in disaster risk reduction: Lesson learned from disease outbreak following natural disasters in Indonesia. International Journal of Disaster Risk Reduction. Volume 29, Pages 94-102, https://doi.org/10.1016/j.ijdrr.2017.07.013 .

[92] Manuel J Loayza-Alarico, Andres G Lescano, Luis A Suarez-Ognio, Gladys M Ramirez-Prada & David L Blazes (2013) Epidemic activity after natural disasters without high mortality in developing settings, Disaster Health, 1:2, 102-109, DOI: 10.4161/dish.27283

The diseases shown represent a variety of contagion pathways, which were color-coded below to match diseases and any factors associated with only one type of contagion pathway. Blue coloring denotes water borne diseases, green corresponds with airborne diseases or those transmitted via respiratory droplets, red represents vector-borne diseases and affiliated factors, and dark brown indicates the disease is related to injuries sustained during or in the aftermath of the disaster.

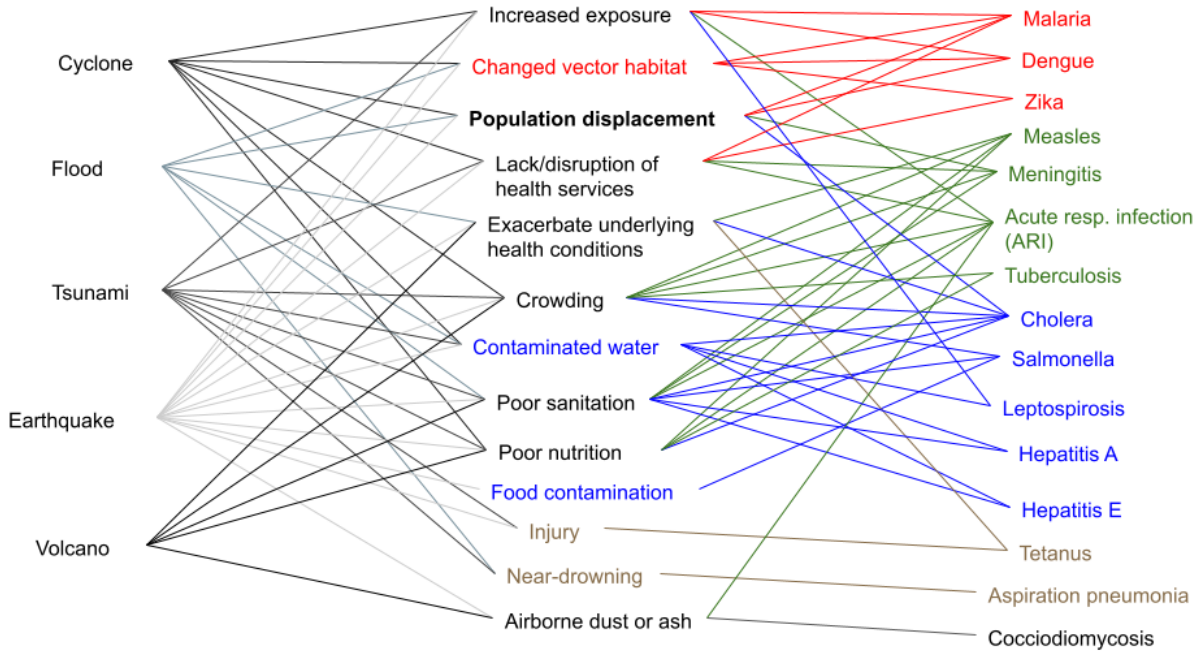

Figure 4. Flow chart typology depicting links between natural hazards, factors promoting outbreaks of infectious diseases, and infectious diseases, as identified in the literature. Coloring corresponds to infection pathway (red = vector borne; green = airborne; blue = waterborne; brown = injury related).

A few intermediary factors had unique relationships with certain diseases or even other factors. The factor "population displacement" is in bold, since many authors identify this factor as the best indicator of increased risk for outbreaks (i.e. if a population is displaced due to a tropical cyclone or warfare, outbreaks are more likely than if there are no displaced persons).[93,94] Indeed, Watson et al. considers population displacement to be a driver behind other risk factors, like crowding.[95] Certain factors, like changed vector habitat, appeared in the literature only in connection with specific contagion pathways. Contaminated food and water have only been observed promoting waterborne diseases like leptospirosis,

[93] Sorensen, C. J., Borbor-Cordova, M. J., Calvello-Hynes, E., Diaz, A., Lemery, J., & Stewart-Ibarra, A. M. (2017). Climate variability, vulnerability and natural disasters: A case study of Zika virus in Manabi, Ecuador following the 2016 earthquake. GeoHealth, 1, 298–304. https://doi.org/10.1002/2017GH000104

[94] Isidore K Kouadio, Syed Aljunid, Taro Kamigaki, Karen Hammad & Hitoshi Oshitani (2012) Infectious diseases following natural disasters: prevention and control measures, Expert Review of Anti-infective Therapy, 10:1, 95-104, DOI: 10.1586/eri.11.155

[95] Watson JT, Gayer M, Connolly MA. Epidemics after natural disasters. Emerg Infect Dis [serial on the Internet]. 2007 Jan [date cited]. Available from http://www.cdc.gov/ncidod/EID/13/1/1.html

and having an injury or nearly drowning have only been directly tied to injury-related diseases (understandably). It seems logical that certain risks are more closely tied to spread of certain pathogens.

Tropical cyclones themselves have been connected either directly or indirectly through a shared factor to all of the listed diseases except for tetanus, aspiration pneumonia, and coccidioidomycosis.

- Directly: **Tropical cyclone → factor → Disease 1**
- Indirectly: **Tropical cyclone → factor**

  Earthquake → **factor → Disease 2**

Thus, the concern that tropical cyclones may increase the likelihood of Covid-19 outbreaks is valid and rooted in disaster theory.

The next step then is to determine which intermediary factors would be most likely to promote a Covid-19 outbreak. Covid-19 spreads via respiratory droplets borne through the air, making factors previously connected to airborne diseases most likely to be a cause for concern. Close examination of the green lines connecting airborne diseases to factors promoting them reveals that increased exposure, population displacement, lack/disruption of health services, exacerbate underlying health conditions (like lack of immunity), crowding, poor sanitation, and poor nutrition have all been factors associated with outbreaks of an airborne disease such as Covid-19. Crowding has been tied to multiple types of airborne diseases, as have poor sanitation, poor nutrition, and lack/disruption of health services. These factors are most likely to be concerns for Covid-19, since they already show evidence of generalizability.

Disaster managers facing tropical cyclones during Covid-19 thus should be wary of crowding, poor sanitation, poor nutrition, and a lack or disruption of health services, as well as population displacement, which may lead to any combination of these factors. In the next chapter, I look at what disaster managers did in real-life cases to prevent Covid-19 when these factors occurred.

Chapter 3: Covid-19 in disaster realities

What did people do when tropical cyclones made landfall during summer 2020?

The prevailing disaster theory, as discussed in Chapter 2, is that natural disasters create circumstances (i.e. change in the environment or human behavior) that promote the spread of infectious diseases. Thus, theoretically, people can take measures to address these circumstances and prevent outbreaks of infectious diseases. In this chapter, I examine how key players addressed Covid-19 while also dealing with high intensity tropical cyclones affecting their coasts.

Covid-19 is largely unprecedented in terms of scale, necessitating real world examples to understand how Covid-19 affects tropical cyclone disaster management and what works for mitigating outbreaks. In this chapter, I will present three cases where disaster managers attempted to prevent or contain Covid-19 amidst tropical cyclones: Cyclone Harold in Vanuatu, Typhoon Ambo in the Philippines, and Hurricane Laura on the Gulf coast of the United States.

For each example case, I provide basic context for the event, the affected region, and how disaster management typically operates there. Based on a review of news articles about each event within the Nexis Uni database as well as select articles and reports available on Google Scholar by October 2020, I compiled relevant information into charts (Fig 5-7) detailing the hazards, vulnerabilities, risk factors, policies, and impacts if any.

Vulnerabilities included any factors within the affected region that could make Covid-19 prevention or recovery more difficult. Risk factors included anything identified that connected to any of the intermediary factors listed in Chapter 2 (i.e. factors that promote disease propagation). Policies included any public-health related actions taken by a group of government in response to the disaster event. Impacts focused on the outcomes of actions in a variety of forms.

