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Vulnerability of Pacific Island Country Hospitals: Critical Infrastructure that must be Addressed

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The COP27 Loss and Damage Fund agreement was a celebrated win for Pacific Island Countries (PICs). They are within the most at risk region worldwide due to being subject to regular extreme weather events. Adaptation funding has not adequately addressed preventing risk and loss. In 2016 the World Risk Report defined critical infrastructure as essential adaptation to address in order to reduce both human and economic losses due to risk vulnerability. The sectors that make up critical infrastructure include "health" which straddles two adaptation sectors: hardscape infrastructure which includes hospitals and conventional health delivery. Hospitals have historically been seen as investments in health. Vulnerable Pacific Island hospitals that lack the luxury of redundancy of services while serving populations of people living on atolls and isolated islands need to be seen as critical infrastructure. This analysis looks at 78 hospitals located in 14 Pacific Island Countries through the lens of climate change critical infrastructure adaptation.

Within one week northern Guadalcanal in Solomon Islands experienced bookend natural disasters: flooding due to heavy rainfall and a 7.0 earthquake followed by multiple aftershocks and a tsunamis alert. As a result of both of these natural disasters the medical staff at National Referral Hospital (NRH) in Honiara had to prepare to evacuate their patients. And while they did not have to move them the very act of preparing to evacuate, including discharging patients deemed stable, is disruptive to care. Heavy precipitation and earthquakes cannot be avoided, they are an inherent part of the risk exposure throughout the Pacific Region. The IPCC AR6 Working Group one projects with high confidence heavy precipitation will increase in frequency and intensity in the western tropical Pacific Region.

Tropical cyclones, a common occurrence in the region, are projected by the IPCC AR6 WG1 to increase in intensity. Combined with a rate of sea level rise 2-3 times the global rate Pacific Island Countries (PICs) are faced with significant adaptation challenges. Mitigation, while seen as a long-term solution, will not build resilience against immediate climate mediated extreme

weather threats Pacific Islands regularly face. Support for adaptation with a focus on infrastructure must be a regional priority.

Small Island states, including the Pacific Islands, lose on average 1-9% of their GDP per year due to damage following natural disasters while they contribute less than 0.03 percent to the world's total greenhouse gas emissions. In 2021 just 21% of global climate funding was spent on adaptation while the majority of funds went to toward mitigation. The UNEP Adaptation Gap Report estimates adaptation costs for developing countries are five to ten times greater than the current adaptation funding available.

Rank	Country	WorldRiskIndex	Exposure	Vulnerability	Susceptibility	Lack of coping capacities	Lack of adaptive capacities
1.	Vanuatu	47.73	82.55	57.82	39.66	81.21	52.59
2.	Solomon Islands	31.16	51.13	60.95	46.07	81.14	55.63
3.	Tonga	30.51	63.63	47.95	28.42	79.81	35.62
4.	Dominica	27.42	61.74	44.41	23.42	71.13	38.67
5.	Antigua and Barbuda	27.28	67.73	40.28	23.80	64.41	32.62
6.	Brunei Darussalam	22.77	58.17	39.14	15.33	68.13	33.96
7.	Guyana	21.83	43.93	49.69	25.96	77.23	45.88
8.	Philippines	21.39	42.68	50.11	28.63	82.14	39.56
9.	Papua New Guinea	20.90	30.62	68.27	55.28	86.16	63.37
10.	Guatemala	20.23	36.79	54.98	32.55	85.66	46.72
11.	Cape Verde	17.72	37.23	47.59	28.86	72.71	41.21
12.	Costa Rica	17.06	44.27	38.54	19.96	65.33	30.34
13.	Bangladesh	16.23	28.11	57.74	32.57	85.57	55.07
14.	Fiji	16.06	34.51	46.55	22.06	76.63	40.95
15.	Cambodia	15.80	26.89	58.76	38.89	86.61	50.79

World Risk Report 2021

The 2021 World Risk report ranked 180 countries based upon their risk due to disasters as determined by:

1. Exposure (heavy rain, earthquakes, cyclones),
2. Susceptibility of infrastructure, food, and economy
3. Coping capacity based upon governance, health and social care systems
4. Adaptive capacity as it pertains to planning for upcoming threats.

Of the top 15 most at risk countries in the WRR 2021 five are Pacific Island Countries: Vanuatu, Solomon Islands, Tonga, Papua New Guinea and Fiji.

The 2016 the World Risk Report addressed "Logistics and Infrastructure" as they pertain to disaster risk and preparedness. In that report WRR defined **critical infrastructure** as "organizational and physical structures and facilities of such vital importance to a nation's society and economy that their failure or degradation would result in sustained supply shortages, significant disruption of public safety and security, or other dramatic consequences." The report identified 9 sectors that constitute critical infrastructure.

