ENVIRONMENTAL SUSTAINABILITY

Human Security and Climate Change

This section examines "Environmental Sustainability" through a relevant focus on human security. After a short explanation of the concept of human security, it focuses on some primary threats in Guam, along with their subsequent effects, followed by examinations of climate change, food security and agricultural expansion, aquaculture development, water resources, and renewable energy. As this study is primarily focused on the political statuses, we encourage the reader to read an East-West Center report entitled, "Climate Change in Guam: Indicators and Considerations for Key Sectors" for a more detailed scientific discussion of these issues.[516]

Moving forward in this section, one will notice discussions in the status analyses which have economic implications. It is important that the economic implications found throughout this section of the study are not considered in isolation. Each of the economic implications should be understood with "reference to" or "in the context of" the disclaimers and analyses found throughout Section: "Economic Impacts" of this study. This is integral to contextualizing material found within this section of the study. Lastly, it should be noted that for this section on environmental sustainability, there are various technical and detailed solutions and considerations regarding implementation for the issues addressed that cannot be included due to their exhaustive scope.

The Changing Paradigm of Security

The concept of human security has been widely associated with the United Nations' *Human Development Report 1994* that sought to redefine security. Traditionally, "security" has been defined through a focus more on "nation-states than to people"[517] and characterized by military power. In contrast, "human

516 Zena Grenci, W. Miles, R. King, A. Frazier, and V. Keener, *Climate Change in Guam: Indicators and Considerations for Key Sectors. Report for the Pacific Islands Regional Climate Assessment*. Honolulu, HI: East-West Center, 2020 accessed at https:/www.eastwestcenter.org/PIRCA-Guam.

517 United Nations Development Programme, Human Development Report 1994 (Oxford: Oxford University Press, 1994), 22, accessed at http://hdr.undp.org/sites/default/files/reports/255/hdr_1994_en_complete_nostats.pdf.

security" is a broad concept focused on people and is understood as having essential characteristics. First, human security is characterized as "a universal concern,"[518] because the threats that arise pose harm to all people. Second, "the components of human security are interdependent," in both relation to each other and across spaces and borders.[519] Thus, threats to human security have resounding impacts in connection with other communities in the region and around the world. Third, human security is considered "easier to ensure through early prevention than later intervention."[520] It is characterized by proactive, not reactive efforts. This study examines how Guam under the three political status options may handle various threats to human security.

Human security is also generally understood to encompass seven primary categories: economic; food; health; environmental; personal; community; and political security.[521] This study outlines some of these main threats to human security in Guam that encompass multiple categories. For example, Guam's rising temperatures due to climate change could affect agricultural production as changing weather patterns make it difficult to grow certain crops and hinder access to food. In addition, rising temperatures may correlate with a rise in heat-related illnesses. Thus, climate encompasses the health, food, and environmental categories of human security. There is an interdependent characteristic to human security in that these seemingly disparate threats may also work in tandem to exacerbate each other. Thus, it is pertinent to examine various threats and explore potential responses, as one threat may impact numerous aspects of human security. This study addresses the advantages and disadvantages of responses to these threats under each political status option.

Threats in Guam

This section examines four primary threats related to the environment and specifically focuses on the interconnected issues of: climate change and natural disasters; climate change and disease; invasive species; and waste management.

Climate Change and Natural Disasters

A rise in global annual average temperatures has ensuing natural consequences that create hazards and stressors for human security. A major component of anthropogenic climate change (originating in human activity) is a rise in global temperature, which subsequently influences regional climatic conditions. The ability for countries to reduce their greenhouse gas (GHG) emissions is a determining factor in the impact of global warming over the next century. Pacific Island leaders are arguing that the most pressing

518 United Nations Development Programme.

519 United Nations Development Programme, "Human Development Report," 22.

520 United Nations Development Programme, "Human Development Report," 22.

521 United Nations Development Programme, "Human Development Report," 24-25.

security threat in the region is climate change caused by the burning of fossil fuels.[522]

The global conditions of increasing average temperatures and GHG emissions carry implications for Guam.[523] The changing weather patterns that result from rising temperatures may affect the environmental conditions that impact the frequency or intensity of certain natural disasters. For Guam, these environmental threats could take the form of rising sea levels, coastal inundation, tropical cyclones, wildfires and drought, and ocean acidification.

Rising Sea Level and Migration

A rise in sea level is one consequence of climate change impacting the island of Guam. As the findings of the *2019 Hazard Mitigation Plan* reflect, flooding due to sea-level rise will generally impact "the port and marinas" as well as "structures, roads, and other infrastructure."[524] Specifically, the island locations that will be most impacted by sea-level rise will be "the southern part of Merizo, parts of Inarajan and Hagåtña, and a portion of Piti between Naval Base Guam and Cabras power plant."[525] These locations are particularly vulnerable, but on the whole, rising sea level poses a general threat to human security because "anything that makes the ocean waves reach farther inland (such as a high tide, a tsunami, or a large storm) will cause more flooding than when the sea level was lower."[526] Flooding, as well as other climate issues such as heavy rains, and severe winds, are all hazards that can cause human insecurities.