Tropical Cyclone Harold: Vanuatu

Tropical Cyclone (TC) Harold made landfall in Espiritu Santo, Vanuatu on April 6, 2020.[96] At this time, Vanuatu was Covid-free, which heavily influenced the management approach. The ni-Vanuatu government managed Covid-19 as a risk factor by maintaining closed borders and dealing with the disaster ‘in-house’.

Vanuatu in the South Pacific is considered a Small Island Developing State. Despite its small population size, Vanuatu has an extensive disaster management network. This network includes

[96] (April 7, 2020 Tuesday). Cyclone Harold batters Vanuatu, heavy damage reported. ABC Premium News (Australia). Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:5YKX-8R11-F031-X26S-00000-00&context=1516831.

government agencies, regional and UN organizations, civil society organizations, NGOs and Red Cross societies, education and research institutes, international donors, and the private sector.[97]

TC Harold was a Category 5 tropical cyclone with wind speeds up to 168 mph and subsequent flooding.[98] TC Harold displaced approximately 80,000 people, a crucial factor connecting disasters with diseases. Several factors with potential to promote post-disaster outbreaks included crowding in emergency shelters,[99] poor sanitation,[100] contaminated water,[101,102,103] insufficient nutrients (many gardens were inundated)[104], and the backdrop of the Covid-19 global pandemic.[105,106] Within Vanuatu, many homes were still being rebuilt from TC Pam in 2015; people living in these areas would more likely need to relocate to seek adequate shelter. Additionally, resources for ni-Vanuatu and international actors were already strained due to economic effects of Covid-19,[102] which limited funds available to supplement response and recovery efforts. In the case of a Covid-19 outbreak, Vanuatu had no ICU beds,[105] making their treatment capacity low. However, they had a major Covid advantage in that Covid-19 was not yet endemic to Vanuatu.

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[97] Vachette, A. 2015. The little handbook of disaster and climate change networked governance structure in Vanuatu. Centre for Disaster Studies of James Cook University, Secretariat of the Pacific Community & Deutsche Gesellshaft für Internationale Zusammenarbeit GmbH .

[98] (April 7, 2020 Tuesday). Cyclone Harold batters Vanuatu, heavy damage reported. ABC Premium News (Australia). Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:5YKX-8R11-F031-X26S-00000-00&context=1516831.

[99] By Catherine Graue and Evan Wasuka. (April 6, 2020 Monday). Coronavirus distancing measures lifted as Cyclone Harold lashes Vanuatu. ABC Premium News (Australia). Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:5YKP-KDP1-F031-X0R9-00000-00&context=1516831.

[100] (April 6, 2020 Monday). NZ:Fears as Cyclone Harold reaches Vanuatu. AAP Newsfeed. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:5YKR-C701-JC0X-K07V-00000-00&context=1516831.

[101] (April 13, 2020). Couple relate trauma of Cyclone Harold in Vanuatu. Hawke's Bay Today. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:5YN2-SRW1-F12B-J0MN-00000-00&context=1516831.

[102] (April 18, 2020 Saturday). NZ:Virus adds to Vanuatu's post-Harold woes. AAP Newsfeed. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:5YP8-1W41-JC0X-K07C-00000-00&context=1516831.

[103] HollandE. (2020). Tropical Cyclone Harold meets the Novel Coronavirus: Dispatch from the Pacific. Pacific Journalism Review : Te Koakoa, 26(1), 243-251. https://doi.org/10.24135/pjr.v26i1.1099.

[104] (April 8, 2020 Wednesday). Vanuatu faces 12-month recovery as Cyclone Harold heads for Fiji. Asia Pacific News. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:5YM4-W8R1-JBN5-F3T8-00000-00&context=1516831.

[105] By Max Walden and Catherine Graue. (April 10, 2020 Friday). Australian aid to help Cyclone Harold relief efforts as COVID-19 frustrates response. Asia Pacific News. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:5YMJ-TNB1-DY47-50GK-00000-00&context=1516831.

[106] Anthony Galloway. (April 8, 2020 Wednesday). 'Nightmare scenario': Pacific islands risk being ravaged by COVID-19. The Sydney Morning Herald (Australia) - Online. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:5YM4-M571-JBJ7-N0SG-00000-00&context=1516831.

The fact that Vanuatu had no Covid cases influenced the disaster response; most of the concerns already listed are only concerns if the disease is present. Thus, the ni-Vanuatu government took an isolation-approach, established by the Recovery Operations Center (ROC) designed to deal with both Covid-19 and the 2020 cyclone season. The ROC relaxed domestic social distancing measures, allowing for evacuation to emergency shelters. Extremely strict measures were put in place at exchange points between Vanuatu and the rest of the world. The government barred entry to foreign aid workers, held cargo donations in the capital Port Vila for 3 days before distribution,[107] and encouraged funnelling financial contributions through locally based NGOs.[108]

Vanuatu maintained zero Covid-19 cases during the response and recovery phases. As a contrasting case, in Haiti in 2010, humanitarians were linked to introducing cholera ten months after the initial earthquake event. Thus, Vanuatu's strictly closed borders and quarantine measures seem to have kept Covid-19 out. However, delays in relief provision and evidence of malnutrition, potentially linked to the 3 day Port Vila quarantine, were reported. Additionally, Vanuatu received less financial assistance from other countries than after TC Pam (a 2015 tropical cyclone), likely because its past donors were dealing with Covid-19 in their own countries.

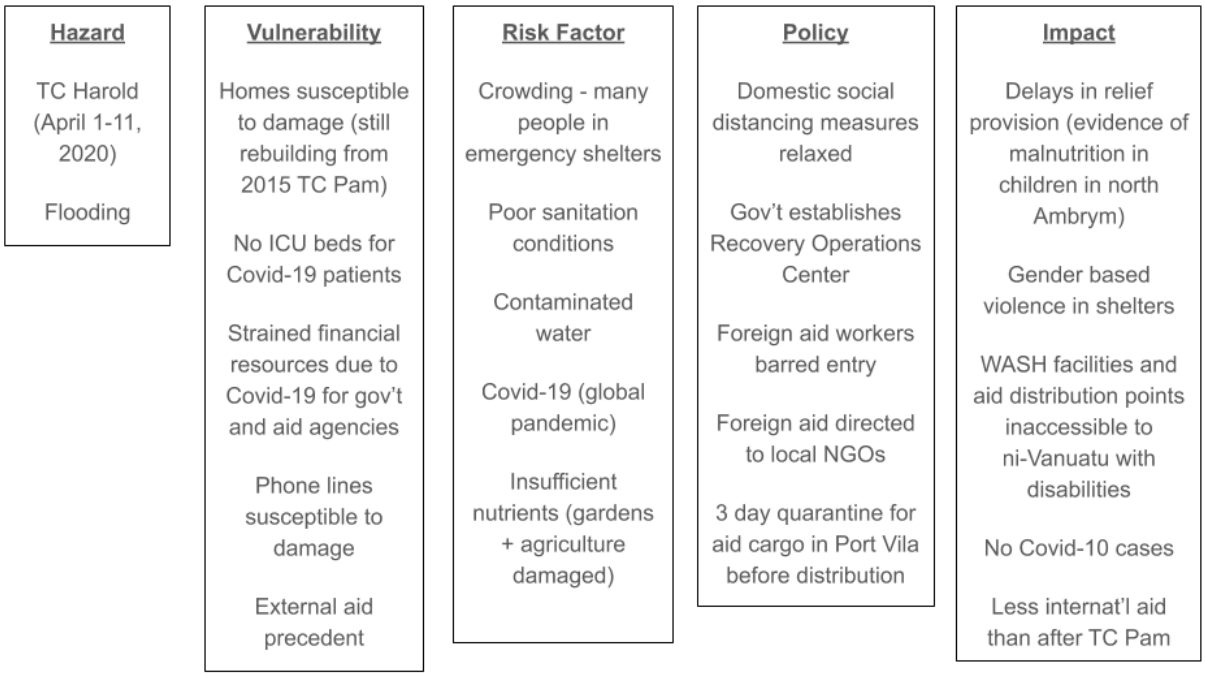

Figure 5. Vulnerability factors, risk factors, policies, and impacts related to TC Harold in Vanuatu. N.B. Not all impacts connect to Covid-19 policy actions, as not all harm experienced was Covid-19 infection.