It is important to note vulnerability to extreme weather events in Pacific Islands not only damages infrastructure but it also contributes to population's health challenges. Extreme weather events can result in the taxing of already under resourced health systems by causing increases in rates of infectious diseases, worsening of existing chronic diseases and increased incidence of acute injuries. These impacts are layered on top of endemic communicable and noncommunicable diseases. Following the 2014 deadly flood in Honiara, Solomon Islands, rates of influenza like illness and diarrhea increased significantly in addition to the injuries and deaths

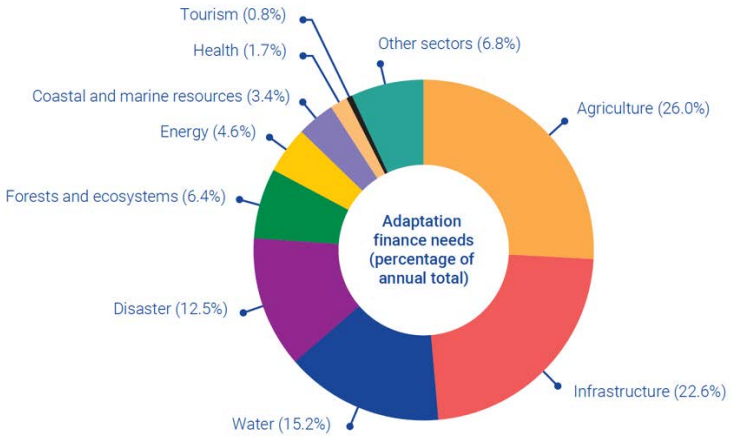
directly related to the flood event. Strong health systems can reduce the acute and subacute medical impacts that follow floods, cyclones and seismic events, while continuing to provide regular medical care.

- **Energy:** electricity, gas, oil
- **Information technology and telecommunication**
- **Transport and traffic:** air transport, maritime transport, inland waterways transport, rail transport, road transport, logistics
- **Health:** medical services, pharmaceuticals and vaccines, laboratories
- **Water:** public water supply, public sewage disposal
- **Food:** food industry, food trade
- **Finance and insurance:** banks, stock exchanges, insurance companies, financial service providers
- **State and administration:** government and public administration, parliament, judicial bodies, emergency/rescue services including civil protection
- **Media and culture:** broadcasting (television and radio), print and electronic media, cultural property, structures of symbolic meaning.

Source WRR 2016 Logistics and Infrastructure report.

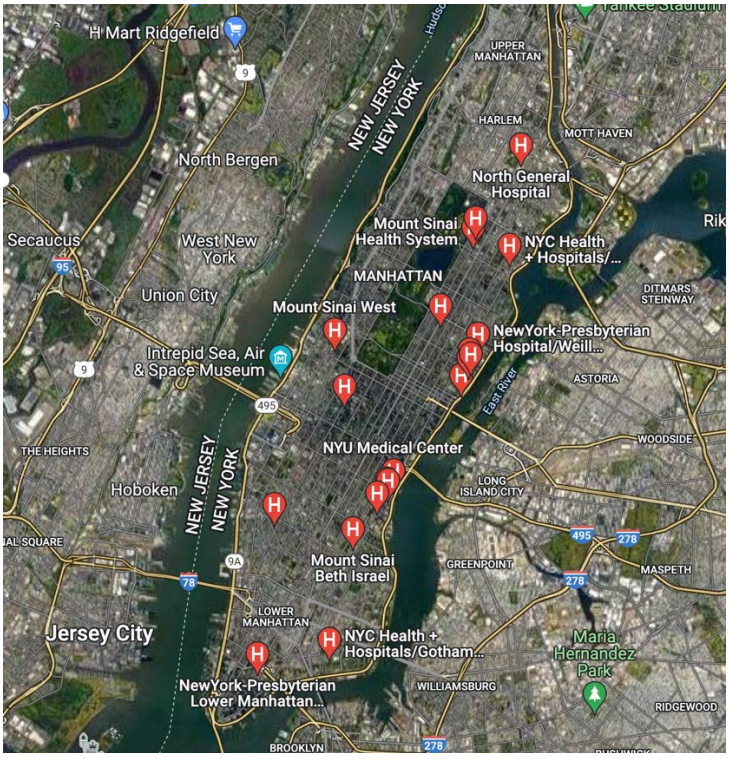
Despite the 2016 WRRs inclusion of health as critical infrastructure adaptation funding does not reflected it. This is partially due to how health, in general, is viewed and where hospitals fit in adaptation.

Figure ES.3 Adaptation finance needs by sectors based on 26 developing countries' NDCs and NAPs



Hospital buildings are health hardscapes making them cross sectoral adaptation projects that address both health and infrastructure. (Source: https://www.unep.org/resources/adaptation-gap-report-2021)

It is important to recognize that health and medical services are critical infrastructure. This includes hardscaped hospitals. In the United States the damage to hospitals following Hurricane Katrina and Superstorm Sandy highlights their vulnerability even in a resource replete environment. They also highlight the key role hospitals play during disasters. Damage to both New Orleans's Charity Memorial Hospital in 2005 and NYU Medical Center in 2012 cost over US$1.5 billion to repair. Charity Memorial Hospital flooded, lost power during an intense heatwave and delayed in evacuating patients and staff resulting in preventable deaths. When Hurricane Sandy's storm surge from the East River caused flooding of the New York University Medical Center 200 patients, some critical, had to be evacuated via the stairways. While the backup power generators were installed on the roof of NYU's 18 story building the distribution circuits and generator fuel tanks were located on the flooded lower levels. Fortunately, there were many hospitals in New York City that patients were safely evacuated to. This redundancy of critical services, additional hospitals to transfer patients to, is one form of adaptation to extreme weather events and external threats.



Google Earth images of hospitals in New York City. During superstorm Sandy patients evacuated from NYU Medical Center were transferred to other hospitals in the area. The redundancy of health infrastructure in New York City prevented catastrophic loss of life and compromise to patient care during an extreme weather event.