Given Guam's proximity to at-risk low-lying islands and the social networks cultivated by existing migrants from freely associated states, it is likely that people impacted by sea-level rise will continue to migrate and resettle in Guam. Dr. Austin Shelton of the University of Guam Center for Island Sustainability and Sea Grant argues that one projection for Guam is, "more climate change refugees or migrants coming."[527] Climate-induced migration becomes an indirect consequence of climate change. The impacts of climate change, particularly sea-level rise, have the potential to make parts of, or entire, low-lying islands uninhabitable. Resettlement to Guam may lead to a lack of capacity in resources such as food, water, and land to provide a quality standard of living for an exponentially growing migrant or refugee population.

Tropical Cyclones

Another threat to the environment is tropical cyclones (TC), which are powerful, circulating

522 Pacific Islands Forum, Majuro Declaration for Climate Leadership (Majuro: Pacific Islands Forum, 2013), 1, https://d3n8a8pro7vhmx.cloudfront.net/majurodeclaration/pages/25/attachments/original/1378363615/130905_RMI_PIF_Majuro_Declaration___Commitments.pdf?1378363615.

523 Guam Homeland Security/Office of Civil Defense, 2019 Guam Hazard Mitigation Plan (Agana Heights: n.p., 2019), 4-2.

524 Guam Homeland Security/Office of Civil Defense, "2019 Guam Hazard Mitigation Plan," 5-44.

525 Guam Homeland Security/Office of Civil Defense, "2019 Guam Hazard Mitigation Plan," 5-43.

526 Pacific Islands Climate Education Partnership, Climate Change in Guam, 2014, 12.

527 Personal Communication with Center for Island Sustainability and University of Guam Sea Grant Director, Austin Shelton, July 14, 2020.

"low-pressure weather systems that range in size from 120- to- 1,500 miles across."[528] Tropical cyclones encompass different types of weather systems: tropical depressions, tropical storms, and typhoons.[529] These can vary in wind speeds, with strong winds causing destruction that may range from damage to buildings, critical infrastructure, and homes while also spreading debris that poses harm to human life and the overall environment. Climate science links climate change to an increasing intensity of tropical cyclones, yet with an overall decrease in frequency. "The likely overall outlook for Guam is for fewer but stronger storms in the future."[530]

Guam is geographically located in the Western North Pacific Ocean, which experiences the most numerous and strongest tropical cyclones on Earth. This area is commonly referred to as "Typhoon Alley" and is where 33% of the world's tropical cyclones form.[531] In Guam, the peak season for cyclones to occur is between July and November, though these weather systems can form at any time. Throughout the island's history, Guam has experienced many destructive typhoons and super typhoons. For example, in 2002 when Super Typhoon Pongsona hit, it resulted in over $700 million in recovery costs as critical infrastructure, homes, and other structures were severely damaged.[532] Super Typhoon Pongsona hit Guam with wind speeds upwards of 144 mph and wind gusts up to 173 mph.[533]

Drought and Wildfires

The continuity of rising global temperatures can also lead to "drier conditions" that increase the likelihood and intensification of droughts.[534] Especially during the dry season, when "water may be less available," climate change could "further exacerbate drought conditions" for Guam.[535] A 2019 report by the US Geological Survey and US Department of Interior, utilized the RCP 8.5 scenario to analyze Guam's annual rainfall in a future climate. Its findings predict that rainfall will decrease from 2080-2099.[536] Overall, drier conditions affect the "duration and the severity" of wildfires, which threaten human safety.[537] The environmental impacts of drought are expansive and can induce "stress to local crops" with "aggravated

528 Guam Homeland Security/ Office of Civil Defense, "2019 Guam Hazard Mitigation Plan," 5-55.

529 Guam Homeland Security/Office of Civil Defense, "2019 Guam Hazard Mitigation Plan," 5-55.

530 Grecni, et al., "Climate Change in Guam: Indicators and Considerations for Key Sectors. Report for the Pacific Islands Regional Climate Assessment." East-West Center, 2020, 22, accessed at https:/www.eastwestcenter.org/PIRCA-Guam.

531 Guam Homeland Security/ Office of Civil Defense, "2019 Guam Hazard Mitigation Plan," 5-56.

532 Federal Emergency Management Agency and Guam Homeland Security Office of Civil Defense, "2018 Guam Catastrophic Typhoon Plan," B-1, accessed at https://www.ghs.guam.gov/sites/default/files/2018_guam_catplan_final_20180213.pdf.

533 US Department of Commerce, "Super Typhoon Pongsona, December 8, 2002," 2003, 1, accessed at https://www.weather.gov/media/publications/assessments/Pongsona.pdf.

534 Guam Homeland Security/Office of Civil Defense, "2019 Guam Hazard Mitigation Plan," 5-65.

535 United States Environmental Protection Agency, "What Climate Change Means for Guam" (EPA 430-F-16-062, n.p., 2016), 2. https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-gu.pdf.

536 Stephen Gingerich et. al. "Water Resources on Guam–Potential Impacts of and Adaptive Response to Climate Change: US Geological Survey Scientific Investigations Report 2019–5095," 2019, accessed at https://doi.org/10.3133/sir20195095.