[107] HollandE. (2020). Tropical Cyclone Harold meets the Novel Coronavirus: Dispatch from the Pacific. Pacific Journalism Review : Te Koakoa, 26(1), 243-251. https://doi.org/10.24135/pjr.v26i1.1099

[108] (May 7, 2020). Firms, workers unite in Vanuatu rebuild. Te Puke Times (New Zealand). Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:5YV6-3BB1-F12B-J0Y4-00000-00&context=1516831.

Major takeaways/areas for concern

Under a global pandemic, external aid can become a risk factor itself (beyond the political structures it promotes), so Vanuatu took steps to keep aid workers and their germs out of the country. Outside of the Covid-19 concerns, there was evidence of gender-based violence in shelters and a lack of accessibility for ni-Vanuatu with disabilities, making it clear that delays and emergency evacuation centers are not designed for everyone. Factors that seem to increase exposure to risk include living in remote communities (safer from initial Covid spread, but resource distribution takes longer), being female (gender-based violence in poorly-lit evacuation shelters), or having a physical disability (inaccessible WASH stations, aid distribution points).

Typhoon Ambo: Philippines

Typhoon Ambo hit Eastern Samar in the Philippines on May 14, 2020. Eastern Samar is an agricultural region. Covid-19 was not yet endemic in Eastern Samar. However, the inundation of a seasonal food source made food supply a serious issue for Eastern Samar residents and disaster managers.

Disaster management in the Philippines features everything from centralized coordination and bureaucracy to NGO involvement to integration with climate change to the community-based *purok* approach. Part of the reason for co-occurrence of these approaches is the high prevalence of natural hazards in the Philippines; hazards are common and continue to affect millions of people in the Philippines. From smallest to largest, the *purok* system relies on self organization within *barangays* or villages.[109] Moving to the Local Governing Unit (LGU) level, LGUs have control over Calamity funds, resources that become available if ⅓ of the LGU area has been affected by a given 'calamity' and the corresponding Governor declares it; these funds make up 5% of the LGUs annual budget.[110]

Outside government, NGOs gained prominence in the Philippines following human rights violations during the 1970s Marcos regime. They first became involved with disaster management during the 1990s, when the Philippines experienced a series of earthquakes, flash floods, and volcanic eruptions. [111]

National level involvement takes the form of the National Disaster Coordinating Council (NDCC), established in 1978. The NDCC set up parallel councils at the municipal, provincial, and regional scales. Like LGUs, the NDCC can declare a state of calamity, which releases national-level calamity funds. The primary disaster framework is the 2010 Disaster Risk Reduction and Management Act currently. National level policy has recently been making steps

[109] Matthies, A. (2017). Community-based disaster risk management in the Philippines: Achievements and Challenges of the Purok System. Austrian Journal of South-East Asian Studies, 10(1), 101-108.
[110] Bankoff, G.E.A, & Hilhorst, D.J.M. (2009). The politics of risk in the Philippines: Comparing state and NGO perceptions of disaster management. Disasters, 33(4), 686-704.
[111] LUNA, Emmanuel M. (2001). Disaster mitigation and preparedness : The case of NGOs in the Philippines. Disasters, 25(3), 216-226.

toward an integrated approach to climate change and disaster management, although the integration has focused on impacts rather than root causes so far.[112]

A review of news articles about Typhoon Ambo revealed key players, risks, and impacts. The National Disaster Risk Reduction and Management Council, the Inter-Agency Task Force (IATF), and Eastern Samar Governor Ben Evardone took leadership roles, with IATF releasing a series of guidelines for expanded typhoon evacuation during Covid-19 and Governor Evardone declaring a State of Calamity.[113] Resources that became available and were used for relief included Calamity funds and some international aid.

A key management concern was Covid-19's endemism in the Philippines, although Covid-19 had not yet spread to Eastern Samar. Other hazards faced included exposure to the destructive force of Typhoon Ambo and inundation, which ruined agricultural crops in the region. The region was vulnerable compared to other regions in the Philippines, in that they had dependence on a seasonal food source and were one of the less wealthy regions, which can make evacuation more difficult. Response policies included provision of food packs[114] and calls for an expanded evacuation,[115,116,117] the national government's plan to reduce Covid-19 risk. However, the reality included makeshift evacuation sites that lacked basic sanitation facilities and thus did not meet handwashing needs. Tension existed between prioritization of Covid-19 against Typhoon Ambo response, and there were discrepancies between planning and response in real-time.[118]

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[112] De Leon, E.G, & Pittock, J. (2017). Integrating climate change adaptation and climate-related disaster risk-reduction policy in developing countries: A case study in the Philippines. Climate and Development, 9(5), 471-478.

[113] (May 18, 2020 Monday). 9 Eastern Samar towns now under state of calamity after Typhoon Ambo. Philippines Daily Inquirer. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:5YXY-PWF1-F00C-60H0-00000-00&context=1516831.

[114] (May 22, 2020 Friday). Philippines : Guv seeks restoration of COVID-19 isolation units in E. Samar. TendersInfo. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:5YYS-BY11-F11P-X4MR-00000-00&context=1516831.

[115] (May 14, 2020 Thursday). Evacuation underway as Albay braces for onslaught of typhoon 'Ambo'. Manila Bulletin. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:5YWV-0NJ1-JDKC-R4FT-00000-00&context=1516831.

[116] (May 15, 2020 Friday). Typhoon Ambo tests government ability to protect evacuees from Covid-19. Business Mirror (Philippines). Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:5YXP-C6P1-F00C-639V-00000-00&context=1516831.

[117] (May 16, 2020 Saturday). NDRRMC admits COVID-19 added challenge to Typhoon Ambo response. Philippines Daily Inquirer. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:5YXP-C651-JCH9-G3VM-00000-00&context=1516831.

[118] Kahambing J. (2020). Public health and local emergency ethics: vulnerability in Eastern Samar, Philippines. Public health, 185, 117–118. https://doi.org/10.1016/j.puhe.2020.05.032

Impacts included damage to some medical infrastructure,[119,120,121,122] although follow up news articles seem to think the actual impact on testing rates were minimal.[121] The eventual outbreak of Covid-19 in Eastern Samar seems not to be associated with Typhoon Ambo based on its occurrence via a hospital transfer independent of the typhoon. The lack of food was the most serious public health concern, additionally because poor nutrition can weaken the immune system, and the lack of proper sanitation in evacuation centers was another key concern.

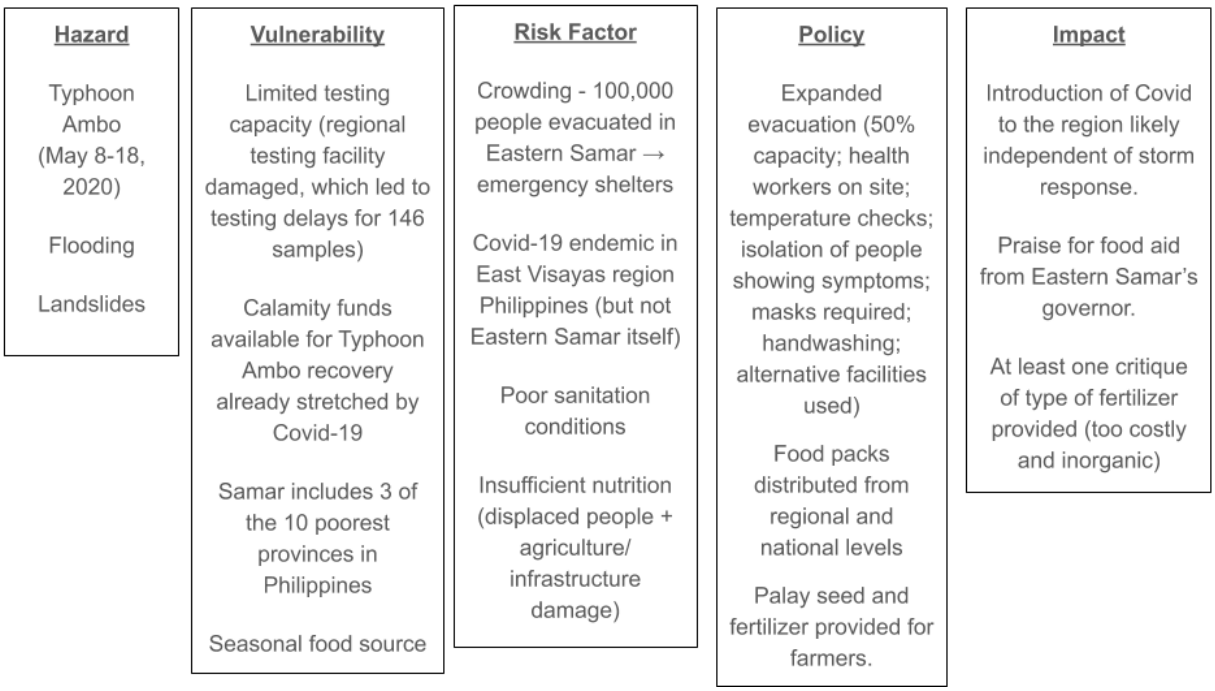

Figure 6. Vulnerability factors, risk factors, policies, and impacts related to Typhoon Ambo in Eastern Samar, Philippines.