In addition to regular exposure to extreme weather events Pacific Island Country hospitals have limited hospital location options based upon geography. Many hospitals can only be built in close proximity to potential hydrological threats. In her paper The Vulnerability of Health Infrastructure to the Impacts of Climate Change and Sea Level Rise in Small Island Countries in the South Pacific Dr Subhashni Taylor used spatial analysis to look at the vulnerability of Pacific Island health facilities, including both clinics and hospitals, relative to distance from the

coastline. Her analysis estimated 62% of health facilities evaluated on 14 Pacific Island Countries were located within 500 meters (one third of a mile) of the coast.

Table 1. Summary information about the 14 PICs included in this study.

COUNTRY	TOTAL LAND AREA[a] (KM^2)	COASTLINE[a] (KM)	POPULATION[a] (2020)	NUMBER OF MEDICAL FACILITIES[B]
Melanesia				
Fiji	18 274	1129	935 974	180
Solomon Islands	27 986	5313	685 097	303
Vanuatu	12 189	2528	298 333	7
Micronesia				
Federated States of Micronesia (FSM)	702	1036	102 436	7
Kiribati	811	1143	111 796	4
Marshall Islands	181	2172	77 917	2
Nauru	21	30	11 000 (2019)	2
Palau	459	1519	21 685	1
Polynesia				
Cook Islands	236	120	8574	2
Niue	260	64	2000 (2019)	1
Samoa	2821	403	203 774	12
Tokelau	12	101	1647 (2019)	3
Tonga	749	909	106 095	3
Tuvalu	26	24	11 342	2

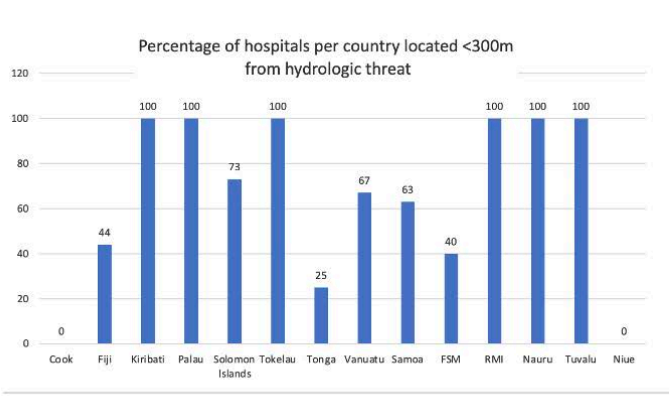
[a]As per literature and The World Factbook (https://www.cia.gov/the-world-factbook/countries/).
[b]Includes major hospitals, community health centers, area health centers, rural health centers, and nurse aid posts.

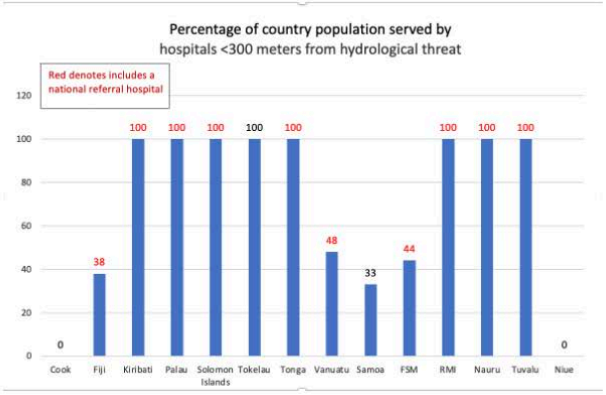
This table is from Taylor S. The Vulnerability of Health Infrastructure to the Impacts of Climate Change and Sea Level Rise in Small Island Countries in the South Pacific. *Health Services Insights*. 2021;14. The population data source is noted above and can reflect some inaccuracy as 2021 census data becomes available.[1]

In following up on Dr Taylor's work this analysis looks at the vulnerability of 78 Pacific Island hospitals in 14 Pacific Island Countries and includes distance from hydrological threat such as coastline or river, elevation above sea level, the number of beds the hospital has and the population catchment served by each hospital. Hospital location GPS coordinates, hospital beds and catchment population were obtained from Pacific Data Hub and Tupaia GIS data. Data was augmented by information from Government and Ministry of Health (MOH) websites. Hospitals were located and distance and elevation measurements collected using Google Earth. 2020 population information was obtained from the World Bank and from individual Pacific Island Country census data when available. Hospital specific information including damage history, relocation and planning were obtained from MOH websites, news searches, journal articles and

[1] Population data accuracy: Many sources estimate population based upon modeling using prior trends. This does not take into account out migration trends being seen in US territory and Compact PICs as well as Micronesia and Polynesia. The population data from RMI exemplifies this. The World Bank overestimated the 2021 population to be 59,618 but just released 2021 census data shows the population is 42,594, a decrease of 20%.

by direct communication with MOH or hospital administration. A list of all hospitals evaluated is at the end of this assessment.