537 Guam Homeland Security/Office of Civil Defense, "2019 Guam Hazard Mitigation Plan," 5-65.

and prolonged" consequences.[538] Researchers John Borja, Jonathan Deenik, Abby Frazier, and Christian Giardina conducted a study, *Drought in the US Affiliated Pacific Islands: Impacts to Agriculture*, which reveals how drought has impacted agricultural growth in Guam, most especially for non-irrigated crops. Their findings indicate that deprivation of water linked with drought and the absence of irrigation leads to "losses in productivity due to water stress."[539] Drought also leads to "an increased incidence of grass fires and wind erosion [that] negatively impacts sensitive areas, including the steep sloping lands of southern Guam."[540]

As drought contributes to a lower level of crop production, the people of Guam will also continue to be dependent upon imports from external sources for essential goods, such as food. According to the *Guam Comprehensive Economic Development Study 2020-2025*, approximately 90% of all goods are imported into the island.[541] There is a need to improve the nutritional quality of imports and to upgrade the food safety system to insure effective protection.[542] Positive perceptions of imported food contribute to reliance upon external food systems, often to the detriment of traditional local foods with higher nutritional value. Experts predict that external challenges, like climate change, will impact the food system and further threaten food security.[543] Current dependency upon food imports reflects how climate change will exacerbate existing agricultural production vulnerabilities for the island. Drought poses particular risks to human security as it can induce wildfire and wind erosion that impacts agricultural and crop production. Considering the evidence that sea level rise threatens ports, marinas, and other critical infrastructure, if Guam's ports were to become compromised it would create shortages and scarcity in food supplies as essential goods became more difficult to access.

Finally, drought implies a lack of fresh water for a variety of everyday needs and demands of humans and vegetation. If there is a high demand for fresh water but low availability due to a lack of precipitation to recharge groundwater and surface water sources, then scarcity will ensue. As the 2019 Guam Hazard Mitigation Plan indicates, "drought can cause a shortage of water for human and industrial consumption, hydroelectric power, recreation, and navigation."[544] Thus, hazards associated with drought can be multidimensional and widespread. In recent years, the Weather Forecast Office (WFO) in Guam has recorded 2009, 2010, 2016, and 2019 as drought years—characterized by having four or more consecutive months of less than four inches of rain.[545] Its findings conclude that the entire island of Guam is susceptible to drought, with a high probability of future events. Drought leads to multiple threats to human security

538 Mark Lander, "Meteorological Factors Associated with Drought on Guam," Technical Report No. 75 of the Water and Energy Research Institute of the Western Pacific, 1994, i., accessed at http://www.weriguam.org/docs/reports/75.pdf.

539 John Borja, Jonathan Deenik, Abby Frazier, and Christian Giardina, "Drought in the US Affiliated Pacific Islands: Impacts to Agriculture," (USGS National Climate Adaptation Science Center, 2019), 2, accessed at http://pi-casc.soest.hawaii.edu/report/EcodroughtWorkshops/USAPI%20Drought%20Report_Impacts%20to%20Agriculture_2019.pdf

540 John Borja et al., "Drought in the US Affiliated Pacific," 2.

541 Guam Economic Development Authority, Guam Comprehensive Economic Development Strategy 2020-2025 (Tamuning: US Department of Commerce, 2019), 13. https://www.investguam.com/wp-content/uploads/2019/Guam%20CEDS%202020-2025.pdf.

542 Food Secure Pacific Working Group, "Towards a Food Secure Pacific. Framework for Action on Food Security in the Pacific: 2011-2015, 2010, 9.

543 Food Secure Pacific Working Group, 9.

544 Guam Homeland Security/Office of Civil Defense, 2019 Guam Hazard Mitigation Plan, 5-16.

545 Guam Homeland Security/Office of Civil Defense, 2019 Guam Hazard Mitigation Plan, 5-17.

as a lack of rainfall and drier conditions can increase the likelihood of enduring severe wildfires, create difficulties in agricultural production, and decrease availability of freshwater. Drought conditions also create a greater likelihood of heat-related illnesses among the island's population.

Diseases

As the spread of infectious disease is directly related to increases in temperature and other adverse effects associated with climate change, the susceptibility of Guam's population to disease must be a priority in all political status considerations.[546] Climate change has a widespread, multifaceted impact on how infectious diseases spread and affect populations. As Wu et. al. explain, "the health effects of climate change on human infectious diseases are imposed through impacts on pathogens, hosts/vectors, and disease transmission."[547] Longer term changes in the climate of particular areas will affect "the development, survival, reproduction, and liability of disease pathogens and hosts," while more "sudden and dramatic" changes in weather conditions such as extreme weather will have unpredictable effects on infectious diseases.[548] According to a Guam-centric analysis of indicators and considerations for climate change, conducted as part of the Pacific Islands Regional Climate Assessment, Guam is vulnerable to several disease risks that will be either exacerbated or directly caused by changes in the island's climate. In regard to how disease spreads, the report notes, "globally, future warming and precipitation changes will likely increase the suitable habitat for pathogens and vectors, thereby increasing the risk of outbreaks of dengue fever, malaria, diarrhea, salmonellosis, and other diseases."[549]

As an example, flash floods and heavy rainfall, such as those that occurred in Guam in August of 2018, "are expected to become more frequent, and flooding will intensify in a warmer future climate," thereby contributing to "increased levels of pathogens in drinking water" and increased "waterborne diseases, such as diarrheal illness."[550] As Wu et. al. assert, however, "humans are more than passive recipients of climate change induced health effects" and can play a "significant and active role by adopting proactive adaption measures in order to control and alleviate the negative health impacts of climate change."[551] Therefore, due to the direct link between climate change and disease, the climate change prevention, mitigation, and adaptation measures considered in each of the status options are not only beneficial to Guam's environment and ecosystem, but to the overall physiological health and well-being of Guam's population.