Main takeaways/areas for concern

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[119] (May 16, 2020 Saturday). Ambo halts COVID-19 contact tracing in Camarines Norte town. Philippines Daily Inquirer. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:5YXP-C651-JCH9-G3V8-00000-00&context=1516831.

[120] (May 16, 2020 Saturday). COVID-19 testing machine in Bicol sustains damage during Typhoon Ambo. Manila Bulletin. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:5YX7-XNV1-F12F-F2GH-00000-00&context=1516831.

[121] (May 26, 2020 Tuesday). Typhoon-damaged Covid-19 testing lab in Bicol resumes operation. Philippines News Agency. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:600F-DYD1-F12F-F1D0-00000-00&context=1516831.

[122] (May 22, 2020 Friday). Philippines : Guv seeks restoration of COVID-19 isolation units in E. Samar. TendersInfo. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:5YYS-BY11-F11P-X4MR-00000-00&context=1516831.

A serious issue in this case, similar to Vanuatu, was that funds were strained from expenditure on Covid-19 relief. The infrastructure did not exist to deal with both issues at once. Although the Inter-Agency Task Force was created for that purpose,[123] the actual implementation of Covid-19 sanitation measures were lacking. Typhoon Ambo brings to the forefront issues of limited resources and the gap between policy and implementation.

Hurricane Laura: United States

Hurricane Laura hit Lake Charles, Louisiana on the Gulf coast of the United States on August 27, 2020. This landing in Lake Charles, Louisiana differed from the other cases in that Lake Charles was a hotspot for Covid-19.[124] Many displaced persons opted for government-sponsored hotels in lieu of evacuation centers,[125] and some neglected to evacuate perhaps because they were more afraid of Covid-19 than the storm.[126]

With a population of 328.2 million, 50 states, and 14 territories, the United States has greater in-house capacity for disaster management -- based on numbers alone -- compared with Vanuatu and the Philippines. That said, the United States response model is similar to that employed in the Philippines, with a process for receiving emergency funds after declaration of a state of emergency.

In case of an emergency in the US, state governors may apply to the federal Congress for an emergency declaration. Once the declaration has been approved, Congress must act to approve allocation of federal funds to the state through the Federal Emergency Management Administration (FEMA). FEMA has funds that are annually available for states in emergency situations, and these funds come from federal taxes and as such are supported by all taxpaying citizens. Provision of federal funds can take time, and states also manage emergencies in house. However, with the nature of 'disasters' being that they overwhelm local capacity, federal aid can be crucial.

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[123] (May 14, 2020 Thursday). Pangasinan braces for Typhoon Ambo, prepares emergency response. Manila Bulletin. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:5YWW-YHJ1-F12F-F2X9-00000-00&context=1516831.

[124] Jenny Haward. (September 19, 2020 Saturday). 'My Family Is Homeless After Hurricane Laura, Our City Has Been Devastated'. Newsweek.com. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:60W5-9721-DY68-11S6-00000-00&context=1516831.

[125] David Jacobs, The Center Square. (August 31, 2020 Monday). Electricity in SW Louisiana may be out for over 3 weeks. New Orleans CityBusiness. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:60RX-TSM1-JCP2-50HX-00000-00&context=1516831.

[126] Botzen, W.J.W. and Mol, J. M. and Robinson, Peter John and Zhang, Juan and Czajkowski, Jeffrey, Individual Hurricane Preparedness During the COVID-19 Pandemic: Insights for Risk Communication and Emergency Management Policies (September 8, 2020). Available at SSRN: https://ssrn.com/abstract=3699277 or http://dx.doi.org/10.2139/ssrn.3699277

As for TC Harold and Typhoon Ambo, Hurricane Laura was a potent storm that forced population displacement, in this case more than 10,000 evacuees,[127] and resulted in power outages.[128] People in the affected region were at risk for exposure to the elements as well as exposure to Covid-19. Covid-19 was particularly concerning in this case compared with the others because Lake Charles was a hotspot for Covid-19 in Louisiana.[129] Those that stayed faced infrastructure damage and high risk of exposure to Covid-19.[129,130] For those who evacuated, Louisiana abandoned previous protocols and evacuation centers in favor of encouraging evacuation to hotels,[127] where isolating 'germ circles' from each other would be easier.

Regarding differences in vulnerability, people in Louisiana would have ranging abilities to evacuate. Ability and willingness to travel would vary and ability to pay for a hotel would vary.[131] Further complicating the evacuation, the state government failed to convince many hotels (already struggling financially during Covid) to donate rooms for displaced persons.[132] Louisiana offered free Covid-19 testing for displaced persons, in an effort to catch and mitigate outbreaks; however, reports indicate this resource was underutilized, which indicates a communication breakdown.

As in other regions, funds had already been strained due to Covid-19.[133] While the U.S. Congress eventually allocated emergency funds,[134] these funds were delayed due to national level

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[127] David Jacobs, The Center Square. (August 31, 2020 Monday). Electricity in SW Louisiana may be out for over 3 weeks. *New Orleans CityBusiness.* Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:60RX-TSM1-JCP2-50HX-00000-00&context=1516831.

[128] (September 22, 2020 Tuesday). Entergy Provides Update on Hurricane Laura; Unprecedented restoration and rebuild work continues. PR Newswire. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:60WT-BN01-JB72-13CS-00000-00&context=1516831.

[129] Jenny Haward. (September 19, 2020 Saturday). 'My Family Is Homeless After Hurricane Laura, Our City Has Been Devastated'. *Newsweek.com.* Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:60W5-9721-DY68-11S6-00000-00&context=1516831.

[130] Matt Haines. (September 2, 2020). How a Louisiana Medical Team Protected COVID-19 Patients as Hurricane Laura Ravaged Lake Charles. Voice of America News. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:60RK-BSS1-DYVR-P406-00000-00&context=1516831.

[131] Targeted News Service. (September 30, 2020 Wednesday). Center for American Progress: 'Equitable and Just Hurricane, Disaster Preparedness Amid COVID-19'. Targeted News Service. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:60YJ-CN01-DYG2-R2J0-00000-00&context=1516831.

[132] By David Jacobs | The Center Square. (September 3, 2020 Thursday). Louisiana struggles to find rooms to shelter Hurricane Laura evacuees. Newstex Blogs The Center Square: Louisiana. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:60RX-FMD1-F03R-N4KN-00000-00&context=1516831.

[133] Targeted News Service. (September 5, 2020 Saturday). Following Hurricane Laura, Cornyn, Cruz Urge Senate to Pass Relief for Texas, Louisiana. Targeted News Service. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:60S5-YYD1-DYG2-R55B-00000-00&context=1516831.