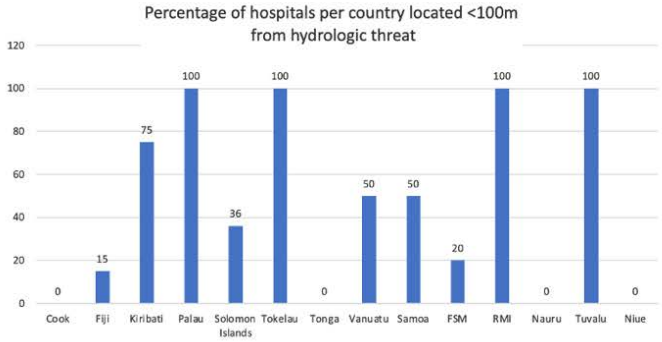


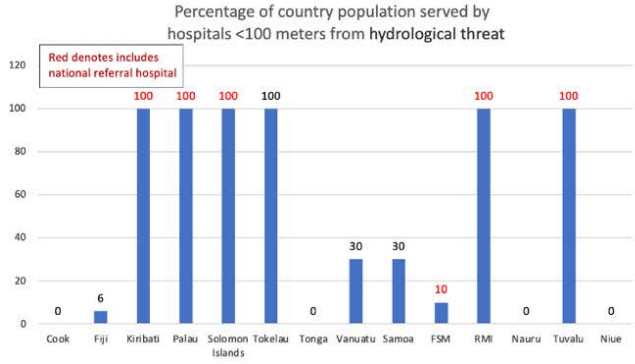
78 hospitals in 14 Pacific Island Countries: percentage hospitals located less than 300 meters from a hydrological threat is collectively 56% (left), the percentage of population at risk of losing hospital services if damaged is collectively 63% (right).

Of the 78 hospitals evaluated 56% are located within 300 meters (one fifth of a mile) of a hydrological threat such as coastline or river. Collectively the location of these hospitals put 63% of the Pacific Islands population at risk of losing hospital services should extreme weather threats such as cyclones, storm surge or sea level rise damage their hospital. 4 countries; Palau, Nauru, Tuvalu and Niue, have one hospital to serve the entire population leaving them with no redundancy of hospital services should their hospital be severely damaged. The majority of Pacific Island hospitals are the only hospital located on an island, atoll or island chain. This compounds a hospital vulnerability risk and makes rebuilding or relocating hospitals essential.

PICS with one hospital	PICs with one hospital per island, atoll or island chain
Palau	Cook Islands
Nauru	Fiji
Tuvalu	Kiribati
Niue	Solomon Islands
	Tokelau
	Tonga
	Vanuatu
	FSM
	RMI

The lack of hospital redundancy in the Pacific Islands puts the population served by them at risk of losing services if the hospital is damaged. 4 PICs have one hospital for the entire country and 38 of 78 (49%) of hospitals assessed are the only hospital serving an island, atoll or island group. Together 54% of PICs have no redundancy of hospital services making the safety of a hospital critical.





When the distance from a hydrological threat is reduced to <100 meters the percentage of vulnerable hospitals in the Pacific Islands decreases to 33%, with 44% of the population at risk of losing hospital services.

The isolation that many Pacific Island hospitals operate under adds to the need to promptly address their vulnerability. Safe hospital adaptation designs should incorporate architecture that stands up to extreme weather, including cyclones, but should also incorporate "island operationality" where the hospital has its own internal infrastructure (electric, water, sewer) that can function regardless of damage to surrounding communities. Hospitals must also be able to "ride out" the duration of a disaster by having adequate supplies of food, water and medicines available.

While the percentage of vulnerable Pacific Island hospitals and the populations they serve in this analysis is based solely upon proximity to a hydrological threat these estimates highlight the need for seeing hospitals as a part of critical infrastructure adaptation. Despite limitation in funding for adaptation many Pacific Island countries have already begun the process of addressing their hospital vulnerability in their National Adaptation Plans. If funding and land is available PICs have relocated hospitals inland and to higher ground. Some hospitals were seriously damaged by cyclones and storm surge making relocation urgent and driving up cost.

One example of relocation as adaptation is the original Nui'iu Hospital on Lifuka in Tonga, located at 19 meters from the coastline with an elevation of 5 meters. The hospital was damaged by Cyclone Ian in 2014. A new hospital was built inland at 1907 meters from coastline and an elevation of 61 meters reducing its vulnerability. Renamed Princess Fusipala Hospital this hospital serves the population of Lifuka and Foa Islands, approximately 6,470 people. That relocation cost US$2.1 million and was funded by the Asia Development Bank and the government of Tonga.

Google Earth images of Tonga's original Nui'iu Hospital (left) and the new Princess Fusipala Hospital (right)

Niue Hospital on Niue, is the only hospital serving the country. Originally known as Lord Liverpool Hospital it was built in 1960s on a cliffside 84m from the coastline. The hospital was destroyed by Cyclone Ofa in 1990. It was rebuilt in the same location for US$2.7 million dollars and destroyed again by Cyclone Heta storm surge and wave action in 2004. Heta, like many tropical storms caused significant coastal erosion and cliff collapse. A temporary field hospital had to be set up until the new hospital, Niue Foou Hospital, was completed in 2006. The relocation cost was US$23 million and was funded by NZAID, DFAT and the EU.

Google Earth image of the original Niue hospital in blue and the new Niue Foou hospital in red (left), 2004 damage to the original Niue hospital from Cyclone Heta (right)

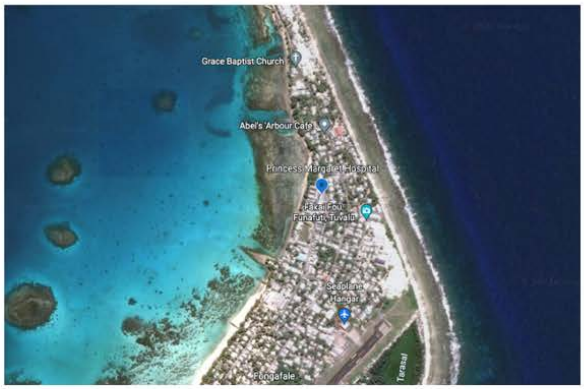
Some Pacific Island Countries, in particular those made up of atolls like Tokelau, Kiribati, Tuvalu and the Republic of Marshall Islands hospitals have undergone adaptation remodeling of their hospitals as their options to move are limited. Fenua Fala Hospital located on the Fakaofo Island group of Tokelau is located 40 meters from the coastline at 8 meters elevation. The hospital serves roughly 500 people who live on Fakaofo. Coastal inundation and storm surge cause frequent flooding across the atoll. Relocation was not an option for Fenua Fala Hospital. In concert with New Zealand Aid Tokaleau's government made the decision to rebuild the hospital on timber piles and cement ground beams. The architecture was built to withstand cyclones.