Other than climate-change related risks of diseaes, Guam faces other challenges as it relates to

546 World Health Organization, "Climate Change and Human Health - Risk and Responses," 16-17, https://www.who.int/global-change/climate/en/chapter6.pdf.

547 Xiaoxu Wu, Yongmei Lu, Sen Zhou, Lifan Chen, and Bing Xu, "Impact of climate change on human infectious disease: Empirical evidence and human adaptation," Environment International 86, (January 2016): 20, https://www.sciencedirect.com/science/article/pii/S0160412015300489.

548 Wu, et al., "Impact of climate change."

549 Grecni, et al., "Climate Change in Guam," 32.

550 Grecni, et al., "Climate Change in Guam," 31.

551 Wu, et al., "Impact of climate change," 20.

disease. Illness and disease, whether related to climate-induced drought conditions or induced through other means, are crucial to understand the health category of human security. Both communicable and non-communicable diseases (NCD) pose harm to the health of individuals and larger threats to the community's well-being.

Tourism is a factor related to disease susceptibility for the island. Guam's geographic location has become "an established hub for airline traffic" with a substantial flow of people arriving from "Asia, Micronesia and Oceania, as well as Hawaii and the continental United States."[552] In 2019, the Guam Visitors Bureau reported there were an estimated 1,631,049 tourists arriving on the island, with a majority of these visitors traveling from Japan, South Korea, Taiwan, China, US/ Hawaii, and the Philippines.[553] This global transportation connectivity has impacts at the local level. Guam does not control outside travel, and as a result, the island's residents are potentially exposed to groups that are mobile at international scales. This international mobility increases pathways for transmission and infection as interactions between tourists and residents may lead to the spread and outbreak of disease.

Certain groups within Guam's existing population are also more vulnerable to spreading or acquiring communicable and non-communicable diseases (NCDs). Communicable diseases are considered "illnesses caused by viruses or bacteria that people spread to one another through contact with contaminated surfaces, bodily fluids, blood products, insect bites, or through the air."[554] Many examples exist, with some of the commonly contracted communicable diseases being "HIV, hepatitis A, B and C, measles, salmonella, measles and blood-borne illnesses." According to the World Health Organization (WHO), the main types of NCDs are "cardiovascular diseases (like heart attacks and stroke), cancers, chronic respiratory diseases (such as chronic obstructive pulmonary disease and asthma) and diabetes" these are also known as "chronic diseases" that tend to be the result of "genetic, physiological, environmental and behavioral factors."[555] The socioeconomic impacts and prevention and control of NCDs are related to Guam's political status.

This section has focused on some primary factors that increase the island's susceptibility to disease. However, the health category of human insecurity reveals that "all of Guam and the people residing in Guam are susceptible to diseases."[556] While the entire island is at risk, large disease outbreaks are more likely to occur in Guam's villages with more dense populations as these areas have "some of the highest numbers of cases [of disease]."[557] The island's most densely populated areas "Dededo, Yigo, and Tamuning/Tumon." These villages have also historically been documented as having the most cases of

552 Guam Homeland Security/Office of Civil Defense and the Guam Emergency Operations Center Emergency Support Function Team, "The Territory of Guam Comprehensive Emergency Management Plan Pandemic Response Annex," 2016, 3, https://www.ghs.guam.gov/sites/default/files/h_pandemic_annex_v2_12.13.16.pdf.

553 Guam Visitors Bureau, "Fiscal Year 2019 Summary," 2019, 1, accessed at https://www.guamvisitorsbureau.com/docs/research/statistics/visitor-arrival-statistics/fy-2019/september-2019-arrival-summary.pdf.

554 Peter F. Edemekong and Ben Huang, Epidemiology of Prevention of Communicable Diseases (StatePearls Publishing, 2020), https://www.ncbi.nlm.nih.gov/books/NBK470303/.

555 World Health Organization, "Noncommunicable diseases," World Health Organization, World Health Organization, June 1, 2018, https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases.

556 Guam Homeland Security/Office of Civil Defense, "2019 Guam Hazard Mitigation Plan," 5-9.

557 Guam Homeland Security/Office of Civil Defense, "2019 Guam Hazard Mitigation Plan," 5-9.

disease in the island.[558] Population growth resulting from the US military buildup may also increase density throughout the island's villages, adding to the increased likelihood for the spread and outbreak of disease in the future. The US military build-up plans involve relocating 5,000 US Marines and their estimated 1,300 dependents to the island over the next thirteen years.[559] The US military's decision to relocate and the increase in the island's overall population are also attributed to Guam's political status.