[134] CityBusiness staff reports. (August 26, 2020 Wednesday). LWC: 400,000 to receive $300 federal benefit starting today. New Orleans CityBusiness. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:60R8-X0G1-F053-W1SV-00000-00&context=1516831.

congressional gridlock. At the state level, tension developed between the legislative and executive branches, which manifested as a special Covid-19 session for the legislature to address the governor's emergency and disaster powers.[135]

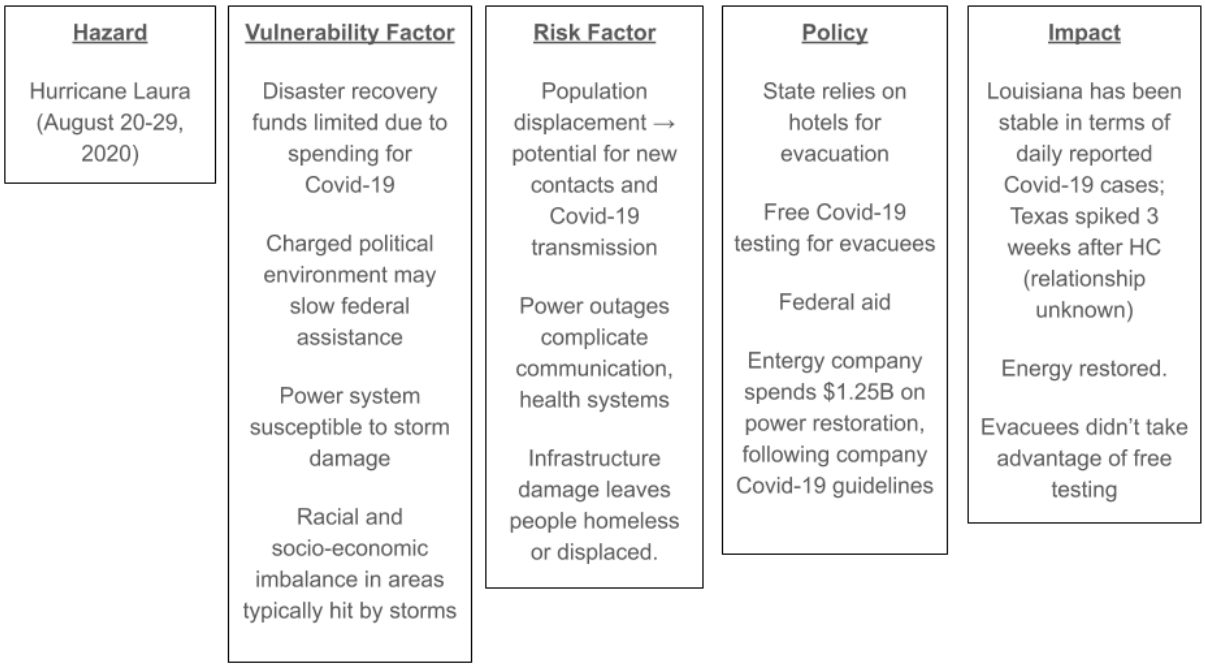

Figure 7. Vulnerability factors, risk factors, policies, and impacts related to Hurricane Laura in Louisiana, USA.

Main takeaways/areas for concern

The main takeaways from this case are the influence of fear and miscommunication on disaster management. Evacuation rates were low, because people feared Covid-19 more than the storm. Miscommunication led to breakdowns in service provision in Congress and in giving out tests. There is no clear evidence of post-disaster Covid spikes. However, that result may be unreliable because most of the press for storms seems to relate to what may happen rather than following up to monitor what does happen.

Summary and Conclusions

[135] MELINDA DESLATTE. (September 21, 2020 Monday). Louisiana lawmakers call another COVID-19 special session. Associated Press State & Local. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:60WN-53F1-DYMD-652T-00000-00&context=1516831.

As of October 2020, disaster response had avoided major spikes in cases, in contrast to the 60-600K projected by Pei et al. 2020.[136] These cases show clear policies taken by governments to incorporate Covid-19 prevention and treatment into disaster response, while also revealing pitfalls of disaster management.

The main strategies employed were a) maintaining distance -- either between borders or evacuees -- to prevent spread of Covid-19 and b) providing resources in the form of food or testing. In terms of addressing factors that promote infectious diseases, these measures concentrated on reducing the likelihood that crowding, disruption of health services, and poor nutrition would promote Covid-19. Provision of food related more to preventing starvation than Covid-19, but the factor still applies.

Lessons learned from these cases include the importance of having a trusted policy in place so people still evacuate. In Louisiana, evacuation rates were a factor of 10 lower than expected (hundreds per day rather than thousands),[137] as people opted for storm exposure over potential exposure to Covid-19. Avoiding voluntary and dangerous storm exposure in the future can be achieved through established and well-communicated protocols for Covid-safety, which I recommend local, state, and national governments build into their disaster management infrastructure prior to the next epidemic. Additionally, disaster management can take different approaches, depending on whether or not the disease is endemic to the affected region. Vanuatu was able to remove distancing measures as long as the country maintained closed borders, while an expanded evacuation (to borrow a term from the Philippines) was essential in Louisiana, USA. It is important to have policies in place that integrate public health measures like these into disaster plans.

In the next chapter, I create a risk assessment matrix and apply it to three pre-existing disaster management plans from Fiji, Tonga, and Vanuatu to determine whether these plans successfully integrate public health measures to address Covid-19 risks.

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[136] Preprint of Pei, Sen, Dahl, Kristina A, Yamana, Teresa K, Licker, Rachel, & Shaman, Jeffrey. (2020). Compound Risks of Hurricane Evacuation Amid the COVID‐19 Pandemic in the United States. Geohealth, 4(12), E2020GH000319-N/a. Accessed at https://www.medrxiv.org/content/10.1101/2020.08.07.20170555v1

[137] States News Service. (October 1, 2020 Thursday). DISPLACEMENT, GENDER DISPARITIES, AND SHELTER UTILIZATION AFTER HURRICANE LAURA. States News Service. Retrieved from https://advance-lexis-com.offcampus.lib.washington.edu/api/document?collection=news&id=urn:contentItem:60YS-51B1-JCBF-S4FD-00000-00&context=1516831.

Chapter 4: Risk assessment for Covid-19 and disaster plans

In the previous chapters of this thesis, I unpacked the relationship between natural disasters and infectious diseases (theory) and examined how disaster managers attempted to prevent Covid-19 amidst a tropical cyclone severe weather event (reality). In this chapter, I look at the link between disaster management theory and a disaster manager's reality through examination of written policy. The policies I analyze in this chapter are all national level disaster plans from my region of interest and include plans from Fiji, Tonga, and Vanuatu. While policies may differ from what is implemented -- as was the case in Eastern Samar, Philippines -- they are still vital frameworks for disaster response and recovery. As such, I examined these policies to determine whether these frameworks prepare disaster managers to combat Covid-19.

The chapter first presents a policy analysis matrix tailored to Covid-19 risks throughout the disaster management cycle. This matrix is then applied to policies from Fiji, Tonga, and Vanuatu to examine the extent to which these plans address Covid-19 risks. Finally, scores generated through the matrix and the policy measures that led to these scores are discussed.

Construction of the matrix

The fundamental goal of policy analysis is to improve policy,[138] and this matrix specifically aims to strengthen disaster management policy against the spread of Covid-19. The matrix contributes this first by identifying Covid-19 risks to which a policy may be susceptible, and then systematically comparing policy measures to these risks. The matrix is based on public health literature[139] and guidelines from the World Health Organization,[140],[141] and it is informed by the discoveries presented in Chapter 2 and 3 of this thesis. The specific risks used are listed in Table 1.

Table 1. Covid-19 risks used in matrix, along with explanation of what the risks are, the category(s) for that risk (prevention, containment, or treatment), and the in-text citation for the source.

Risk to Address	Explanation	Category	Source

[138] Dunn, William N. (2018). Public Policy Analysis (6th ed.). Milton: Routledge. p. 27.
[139] Kim, Eun-A. (2020). Social Distancing and Public Health Guidelines at Workplaces in Korea: Responses to Coronavirus Disease-19. Safety and Health at Work, 11(3), 275-283.
[140] n.d. 2020. "Critical preparedness, readiness and response actions for COVID-19". World Health Organization. Accessed at: https://www.who.int/publications/i/item/critical-preparedness-readiness-and-response-actions-for-covid-19.
[141] n.d. 2020. "WHO mass gathering COVID-19 risk assessment tool – Generic events". World Health Organization. Accessed at: https://www.who.int/publications/i/item/10665-333185.