Google Earth image Fenua Fala hospital (left), the new Fenua Fala hospital near completion.

A similar adaptation design was used in the rebuilding of Nukunonu Hospital also in Tokelau in 2013. The new building has a storage tank as its foundation and the two-story building is concrete framed to withstand cyclones. The second story allows for a safe place for medical records and valuable equipment to be stored should flooding effect the lower level. This hospital building was built adjacent to the old hospital building.

Google Earth image of Nukunonu hospital (left), the new 2 story Nukunonu hospital built adjacent to old building shown in green.

Some Pacific Island countries have incorporated protection of their hospitals and other critical infrastructure into larger adaptation projects. Tuvalu has implemented a two-phase Coastal Adaptation Project in order to protect their critical infrastructure including their only hospital, Princess Margaret Hospital. The hospital is 30 meters from the coastline at an elevation of 5 meters. It serves over 12,000 people living on the atoll. The Tuvalu Coastal Adaptation Project (TCAP) combines the use of raised, safe land on the lagoon shore in Funafuti, berm top barriers, reef top barriers and concrete seawalls. The project is funded by the Green Climate Fund and the Tuvalu government with a price tag of US$39 million.



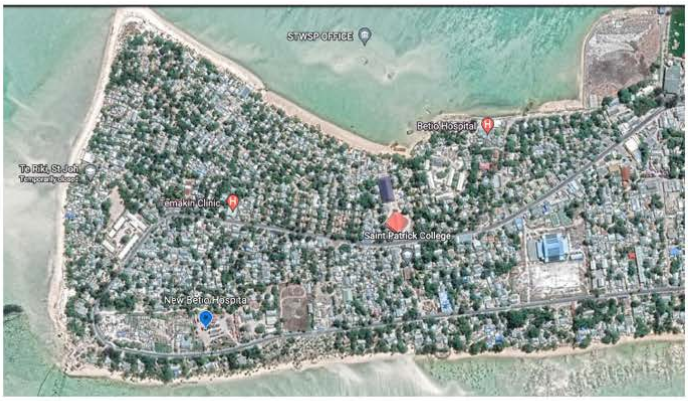
Google Earth view of Princess Margaret Hospital at blue marker (top left), the hospital entrance (top right), proposed Coastal Adaptation Project 2021 (bottom)

While these examples of relocated and adaptive redesigned hospitals are progress a number other Pacific Island hospitals remain highly vulnerable and without adequate funding sources to assist in reducing their risk vulnerability. The table below summarizes the most vulnerable hospitals based upon location less than 100 meters from a hydrological threat, elevation less than 10 meters above sea level and a population catchment that serves more than 30% of the population.

country	hospital	<100m hydrologic threat	<10m elevation	>30% pop	Adaptation
Kiribati	Betio Hospital, South Tarawa	yes	yes	53	plans for relocation MFAT
Kiribati	Tungaru Central Hospital	yes	yes	100	no plans found
Palau	Belau National Hospital	yes	yes	100	plans for relocation
SI	National Referral Hospital	yes	yes	100	plans for relocation
Tokelau	Lomaloma Hospital, Atafu	yes	yes	37	plans for seawall NZAI
Tokelau	St Joseph's Hospital,Fenua Fala Fakaofo	yes	yes	36	rebuilt pilings 2019
Tokelau	St Joseph's Hospital, Nukononu, NRH	yes	yes	33	rebuilt pilings 2013, 2 stories
RMI	Leroj Atama Medical Center, Majuro	yes	yes	64	renovation planning JICA
RMI	Leroj Kitlang Kabua Health Center, Ebeye, Kwa	yes	yes	38	New roof 2020
Tuvalu	Princess Margaret Hospital, Funafuti	yes	yes	100	Coastal adaptation project 2021

The most vulnerable hospitals in Pacific Islands based upon three criteria: location <100 meters from a hydrological threat, elevation <10m above sea level, serves more than 30% of the country's population. The hospitals in red are currently vulnerable. The hospitals in black have addressed or are in the process of addressing their vulnerability through adaptation.

Betio Hospital on the west side of South Tarawa, Kiribati is located 5 meters from the coastline at an elevation of 6 meters. It serves 64,000 people. In 2021 Kiribati initiated its Health Infrastructure Strengthening Program. This included relocation of the current Betio Hospital to the opposite side of the island and the incorporation of a climate resilient and sustainable design. The new hospital design incorporates elements of the PAHO Smart Hospital Framework Program and is being funded by New Zealand MFAT.



Google Earth image Betio hospital current location in red and planned relocation site in blue (left), proposed new hospital schematic (right).

Tungaru Central Hospital on the east side of South Tarawa, Kiribati is located 25 meters from the coastline at 6 meters elevation. The hospital is the made up of a number of wood and timber frame structures built at varying times beginning in 1991. It is the country's national referral hospital that provides advanced medical and surgical care and takes referrals from Kiribati's 3 sub-division hospitals including Betio hospital (above). Despite coastal erosion there is no seawall in front of TCH.