The people of Guam have experienced several disease outbreaks and epidemics, or "a disease that affects numerous people, animals, or plants at one time."[560] One of the more recent epidemics experienced in Guam occurred in 2010, with 502 reported cases of mumps.[561] Additionally, the island "encounters imported dengue cases nearly annually because of frequent travel to and from Guam and areas with active DENV transmission."[562] While travel-related disease cases are common, in 2019 the first locally acquired case of dengue fever in 75 years was reported.[563] Reports of locally acquired dengue fever continue, with a total of 13 cases documented from September 9, 2020 to November 25, 2020.[564] This number of dengue fever cases is significant because it indicates the local transmission of the disease. These situations reveal that the island is susceptible to epidemics. However, the most prominent example of a communicable disease outbreak is seen with the coronavirus disease 2019 (COVID-19) global pandemic.

Invasive Species

Guam is vulnerable to invasive species. An invasive species may be defined as "an alien (i.e., nonnative) species whose introduction causes, or is likely to cause, economic or environmental harm or harm to human health."[565] Guam's invasive species are detrimental to the island's ecosystem and natural habitats and lead to "the overall declining health of the natural environment."[566] Invasive species put native/endemic species at risk by disrupting food webs and habitats. For example, the *Boiga irregularis*, also known as the brown tree snake (BTS), was unintentionally introduced to Guam during the post-World War II rebuilding efforts, when a "single pregnant female brown tree snake" stowed away on a "military cargo [ship]."[567] The brown tree snake has thrived in Guam's climate and ultimately caused the "extinction

558 Guam Homeland Security/Office of Civil Defense, "2019 Guam Hazard Mitigation Plan," 5-9.

559 Guam Homeland Security/Office of Civil Defense, "2019 Guam Hazard Mitigation Plan," 4-13.

560 Guam Homeland Security/Office of Civil Defense, "2019 Guam Hazard Mitigation Plan," 5-7.

561 Guam Homeland Security/Office of Civil Defense, "2019 Guam Hazard Mitigation Plan," 5-11.

562 Stephanie Kern-Allely, Ann Pobutsky, and Thane Hancock, "Notes from the Field: First Evidence of Locally Acquired Dengue Since 1944 – Guam, 2019," Centers for Disease Control and Prevention, Centers for Disease Control and Prevention, April 3, 2020, https://www.cdc.gov/mmwr/volumes/69/wr/mm6913a4.htm.

563 Gaynor Daleno, "Guam has 1st local dengue in 75 years," Guam Daily Post, September 13, 2019. https://www.postguam.com/news/local/guam-has-st-local-dengue-in-years/article_7ae90b68-d544-11e9-aeaa-6fff668966e0.html.

564 Stephanie Kern-Allely, Ann Pobutsky, and Thane Hancock.; see also Guam Homeland Security/ Office of Civil Defense, "2019 Guam Hazard Mitigation Plan," 5-11.

565 Guam Homeland Security/Office of Civil Defense, "2019 Guam Hazard Mitigation Plan," 5-8.

566 Guam Invasive Species Council, "2017-2019 Interim Guam Invasive Species Management Plan," 2017, 6. https://www.sprep.org/attachments/VirLib/Guam/nissap-2017-2019.pdf.

567 Guam Invasive Species Council, "Invasive Species Management Plan," 4.

and extirpation of many native and endemic species," most notably native birds.[568] Guam is one of the "most human-altered places on earth, with the invasive brown tree snake having caused the loss of nearly all forest bird species and declines in other vertebrate species."[569] Ecologically, the extinction of native birds also leads to a loss of pollination, which has negative impacts on the regeneration of the forests in Guam. Invasive species and native species extinctions are "considered by scientists and conservationists as two of the most pressing ecological concerns globally. The introduction rate, magnitude, and spread of invasive species in Guam is rampant. According to Dr. Aubrey Moore, "one new species arrives on Guam every few months," which is "10,000 times the natural rate."[570] This is alarming as the introduction of new species not only impacts the natural environment but also has direct and indirect effects on humans.

Securing Guam's ports of entry and exit can help stop the introduction and spread of invasive species. Coupled with international travel from tourism and travel related to the military, there are opportunities for invasive species to enter Guam's borders despite the geographical distance of the island. As the findings of the *2017-2019 Interim Guam Invasive Species Management Plan* indicate, "Guam's borders must be strengthened by improving its capabilities in the prevention of alien invasive species from not only reaching the shores of Guam but entering our neighbors in the region like the Northern Marianas, the rest of Micronesia and Hawaii."[571] Invasive species directly impact Guam's economy and also have broader implications for regional ecosystems, human health, and economies.

Waste Management

Solid waste management is another important aspect of human security. Pacific Islands face considerable challenges of escalating waste and its related pollution. As an island, there are many common difficulties that Guam faces in setting up and operating waste management systems. These "barriers include (1) limited physical space, (2) lack of capital and financing options, (3) vulnerability to weather, water, and extreme events, (4) high operational costs, (5) small market sizes and diseconomies of scale, and (6) changing social norms regarding product reuse, repair, and recycling."[572] While there are many reasons for increased production of waste, economic development, population growth and urbanization are linked to the increase.[573] Improper or insufficient management of waste can subsequently threaten human security.

568 Guam Invasive Species Council, "Invasive Species Management Plan," 4.

569 Dara M. Wald, Kimberly A. Nelson, Ann Marie Gawel, Haldre S. Rogers, "The Role of trust in public attitudes toward invasive species management on Guam: A Case study," *Journal of Environmental Management*, 229 (2019): 141, https://doi.org/10.1016/j.jenvman.2018.06.047.