Prevent close contact within endemic areas?	Close contact facilitates spread of Covid-19	Prevention	Kim (2020)
Prevent transfer of virus to non-endemic areas?	Transfer of virus from endemic to non-endemic areas	Prevention	“Critical preparedness” (2020)
Hand hygiene measures?	Lack of hand hygiene (washing with soap and water and/or applying hand sanitizer) facilitates spread	Prevention, Containment	“WHO mass gathering” (2020)
Respiratory etiquette measures?	Lack of ‘respiratory etiquette’ (wearing a mask, social distancing, etc.) facilitates spread	Prevention, Containment	“WHO mass gathering” (2020)
Detection strategy for infected persons?	Infected people go undetected, permitting unmonitored viral spread	Containment	Kim (2020)
Isolation strategy for infected persons?	When infected people are not isolated, they can further propagate the virus	Containment	“Critical preparedness” (2020)
Contact tracing measures?	Lack of contact tracing permits spread beyond case zero	Containment	“Critical preparedness” (2020)
Sufficient PPE and testing equipment?	Inadequate PPE to prevent spread or testing equipment to monitor and stem outbreaks	Containment	“WHO mass gathering” (2020)
Emergency transportation services?	Lack of transportation services means people can’t be isolated if showing symptoms	Containment, Treatment	“WHO mass gathering” (2020)
Ability to treat infected patients?	Inability to treat infected patients may increase Covid-19 morbidity	Treatment	“Critical preparedness” (2020)
Special measures for most at-risk?	Virus transferred to people with elevated risk for adverse effects of Covid-19 (elderly, etc.) can yield higher morbidity	Treatment	“WHO mass gathering” (2020)
Medical centers prepared?	Medical centers not prepared	Treatment	“WHO mass gathering” (2020)
Clear delineation of who is responsible for	Unclear who is responsible for providing care during a natural	Treatment	“WHO mass gathering” (2020)

medical care?	disaster		
Clear risk communication strategy?	Lack of clear risk communication strategy can lead to preventable risk exposure	Prevention, Containment, Treatment	"WHO mass gathering" (2020)
Adequate funding?	Lack of funding for Covid-19 prevention measures	Prevention, Containment, Treatment	"WHO mass gathering" (2020)
Provide training?	Staff / disaster response teams untrained in Covid-19 prevention	Prevention, Containment, Treatment	"WHO mass gathering" (2020)
Coordinated efforts?	Coordination between departments and levels of government is essential when dealing with multiple 'disasters'	Prevention, Containment, Treatment	"WHO mass gathering" (2020)

Some of these risks are more essential for Pacific Islands than others. As was shown with Tropical Cyclone Harold, water barriers in Pacific Islands apply to both resource provision as well as viral spread; preventing viral spread from endemic areas to non-endemic is thus an important feature that can be more easily controlled than in a land-dominated region. "Medical centers prepared?" is probably the least applicable to Pacific Island nations. Vanuatu, for example, is an archipelago of 83 islands but 5 public hospitals; this means that medical center preparedness is less important than a clear delineation of who is responsible for medical care, particularly on the more remote islands. However, for the sake of this analysis, all risks were given equal importance in scoring.

The risks are grouped into categories, based on Chapter 2's literature review as well as the policy and impact trends present in Chapter 3. When examining the news articles to identify factors that increased Covid-19 vulnerability and government actions against Covid-19, there were a wide range of vulnerabilities and actions, combating different aspects of Covid-19. For example, in Vanuatu, concerns about the lack of ICU beds and the potential for Covid-19 to enter the country were both related to Covid-19; however, one was a concern about Covid-19 getting into the country, and the other was a concern about what would happen once it got there. Additionally, the expanded evacuation in the Philippines and emphasis on testing in the U.S. (although both experienced implementation shortcomings) were both attempts by their respective governing bodies to contain existing Covid-19 cases. Thus, three categories of concerns and government actions exist to mitigate Covid-19 outbreaks in the aftermath of a tropical cyclone or other hazard: prevention, containment, and treatment. Covid-19 **prevention** involves preventing an outbreak in the first place, **containment** describes measures to control the severity of an

outbreak, and **treatment** involves measures to treat Covid-19 patients, decreasing morbidity rates. The risks grouped as shown in Table 1, with some risks applying to multiple categories.

I set up the matrix to analyze each policy for whether it addresses these risks, with a separate row for each policy measure within the larger policy documents. Policy documents receive multiple scores, including scores to address the multiple phases of disaster management (mitigation, preparedness, response, and recovery). Each "score" equates to "number of risks addressed" within each risk category. The same risk could be addressed by multiple policy measures, and the plan being analyzed would still only receive one point for that risk.

Below is a hypothetical matrix application for Country 1, Document 1, with hypothetical policy measures A, B, and C related to tropical cyclone response. For viewing purposes, the 35 column spreadsheet has been broken up into 4 parts and filled out with three hypothetical policies. The complete version of the matrix, containing the actual policy measures and what risks they addressed, can be found in the supplementary.

Table 2a. Columns 1-4 of the risk matrix, with 3 hypothetical policy measures related to response for hypothetical Country 1, Document 1.

Country (Fiji, Vanuatu, Tonga)	Policy Document	Policy Measure	Management Stage (Mitigation, Preparedness, Response, Recovery)
Country 1	Document 1	Measure A	Response
Country 1	Document 1	Measure B	Response
Country 1	Document 1	Measure C	Response

Table 2b. Columns 5-13 of the risk matrix; determining prevention score for 3 hypothetical policy measures.

Prevent transfer of virus to non-endemic areas?	Prevent close contact within endemic areas?	Hand hygiene measures?	Respiratory etiquette measures?	Clear risk prevention communication strategy?	Adequate funding for prevention?	Training for prevention measures?	Coordinated efforts to aid prevention?	Prevention Score (out of 8)
		X	X					
				X		X		
					X			**5**

Table 2c. Columns 14-25 of the risk matrix; determining containment score for 3 hypothetical policy measures.

Detection strategy for infected persons?	Isolation strategy for infected persons?	Contact tracing measures?	Hand hygiene measures?	Respiratory etiquette measures?	Sufficient PPE and testing equipment?	Emergency transportation services?	Clear risk containment communication strategy?	Adequate funding for containment?	Training for containment measures?	Coordinated efforts to aid containment?	Containment Score (out of 11)
	X		X	X							
							X		X		
X								X			**8**

Table 2d. Columns 26-35 of the risk matrix; determining treatment score for 3 hypothetical policy measures.

Ability to treat infected patients?	Medical centers prepared?	Clear delineation of who is responsible for medical care?	Special measures for those most at-risk?	Emergency transportation services?	Clear risk treatment communication strategy?	Adequate funding for treatment?	Training for treatment measures?	Coordinated efforts to aid treatment?	Treatment score (out of 8)
					X				
						X			**2**

Using this Matrix, I analyzed three national level disaster management policies: Fiji's National Disaster Management Plan,[142] Vanuatu's National Cyclone Support Plan,[143] and Tonga's National Emergency Management Plan.[144] These plans were provided via DropBox access from Mosese Sikivou, Regional Coordinator of the Pacific Resilience Program.

Fiji's National Disaster Management Plan

Fiji's National Disaster Management Plan was prepared by their National Disaster Management council and Government Agencies and published in 1995. The policy is divided into six sections:

1. General Background Information
2. Organization
3. Principle Roles & Responsibilities of Agencies
4. Emergency operations
5. Relief + Rehabilitation
6. Mitigation, Public Awareness and Training

Overall, Fiji scored 8/8 for Prevention, 8/11 for Containment, and 9/9 for Treatment. Risks were addressed to variable degrees; within Prevention, only one measure -- "Health and Sanitation: To take measures to safeguard the health of victims and to maintain reasonable sanitation facilities" applied to respiratory etiquette measures; conversely, 56 measures addressed coordinating efforts that could aid Prevention.

The same coordination-emphasis applied to Containment. Within the Containment category, Fiji's plan lacked any information or infrastructure that applied to or could be adapted for a detection strategy, isolation strategy, or contact tracing.

Fiji's plan had a variety of measures that addressed Treatment risks, such as "The Health Department takes appropriate measures to ensure that environmental conditions are such that these do not give rise to increased health risks," which is probably the most directly applicable to Covid-19 and designates responsibility to the Health Department. Additionally, "The Public Works Department assumes responsibility for the provision of access to safe water, including the management of an emergency water supply operation, the distribution of containers and other measures" applied to ensuring medical centers are prepared to treat sick patients.

The scores for each management phase (preparedness, response, etc.) are described in the summary table below.