Google Earth view of Tungaru Central hospital on Southeast Tarawa (left), TCH buildings (right)

As part of the Kiribati Health Infrastructure Strengthening Program a request was also made to the World Bank by the Kiribati government to assist in rebuilding the London Kiritimati Hospital, a 15 bed hospital located 47 meters from the coast and at 5 meters elevation on the Kiritimati atoll. While this hospital serves a small percentage of Kiribati's total population, approximately 5000 people, it is the only hospital on the Kiritimati atoll and provides care to other islands in the Line Islands chain. The relocation of London Kiritimati Hospital is part of a larger health system strengthening proposed project.

Google Earth image of London Kiritimati Hospital (left), London Kiritimati hospital (right)

Belau National Hospital in Palau (BNH), a nation that has a Compact of Free Association (COFA) with the US, has formed an exploratory committee tasked with relocating its only hospital which serves nearly 12,000 people. The committee will review location options as well as financing and sustainability. Located 15 meters from the coastline and 1 meter above sea level access to BNH is via the low lying Meyungs causeway connecting Ngerkebesang Island with Koror Island. An additional 2 causeways, Malakal and Airai, connect Palau's 3 main islands. These causeways date back to WWII and required regular repairs. In the event of the loss of the Meyungs causeway during a storm direct access to the hospital would be lost. During

the current negotiations on renewing the Palau-US COFA the Palau government has included the cost of relocating their only hospital in that negotiation.[2]

Google Earth view of Belau hospital (left), causeways connecting the 3 main islands and the hospital (right)

The National Referral Hospital (NRH) in Solomon Islands is the largest highly vulnerable hospital in the Pacific Region. NRH has 380 beds and serves a dual purpose. It is a community hospital for 161,197 people living on Guadalcanal and as the nation's only referral hospital it provides advanced medical, surgical and obstetrical care for 686,878 people living across the archipelago of over 900 islands. There is a small faith based hospital also on Guadalcanal, Good Samaritan Hospital, that provides limited services focusing mainly on routine obstetrical care. While there are 2 secondary hospitals located on other islands, Ghizo and Malaita, all cancer care, complex obstetrics and major surgery is provided at NRH. NRH is located 11 meters from the coastline, 140 meters from the Mataniko River and just under 2 meters above sea level. NRH has a history of being impacted by storm surge and flooding following heavy precipitation. In 2014 tropical storm Ita caused massive flooding on northern Guadalcanal killing 22 people, mainly women and children. Portions of the hospital were damaged by storm surge. A vulnerability assessment using the PAHO Safety Index for Hospitals was conducted by the MOH and the WHO in 2014. The assessment found the location highly vulnerable and safety issues in a number of areas. In 2016 a gabion seawall was constructed as a temporary measure while a hospital relocation committee was formed.

[2] Personal communication Gaafar J. Uherbelau Minister of Health & Human Services, Republic of Palau

Google Earth view of the National Referral Hospital (NRH) (left), Proposed relocation site blue marker, with current location of NRH marked by red arrow (right).

The hospitals described in this assessment are examples of how some hospitals have been made safe and others hospitals that are recognized as critical infrastructure are struggling with funding. This is largely due to how many Official Development Assistance (ODA) partners see hospitals as a health expenditure. That view needs to change. Just as roads, bridges, ports and runways must be as disaster risk free as possible the same prioritization must be applied to hospital hardscaping. Building and rebuilding safe and efficient hospitals throughout the Pacific Islands where there is limited or no redundancy of services is needed in order to keep health and social services available during a disaster or not.

A number of resources to assist in assessing hospital safety are available. The PAHO Hospital Safety Index is one of them (see link above). The PAHO Smart Hospital Framework also gives guidance on how to make hospitals safe while incorporating "green" or smart hospital elements into a design.

A **safe health facility** is structurally, non-structurally and functionally able to withstand the impact of all types of natural hazards and mitigate the impacts associated with climate change and variability.
A **green health facility** has a small carbon footprint and an equally small environmental footprint.
A **smart health facility** incorporates both safe and green elements so it protects the lives and health of patients and health workers. It takes measures to reduce the damage to hospital infrastructure and equipment as well as the surrounding environment; continues to function as part of the health network, provides services under emergency conditions; uses scarce resources efficiently, reduces operational costs; and improves strategies to adjust to and cope better with future hazards and climate change.

A good example of a PAHO Smart hospital is Peebles Hospital in Tortola, British Virgin Islands. This hospital is located in what is referred to as the Atlantic Ocean's Hurricane Alley as it is

subjected to on average 10 named storms per year. Peebles hospital underwent a US$107 million rebuild in 2014 which incorporated safe as well as smart elements. While debates have been had about actual construction costs exceeding proposed costs the hospital has demonstrated its safety value. In 2017 Peebles survived two category 5 hurricanes (Irma and Maria) within one month. The building sustained only cracked windows, while homes and buildings around it were destroyed.