570 Guam Invasive Species Council, "Invasive Species Management Plan," 5.

571 Guam Invasive Species Council, "Invasive Species Management Plan," 6.

572 Matthew J. Eckelman, Weslynne Ashton, Yuji Arakaki, Keisuke Hanaki, Shunsuke Nagashima, and Lai Choo Malone-Lee (2014). "Island Waste Management Systems," Journal of Industrial Ecology 18, no. 2 (2014): 308, accessed at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2425956.

573 Masaru Tanaka (2014). Sustainable society and municipal solid waste management, in Agamuthu Pariatamby and Masaru Tanaka (eds.), Municipal solid waste management in Asia and the Pacific Islands. Singapore: Springer.

Landfills & Environmental Pollution

Since World War II, the Ordot dump operated as the primary waste facility in Guam. On September 8, 1983, the dump was listed on the "National Priorities List of hazardous waste sites,"[574] and in March 1986 the US Environmental Protection Agency (EPA) determined that the Ordot dump violated the Clean Water Act.[575] These environmental concerns culminated as leachate, a liquid "formed when rain water filters through wastes placed in a landfill,"[576] was being dumped into the Lonfit River that connects to the Sigua River and Pago River and eventually drains into Pago Bay.[577] Longitudinal studies reported that the emission of leachate from the 1980s to 2010s was a significant source of pollution for the Lonfit River and these related bodies of water. For example, a 2008 study found that enterococcus and E. coli "exceeded the Guam recreational water quality standards...by at least three orders of magnitude."[578] This evidence clearly identified the Ordot dump as "a potential source of waterborne diseases in view of the high densities of fecal indicator bacteria encountered."[579] Such disease threats are also concerning because the Lonfit River and its connected bodies of water are used for recreation on the island. Therefore, if people come into contact with the waterborne pollutants, they will be at greater potential risk for contracting illness and disease.

To understand the extent and severity of the leachate generated by the dump, the Guam Solid Waste Authority's (GSWA) Receiver noted that from January 30, 2015 to March 10, 2016, an estimated 8 million gallons of leachate was redirected to avoid contaminating the Lonfit River and instead was sent to a wastewater treatment plant.[580] Despite these efforts to reduce the environmental contamination of the Lonfit River and its connected bodies of water, the dump has been directly linked to other forms of pollution, namely methane, a greenhouse gas that contributes to climate change. From September 14, 2015, through March 9, 2016, the Guam Solid Waste Receivership information center reported that, "12,539 metric tons of methane has been captured and properly disposed."[581] Even with proper disposal, methane is the second most widespread GHG emitted from anthropogenic activity. Relative to carbon dioxide, it is "25 times more effective at trapping atmospheric heat."[582]

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574 Staff Reports, "Guam's solid waste timeline," Pacific Daily News, December 25, 2017. https://www.guampdn.com/story/news/2017/12/25/guams-solid-waste-timeline/933165001/.

575 Staff Reports, "Guam's solid waste timeline."

576 United States Environmental Protection Agency, "Municipal Solid Waste Landfills," Mar. 26, 2020, accessed at https://www.epa.gov/landfills/municipal-solid-waste-landfills#:~:text=Leachate%20%2D%20formed%20when%20rain%20water,or%20constituents%20from%20those%20wastes.

577 Gary Denton, Mohamad Golabi, Harold Wood, C. Iyekar, L.P. Concepcion, and Yuming Wen, "Impact of Ordot Dump on water quality of the Lonfit River basin in central Guam. 2. Aqueous chemical and biological contaminants," Micronesica 40, no.½ (2008): 151. accessed at https://www.academia.edu/21530472/Impact_of_Ordot_Dump_on_water_quality_of_the_Lonfit_River_basin_in_central_Guam_2_Aqueous_chemical_and_biological_contaminants.

578 Denton, et al., "Impact of Ordot Dump on water quality," 156.

579 Denton, et al., "Impact of Ordot Dump on water quality," 156.

580 Gershman, Brickner & Bratton, Inc., "Latest Updates," Guam Solid Waste Receivership Information Center, Apr. 29, 2019, http://www.guamsolidwastereceiver.org/updates-done.shtml.

581 Gershman, Brickner & Bratton, Inc., "Latest Updates."

582 Ginger Birkeland and Robert Christopherson, An Introduction to Physical Geography: Geosystems Ninth Edition (Boston: Pearson, 2015), 310.

In April 1994, Public Law 22-115 mandated that the Ordot dump be closed by April 25, 1997 in order to address the extensive use and contamination through leachate and methane generation.[583] Despite this mandate to close in 1997, the Ordot dump continued to be used until August 31, 2011, when the Layon Landfill was opened.[584] In 2002, the US EPA filed a lawsuit to force Guam to close the Ordot dump.[585] Two years later, in 2004, Guam and the EPA entered into a consent decree, which required Guam to pay a civil penalty and to close and cover the dump. As an unincorporated territory of the United States, Guam is subject to adhere to the US EPA's regulations. Due to lack of progress with the 2004 consent decree, the adoption of a receivership in which control of operations of the Guam Solid Waste Authority was given to the "consulting firm Gershman Brickner & Bratton (GBB)."[586]