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[142] National Disaster Management Council. (1995). *Fiji National Disaster Management Plan*. Republic of Fiji.
[143] Ministry of Climate Change Adaptation, Energy, Environment Geo-Hazards and National Disaster Management Office. (2019). *National Cyclone Support Plan 2019-2020.* Republic of Vanuatu.
[144] Kingdom of Tonga. (2007). *NATIONAL EMERGENCY MANAGEMENT PLAN*. Kingdom of Tonga.

Kingdom of Tonga's National Emergency Management Plan

The Kingdom of Tonga's National Emergency Management Plan was developed by the National Emergency Management Committee's Planning Working Group and published in 2007. The Plan relies on the Comprehensive Hazard and Risk Management (CHARM) framework, developed by the Pacific Islands Applied Geoscience Commission (SOPAC). This policy document is separated into three parts:

- Part A: Country Profile
- Part B: Disaster Risk Reduction
- Part C: Emergency Management

Overall, Tonga scored 8/8 for Prevention, 11/11 for Containment, and 9/9 for Treatment. Tonga has clearly delineated who is responsible for what and has infrastructure to address all risks. Coordination and communication were highly represented across risk categories, and the Ministry of Health had responsibility for addressing the most Covid-19-specific (i.e. "The Ministry of Health is responsible for ongoing medical and health services required during the recovery period to preserve the general health of the community" (p. 54)). Notably, Tonga incorporated infectious diseases into the policy text through the measure, "The Ministry of Health is responsible for epidemiology/disease surveillance" (p. 54), which addressed five risks between prevention and containment.

Vanuatu's National Cyclone Support Plan

Vanuatu's National Cyclone Support Plan was created by the Ministry of Climate Change Adaption, Energy, Environment Geo-Hazards and the National Disaster Management Office. The Plan was published September 2019, although it is a reiteration of the equivalent plan published in 2012. This policy document is organized by cluster, with 30 sections in the document covering everything from Section 2: Activation of Cyclone Support Plan and Declarations to Section 15: Evacuation Centres/Safe Shelters to Section 19: Humanitarian Response.

Overall, Vanuatu scored 8/8 for Prevention, 11/11 for Containment, and 9/9 for Treatment, meaning each risk was addressed by at least one policy measure. Vanuatu emphasizes coordination and clusters as well as self-reliance (especially for regions not covered by the more centralized clusters). The policy focused heavily on coordination, communication, and responsibility allocation. The plan was adaptable, with policies like "Before the end of October each year, NDMO will coordinate meetings with cluster leads to assess planning and preparedness across all clusters" (p. 13), which would allow for management tailored to the unique needs of each year.

Within Prevention, key contributing measures were Vanuatu's biosecurity stipulations and emphasis on WASH. Example policies include: "Department of Biosecurity will facilitate the

quarantine clearance of international aircraft loaded with disaster relief supplies donations . . . [and] will always safeguard our borders from foreign damaging pests and diseases" (p. 27) as well as "Within the Cluster for Health and Nutrition, Save the Children is responsible for prevention campaigns on WASH and Nutrition . . . at Health facilities and community level" (p. 33). Vanuatu did not have any huge policy gaps, except a lack of mitigation measures.

Overarching Results and Conclusions

Scores By Management Phase

Table 3. Risk scoring by management phase and Covid risk category for national level policy plans from Tonga, Vanuatu, and Fiji.

			Score				
Country	**Policy Plan**	**Covid Risk Category**	*Mitigation*	*Preparedness*	*Response*	*Recovery*	***Overall***
Tonga	Kingdom of Tonga National Emergency Management Plan	*Prevention*	2	8	8	7	**8**
		Containment	1	8	11	10	**11**
		Treatment	3	8	9	8	**9**
Vanuatu	Vanuatu National Cyclone Support Plan 2019-2020	*Prevention*	0	8	8	8	**8**
		Containment	0	9	11	11	**11**
		Treatment	0	9	9	9	**9**
Fiji	Fiji National Disaster Management Plan January 1995	*Prevention*	4	5	8	8	**8**
		Containment	4	6	8	8	**8**
		Treatment	4	8	9	9	**9**

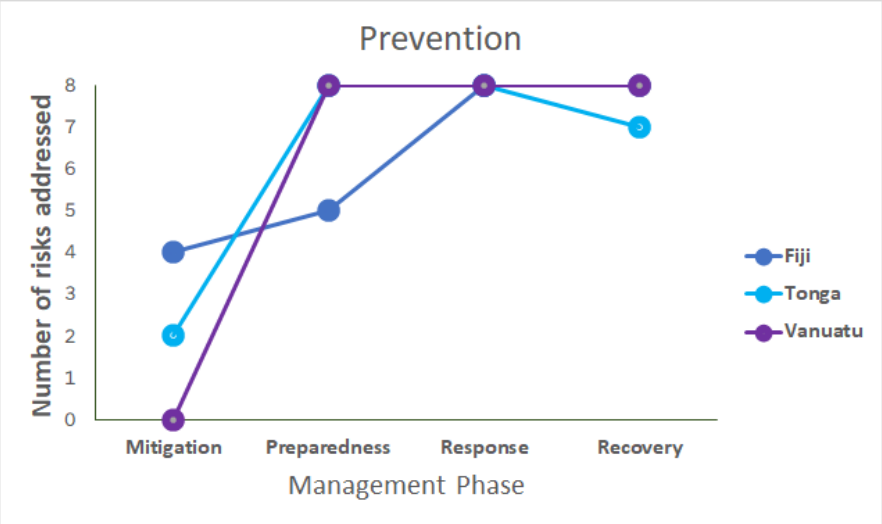

Figure 8. Line graph of number of risks addressed within subsequent management phases for Fiji (dark blue), Tonga (light blue), and Vanuatu (purple) within the Prevention risk category.

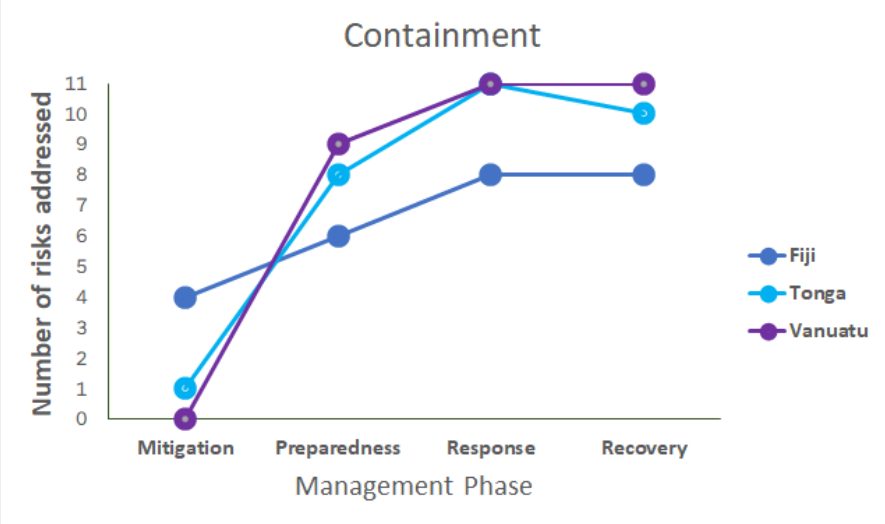

Figure 9. Line graph of number of risks addressed within subsequent management phases for Fiji (dark blue), Tonga (light blue), and Vanuatu (purple) within the Containment risk category.

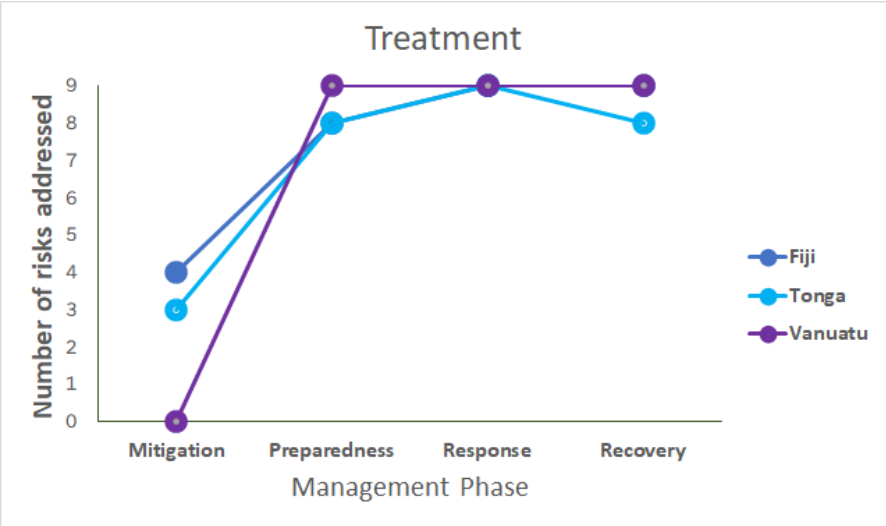

Figure 10. Line graph of number of risks addressed within subsequent management phases for Fiji (dark blue), Tonga (light blue), and Vanuatu (purple) within the Treatment risk category.