Google Earth view of Peebles hospital, Tortola, BVI (left), aerial view of Peebles Hospital with surrounding destruction following Category 5 Irma and Maria hurricanes (right). (source PAHO CC report)

Pacific Island Countries know how vulnerable their critical infrastructure is. This discussion is not meant as criticism. It is meant to highlight to stakeholders and development partners the nuance of how hospitals are cross sectorial, as health and critical infrastructure making them important for adequate adaptation funding. Some Pacific Island Countries have been able to obtain full or partial funding to assist with these expensive adaptation projects. Many of the Pacific Island Countries with the most vulnerable hospitals continue to struggle in accessing adequate funding. A number of factors have contributed to this:

- Failure of governments and stakeholders to recognize hospitals as critical infrastructure and therefore fail to prioritize renovation or relocation of until damage occurs.
- ODA funding limitations.
- Climate change adaptation and resilience funding is constrained by current qualification metrics based heavily on Gross National Index (GNI). This fails to recognize unique threats Pacific Islands face. The UN Multi-dimensional Vulnerability Index (MVI) seeks to correct this by decreasing GNI weighting in favor of recognizing loss and damage.
- Adaptation funding is not currently based upon any kind of hospital vulnerability weighting that takes into account location as well as the population served and lack of hospital service redundancy.
- Geotechnical challenges unique to Pacific Islands: includes unexploded ordinances (UXO), caves, tunnels, land limits and other ecological variables.

During the frenetic final days of COP27 an agreement on climate reparations for loss and damage to countries like the Pacific Islands was reached. The last minute agreement commits to

creating a fund to aid "poor countries" harmed by impacts from climate change. While the Loss and Damage agreement is celebrated by Pacific Island Countries this language could work against Pacific Island Countries as they may not be economically stratified as "poor" yet they suffer disproportionate risk and damage from regular climate mediated extreme weather events. The language used to describe the Loss and Damage Fund must be that the "most vulnerable nations" be prioritized for funding first, while high CO2 emitters including China and India be required to contribute to the fund along with other high emissions nations. It is unclear what the timeline will be for the benefits conferred by the UN MVI or the COP27 Loss and Damage Fund. In the meantime, Pacific Island vulnerable hospitals will continue to be at risk.

In June of 2022 the United States Biden Administration announced a new initiative: The Partners in the Blue Pacific (PBP). At that time the informal association included the US, Australia, New Zealand, Japan, and the UK. PBP's goal has been unclear. In September 2022 the White House offered some clarity on what PBP would do when it announced a more formal outline of PBP's goals: Pacific Partnership Strategy. PBP's main goal is to align its programs with the Pacific Island Forum's Blue Pacific. Included in PBP's strategy are four objectives. The third objective focuses on the establishment of "a resilient Pacific Islands Region prepared for the climate crisis and other 21st century challenges." PBP now has 6 members. It must recognize the climate crisis is already impacting Pacific Islands and that investments in adaptation must be prioritized. This includes relocating and shoring up hospitals.

During natural disasters studies have shown hospitals can be a part of the problem as well as a solution. We saw this with Charity Memorial Hospital in New Orleans. Hospitals care for some of the most vulnerable people, offer shelter to families and the community who leave their homes during storm and strife, but they also present some of the most difficult challenges once damaged or compromised. Safe and smart adaptation projects can prevent this.

Relocating a hospital is a large capital expenditure for many Pacific Island Countries as is evidenced by the cost range of US$1.1 million to US$23 million for the examples presented in this analysis. For Pacific Island countries with limited economic flexibility worsened by the pandemic and annual disaster expenses the ability to budget for hospital adaptation such as relocation or remodeling is nearly impossible. While the majority of climate change policy and funding addresses efforts to cut greenhouse gas emissions, it is crucial to address adaptation to the risks from vulnerability that are already "locked in." This must include changing the way hospitals are viewed. Safe and resilient hospitals in Pacific Islands Countries are like lighthouses in a storm. They are as essential as the roads, ports and airports that move relief supplies during a disaster. It is time to stop seeing them as luxury health development items and see them for the critical role they play in resilience building in one of the most risk vulnerable regions of the world.

List of Pacific Island Country hospitals and data on number of beds, population served, distance from hydrological threat and elevation.

Country	Hospital name	Island	Catchment population	Number of beds	meters from hydrologic threat	meters above sea level
Cook Islands	Rarotonga Hospital	Raratonga	17456	75	598m	86m
	Aitutaki Hospital	Amuri	1600	25	726m	58m
Fiji	Colonial War Memorial Divisional Hospital	Suva, Viti Levu	330,245	458	953m	52m
	Labasa Divisional Hospital	Vanua Levu	150000	161	188m river	13m
	Lautoka Divisional Hospital	Lautoka, Viti Levu	337041	339	1934m	40m
	St. Giles Hospital	Suva, Viti Levu	330,245	136	509m	44m
	Oceana Private Hospital	Suva, Viti Levu	330,245	66	884m	52m
	Low Makoi Birthing Unit	Nasinu, Viti Levu	100,000	10	>2000	60m
	Korovou Sub-divisional Hospital	Korovou, Viti Levu	24184	17	217m	16m
	Vunidawa Sub-divisional Hospital	Vunidawa, Viti Levu	19332	21	71m	26m
	Royal Fiji Military Forces	Suva, Viti Levu	8228	0	>2000m	41m
	Nausori Maternity Hospital	Nausori, Viti Levu	47891	15	282m	12m
	Navua Sub-divisional Hospital	Meli Meli, Viti Levu	30000	30	1000m	24m
	Wainibokasi Sub-divisional Hospital	Wainibokasi, Viti Levu	14000	14	61m	7m
	Tamavua PJ Twomey Hospital	Tamavua, Suva, Viti levu	450,000	91	>2000m	135m
	Lomaloma Sub-divisional Hospital	Vanua Balavu	2128	16	31m	5m
	Levuka Sub-divisional Hospital	Levuka, Lovoni	16400	40	19m	11m
	Vunisea Sub-divisional Hospital	Kadavu	11000	22	147m	21m
	Rotuma Sub-divisional Hospital	Rotuma Group islands	2,479	14	122m	25m
	Lakeba Sub-divisional Hospital	Lakeba Island	8149	12	294m	8m
	Nabouwalu Sub-divisional Hospital	Vanua Levu	16642	31	192m	49m
	Savusavu Sub-divisional Hospital	Vanua Levu	32204	58	433m	27m
	Waiyevo Taveuni Sub-divisional hospital	Taveuni	17000	33	618m	77m
	Ra Maternity Hospital	Viti Levu	10000	7	556m	22m
	Ba Mission Sub-divisional Hospital	Viti Levu	60700	50	960m	19m
	Rakiraki Sub-divisional Hospital	Viti Levu	29926	22	>2000	27m
	Sigatoka Sub-divisional Hospital	Viti Levu	54418	60	522m	11m