The Layon Landfill is located in southern village of Inarajan. It was constructed to be a "high-tech, environmentally sound and highly controlled landfill for non-hazardous municipal solid waste," and was predicted to service Guam for more than 30 years.[587] Past this time frame for Layon's operation, one must consider the future of Guam's waste management and the land that will be available to construct a new landfill. The Layon Landfill is situated in close proximity to fragile ecosystems and human settlements. The placement of island landfills near coastlines risks the "negative impacts of waste on marine and freshwater ecosystems"[588] These impacts are also exacerbated by climate change, which amplifies existing problems of landfills in proximity to human settlements that are exposed to rising sea levels and other weather events.[589]

In 2017, the government of Guam filed a lawsuit against the US Navy to bear some of the financial burden of repairing the environmental damage from the Ordot dump. The lawsuit calls attention to the Navy and US government supervision of the Ordot dump prior to World War II and throughout the early 1970s. This lawsuit is a continuation of some of the 1988 findings from the EPA that determined the Navy was "a responsible party" and thus liable for cleanup of the site.[590] In February 2020, the government of Guam's lawsuit against the military to pay for part of the Ordot closure and cleanup was dismissed. The US District Court of Appeals for the District of Columbia Circuit issued the decision, stating, "Guam cannot now seek recoupment from the United States for the contamination because its

583 Staff Reports, "Guam's solid waste timeline."

584 Staff Reports, "Guam's solid waste timeline."

585 Genevieve Glatsky, "Trouble in paradise: Recycling a tough proposition for US territories," WasteDive, Nov. 19, 2019, https://www.wastedive.com/news/trouble-in-paradise-recycling-a-tough-proposition-for-us-territories/567477/.

586 Glatsky, "Trouble in paradise."

587 Guam Solid Waste Authority, "Layon Landfill," Accessed Aug. 31, 2020, accessed https://guamsolidwasteauthority.com/gswa-layon-landfill.shtml.

588 Wu Yang, Thomas Dietz, Daniel B. Kramer, Xiaodong Chen, and Jianguo Liu. "Going beyond the millennium ecosystem assessment: an index system of human well-being," PLOS ONE 8 no.5 (2013): https://doi.org/10.1371/journal.pone.0064582.

589 Farrelly et al., "Trading in waste," 29. ; N. Mimura, L. Nurse, R.F. McLean et al. (2007) "Small Islands," in M.L. Parry, O.F. Canziani, J.P. Palutikof, J. van der Linden and C.E. Hanson (eds.), Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University Press.

590 Matthew M. Burke, "Guam Lawsuit says Navy should pay its share of dump cleanup," *Stars and Stripes*, March 7, 2017, accessed https://www.stripes.com/news/pacific/guam-lawsuit-says-navy-should-pay-its-share-of-dump-cleanup-1.457398.

cause of action for contribution expired in 2007."[591] The government of Guam appealed and the case was heard in the US Supreme Court in April 2021. In May 2021, an opinion was issued in which Guam could seek compensation under the Superfund Act. JD Supra summarizes the case as follows, "Does a consent decree under the Clean Water Act trigger a three-year limitation period to bring a contribution claim under the Comprehensive Environmental Response, Compensation and Liability Act when the consent decree makes no mention of CERCLA."[592] The unanimous opinion by the US Supreme Court, written by Justice Thomas, states, "The most natural reading of § 113 (f) (3) (B) is that a party may seek contribution under CERCLA only after settling a CERLA-specific liability." Thus, Guam will be able to proceed with its actions (against the Navy) to recover cleanup costs.[593]

This recent lawsuit illustrates some of the potential considerations that Guam will continue to grapple with under any political status option. It must consider the impacts that major industries will have on the existing and future waste management systems.

Illegal Dumping

Illegal dumping threatens the environment and overall human security through improper disposal of solid waste. In a 2019 interview, Nic Lee, the spokesman for Guam EPA, estimated that approximately "12,000 tons" of trash had been illegally dumped in Guam.[594] In an effort to combat this problem, Ch.51 §51207 of the Guam Code Annotated asserts that "littering shall be punishable by a fine of not less than Two Hundred Dollars ($200.00), nor more than One Thousand Dollars ($1,000.00)."[595] However, between the years of 2017 to 2019 Guam EPA only issued "47 littering citations."[596] A lack of enforcement in issuing littering citations weakens this form of deterrent throughout the island. Failure to properly dispose of waste leads to a variety of pollutants and destruction of the environment. The island's disposal fees are also mentioned as a cause of illegal dumping. Some of Guam's residents do not have the means to pay for their trash disposal because they cannot afford the monthly fee. This situation is compounded by the inaccessibility of proper trash disposal locations for many residents.[597] The lack of accessibility and

591 Jasmine Stole Weiss, "GovGuam's lawsuit against Navy for dump closure costs dismissed," *Pacific Daily News*, February 14, 2020, accessed at https://www.usatoday.com/story/news/local/2020/02/14/govguam-lawsuit-case-dismissed-navy-dump-closure-cost/4767117002/.

592 Stoel Rives, "US Supreme Court Decision Revives Guam Suit, Clarifies CERCLA, and Provides Cautionary Tale," JDSupra, June 8, 2021, accessed at https://www.jdsupra.com/legalnews/u-s-supreme-court-decision-revives-guam-7352008/.