Overall, the Response phase was most highly represented in these disaster plans, followed by Preparedness, Recovery, and finally Mitigation. Preparedness, Response, and Recovery are probably the most pertinent phases because the main way to mitigate natural disasters for Island Nations in the South Pacific at this point is to take drastic climate action, which lies partly beyond the control of these States.

Vanuatu's cyclone scored highest for Preparedness through Recovery, but completely lacked Mitigation measures that were applicable to Covid-19. That said, measures applicable to Mitigation for Tonga and Fiji were also applicable to Preparedness, as these policies did not treat the two as mutually exclusive. One example of a mitigation/preparedness measure from Fiji was, "NDMO specific tasks on Mitigation & Preparedness include to maintain liaison with International Agencies on disaster-related projects for Fiji". This measure is adaptable for vaccination campaigns in Fiji before the next cyclone season.

These policies tended to cover most risks within the "Treatment" risk category, which is expected given the need for treatment capacity for disaster-related injuries or similar pre-dating Covid-19.

Strengths in Common

A strength that has likely facilitated effective management of both tropical cyclones and Covid-19 is the inclusion of the health ministries and organizations like the Red Cross as key players in disaster management across these three plans. Vanuatu and Tonga were more specific than Fiji in what responsibilities were assigned to health ministries, such as Tonga specifying epidemiology/disease surveillance and Vanuatu requiring a scale up of their "syndromic surveillance system accordingly" (p. 32). A possible explanation for this absence on Fiji's part is that Fiji's Disaster Management Plan pre-dates the 2004 earthquake and tsunami that inspired much of the attention to the relationship between disasters and infectious diseases. The ni-Vanuatu and Tongan policies came after this event and as such, it makes sense that they would include specific language on disease surveillance.

Probably the greatest strength of these policies is their adaptability. Each plan includes a measure to adjust the disaster management team or approach based on what a particular event or tropical cyclone season demands:

- **Tonga:** "'Residual risks' and any additional or resultant risks identified in the course of the ongoing monitoring and review process need to be referred to the National Emergency Management Office for consideration as to whether existing or general emergency management programs (covering preparedness, response and relief activities) will address such risks, or whether a particular emergency management sub-plan needs to be developed." (p. 40)
- **Vanuatu:** "The NDC can increase the NDMO resources to include persons with specific skills and expertise to provide technical advice and surge capacity with line government staff as required." (p. 7)
- **Fiji:** "It is the Chairman's prerogative to call for member's attendance according to each disaster management needs. In addition, the Chairman has the right to co-opt Divisional Commissioners and representatives from any other agencies to invite those NGOs whom he considers will help to achieve disaster management objectives."

Allowing for development of a sub-plan or recruitment of agencies and/or persons with specific skills allows disaster managers to tailor management to the needs of a given scenario, which will be increasingly important as tropical cyclones worsen and epidemics may become more frequent.

Additionally, all plans included a feedback mechanism, through annual meetings or similar, by which to strengthen disaster management. Having a feedback mechanism built-in is important to prevent ineffective policy from continuing year-to-year.

Areas for Improvement: What is the policy gap in terms of addressing Covid-19?

Fiji's National Disaster Management Plan neglected Covid-19 risks related to containment, with a lack of measures adaptable to a) detection strategies for infected persons, b) isolation strategies for infected persons, and c) contact tracing measures. However, given Fiji's Covid-19 response included development of a contact tracing app (CITE), the country has infrastructure to cover this gap, even though it is not embedded in the policy.

Compared with the other two policies, the Kingdom of Tonga's National Emergency Management Plan had fewer policies related to training. Tonga also had a lower score for recovery-relevant policies. Rather than go into recovery-specifics, the policy set up a post-impact assessment process to inform needs.

Vanuatu's gap was the lack of mitigation policies. This absence may be related to the plan being specific to a type of hazard (tropical cyclones) rather than an overarching disaster or emergency management plan. Additionally, Vanuatu's strict requirements for food aid, requiring "receipt and analysis of damage and needs assessment reports" (p. 22), may have exacerbated the delays experienced during Tropical Cyclone Harold.

No policy perfectly addressed all Covid-19 risks across all phases of disaster management. However, policies are just documents, and what is implemented may differ. There is a trade-off in disaster

management between having specific plans and making plans adaptable to unforeseen hazards. These are the gaps that would need to be covered by adaptive management, which fortunately these policies allow.

Chapter 5: Conclusions

In this thesis, I completed three separate analytical tasks to determine what the nations of Fiji, Tonga, and Vanuatu need to do to prevent Covid-19 outbreaks amid tropical cyclone threats.

The first of these, the flowchart summary of disaster management theory on infectious diseases, answered the question, what relates tropical cyclones and Covid-19. My answer was crowding, poor sanitation, poor nutrition, and lack or disruption of health services. Population displacement in particular was emphasized, as population movement can provide new exposure pathways as well as being associated with lowered nutrition or sanitation.

My review of severe weather events in Vanuatu, the Philippines, and Louisiana, USA showed ways that disaster managers attempted to prevent or contain Covid-19. When Tropical Cyclone Harold hit Vanuatu in April, Vanuatu's closed-border policy stemmed Covid's introduction. However, articles reported aid delays and malnutrition in remote regions, connected to the 3-day aid quarantine in Port Vila. Vanuatu also received substantially less financial support compared with TC Pam in 2015; this difference may be inherent to a global pandemic -- governments will prioritize international aid less while they deal with effects of Covid-19 in their own nations. This trend of Covid-strained resources also emerged in news articles about Typhoon Ambo in the Philippines. Typhoon Ambo hit the Eastern Samar region, where Covid-19 was not yet endemic, and their agricultural food source was inundated. Eastern Samar's government had already stretched calamity funds for Covid-related aid, so the Philippine government sent food packs. The Philippine government also ordered for an 'expanded evacuation' with distancing, health, and hygiene measures. However, at least one paper reports evacuation sites without hand washing stations, indicating a discrepancy between policy and implementation. The United States attempted to curtail potential outbreaks when Hurricane Laura hit Louisiana in August. State government response teams provided free Covid-19 testing and encouraged evacuation to hotels. However, they had coordination problems -- few people took advantage of the free testing and not all hotels wished to donate rooms. Critically, my review revealed policy breakdowns, with the questionable sanitation for evacuation in the Philippines, under-utilized Covid-testing in the USA, and inaccessible WASH stations in Vanuatu.

Finally, I generated a risk assessment matrix to determine whether pre-existing policies for Fiji, Tonga, and Vanuatu were Covid-19 ready. Tonga and Vanuatu scored well, with some preparedness and recovery gaps for Tonga and a major mitigation gap for Vanuatu. Fiji scored less well in detection, isolation, and contact tracing measures, although this policy scored best for Covid-19 adaptable measures in the mitigation phase.

To answer the question, what can disaster managers do to prevent Covid-19 outbreaks, I would say the following:

- Be mindful of population displacement and the crowding, poor sanitation, poor nutrition, and lack or disruption of health services that may occur along with it;
- Ensure policy implementation;
- Take advantage of adaptable measures and feedback mechanisms in policies to address Covid-19 risks.

Ensuring policy implementation is critical. With the case of Vanuatu, Vanuatu did execute a Desktop Simulation Exercise for Covid-19 preparedness, as stipulated in their policy. However, despite having a policy that “Facilities and services provided for the community must cater for People Living with Disabilities (PLWD) and provide accessibility for all;” inaccessibility was still an issue during TC Harold.

Covid-19 will not be around forever, or at least not in the way that it has permeated the globe since 2020. However, with tropical cyclones projected to worsen and epidemics likely to come again, it is important to have management that intentionally integrates addressing these risks into common practice.