	Tavua Sub-divisional and maternity Hospital	Viti Levu	28160	42	132m	24m
	Nadi Sub-divisional Hospital	Nadi, Viti Levu	98000	85	380m	14m
Kiribati	Southern Kiribati Hospital	Tabiteuea, Utiroa	4,120	19	174m	8m
	Kiritimati London Hospital	Kiritimati	5115	15	47m	5m
	Betio Hospital	South Tarawa	63439	20	5m	6m
	Tungaru Central Hospital (RH)	Nawerewere, Tarawa	121388	139	25m	6m
Palau	Belau National Hospital	Ngerkebesang Island	18092	75	**15m**	**1m**
Solomon Islands	Taro	Choiseul	2121	28	144m	0m
	National Referral Hospital (RH)	Guadalcanal	686878	380	11m	2m
	Gizo Hospital	Ghizo	39735	91	120m	10m
	Helena Goldie Hospital	Munda, New Georgia	7000	66	72m	4m
	Buala Hospital	Buala	26000	44	58m	6m
	Tulagi Hospital	Tulagi	3735	23	55m	0.1m
	Good Samaritan Hospital	Guadalcanal	30000	33	>2000m	11m
	Kilu'ufi Hospital	Malaita	60000	123	1600m	20m
	Atoifi Hospital	Malaita	26000	17	352m	32m
	Kirakira Hospital	Makira	2287	49	240m	9m
	Lata Hospital	Temotu	40000	52	254m	25m
Tokelau	Lomaloma Hospital	Atafu	500	12	53m	7m
	St Joseph's Fenua Fala Hospital	Fenua Fala Fakaofo	483	12	40m	8m
	St Joseph's Nukunonu Hospital, NRH	Nukunonu	452	12	12m	8m
Tonga	Princess Fusipala Hospital	Ha'apia Lifuka	6500	22	709m	18m
	Niu'eiki Hospital	Eua	5371	17	1600m	96m
	Vaiola Hospital (RH)	Tongatapu	109000	200	131m	8m
	Ngu Hospital (Prince Wellington)	Vava'u group	15000	43	589m	49m
Vanuatu	Quatvaes Hospital	Vanua Lava, TORBA	11,330	10	83m	26m
	Northern Provincial Hospital (RH)	Luganville, Espiritu Santo, SANMA	43165	113	556m	62m
	Godden Memorial Hospital (Lolowai)	Ambae, PENAMA	35,607	30	87m	21m
	Norsup Hospital	Malekula, MALAMPA	42,400	64	25m	6m

	Port Vila Central Hospital (RH)	Efate, SHEFA	54953	156	196m	43m
	Lenakel Hospital	Tanna, TAFEA	45714	43	758m	71m
West Samoa	Tupua Tamasese Meaole Hospital (RH)	Apia, Upolu	95,907	221	>2000m	59m
	Leulumoega District Hospital	Leulumoega, Upolu (Northwest)	23000	12	17m	10m
	Lalomanu District Hospital	Lalomanu, Upolu (southeast)	22,769	10	366m	45m
	Poutasi District Hospital	Poutasi, Upolu (south central)	11000	10	99m	10m
	Foailalo District Hospital	Satupa'itea, Savai'i	5304	7	164m	39m
	Malietoa Tanumafili II Hospital (RH)	Tuasivi, Savai'i	13000	33	40m	15m
	Sataua District Hospital New	Sataua, Sava'i	7904	10	1020m	142m
	Safotu District Hospital	Safotu, Savai'i	12,718	15	91m	15m
	Sa'anapu District Hospital	Upolu	proposed			
	Falelatai District Hospital	Upolu	proposed			
FSM	YAP State Hospital	Colonia, Yap	11,867	43	44m	25m
	Pohnpei State Hospital	Kolonia, Pohnpei	39282	91	235m	8m
	Genesis Private Hospital	Kolonia, Pohnpei	11,867	36	507m	15m
	Arthur Sigrah Memorial Hospital	Tofol, Kosrae	6047	40	854m	13m
	Chuuk State Hospital	Chuuk	45973	125	833m	21m
RMI	Leroj Atama Medical Center	Majuro, Ratak Chain	27,349	101	89m	7m
	Leroj Kitlang Health Center	Ebeye, Kwajalein, Ralik Chain	16,332	45	62m	5m
Nauru	Nauru Ron Hospital, Yaren	Nauru	10,981	56	206m	9m
Tuvalu	Princess Margaret Hospital	Funafuti Atoll	12,127	50	30m	5m
Niue	Niue Foou Hospital (Lord Liverpool Hospital)	Niue	2000	20	1907m	61m

Population data source: World Bank except Vanuatu (2020 census data)