593 Stoel Rives, "US Supreme Court Decision Revives Guam Suit, Clarifies CERCLA, and Provides Cautionary Tale," JDSupra, June 8, 2021, accessed at https://www.jdsupra.com/legalnews/u-s-supreme-court-decision-revives-guam-7352008/.

594 Chris Barnett, "Guam EPA prefers dumpers clean up than get fined," KUAM News, Apr. 2, 2019. https://www.kuam.com/story/40234073/guam-epa-prefers-dumpers-clean-up-than-get-fined.

595 An Act to Amend §§51202(a) and 51207 of Article 2, Chapter 51 of Title 10, Guam Code Annotated; and to Amend §3401.1(h)(4) of Title 16 of the Guam Code Annotated, Relative to Doubling the Penalties for Littering for Violators that Discard Cigarettes from Vehicles When the Fire Danger Rating is High, P.L. 30-135, 30th Guam Legislature, 2010.

596 Barnett, "Guam EPA prefers dumpers clean up."

597 Manny Cruz, "Mayors worry illegal dumping will increase," *Pacific Daily News*, September 25, 2018, accessed at https://www.guampdn.com/story/news/2018/09/25/mayors-worry-illegal-dumping-increase/1287640002/ ; Steve Limtiaco, "Virus closures take big bite out of solid waste revenue," Pacific Daily News, April 4, 2020, accessed at https://www.usatoday.com/story/news/local/2020/04/24/coronavirus-guam-solid-waste-authority-revenue-down-amid-closures/5169790002/.

financial security for residents are issues that the island must address under any political status option.

In addition, the growth of tourism and the military can also overload the waste management system, as the generation of waste from these industries could continue to rise to a point where there is a lack of capacity to properly dispose of it. The risks associated with improper or insufficient waste disposal increase the risks of harm to the people of Guam and the environment through pollution. The waste generated by these core industries may potentially be mitigated by recycling and zero waste efforts. With any plan for waste management, the political status context will need to be considered.

Recycling & Zero Waste

The island has limited capacity to dispose of waste due to its geographic characteristics, and it also faces challenges due to its relative lack of recycling capabilities that could otherwise help to alleviate the ongoing waste crisis.[598] Recycling programs are challenging, given the geographic isolation of the island from end markets and a lack of sufficient quantities to support processing investments. Shipping recyclables off-island is expensive and yields relatively low profits, particularly given the limited recycling activity for the island overall. As of 2012, while off-island markets for metal, aluminum beverage containers, cardboard, and computer components were all "revenue-positive," items such as "mixed paper and plastics #1/#2" were "revenue-negative."[599] The *Guam Zero Waste Plan*, published by the Guam Environmental Protection Agency in 2013, notes that port charges for shipping recyclables usually range from "$700 to $800 per load…at both export and import points."[600] The implication is that while some recycled goods generate revenue when shipped, the cost of shipping others is often more than the revenue gained. While recycling helps to reduce the amount of waste created in Guam, it may be costly. Nearly all Pacific Island countries and territories face the irony that "not enough waste is produced to make recycling economically attractive" on the island.[601] Additionally, in the context of international markets, the high cost of shipping make recyclable materials comparatively expensive and burdensome.[602]

Dr. Austin Shelton, director of the University of Guam Sea Grant and Center for Island Sustainability, explains that, as of 2020, it costs approximately "$1,000 per ton to ship off to Indonesia every month."[603] Reducing the amount of waste in Guam through recycling in order to decrease the amount of trash in the Layon Landfill, or illegally dumped, is necessary. However, high costs pose a hindrance to this effort. Transforming Guam's political status will not change the island's geographic location, which plays a role in the high shipping costs. However, opportunities to collaborate with US states and the federal government or

598 Personal Communication with Center for Island Sustainability and University of Guam Sea Grant Director Austin Shelton, July 14, 2020.

599 Guam Environmental Protection Agency, "Guam Zero Waste Plan," 12.

600 Guam Environmental Protection Agency, "Guam Zero Waste Plan," 12.

601 Farrelly, et al., "Trading in Waste," 29.

602 Eckelman, et al. "Island Waste," 310.

603 Personal Communication with Center for Island Sustainability and University of Guam Sea Grant Director Austin Shelton, July 14, 2020.

other countries as an independent or freely associated country may arise. Such opportunities are potential ways to improve the utilization of recycling in Guam now and in the future.

Sustainability & the Circular Economy

Sustainable consumption and production (SCP) is considered to be a comprehensive approach to address threats for environmental change by achieving low-carbon economies and supporting local environments.[604] One potential method to decrease Guam's amount of current and future solid waste production under any political status is by shifting where goods are produced in an effort to establish a more sustainable economy. In the Pacific, the United Nations argues that urgent proactivity is necessary to insure inclusive, environmentally sustainable pathways for the future. The approach the UN promotes is the "circular economy," which shifts from a linear system of production and consumption that generates waste through a "take, make, and dispose" orientation. A circular economy "offers a holistic, cyclical process which turns waste into a resource."[605] As Dr. Shelton explains, "our current economy is linear, which means that you take something from the earth, you extract it and then you make something out of it, you use it then you throw it away and you start all over again."[606] A circular economy would "bend that process into a loop," in which materials are remade into new goods and therefore do not become waste or pollution.[607]

Less waste may be generated by promoting local alternatives to goods that are typically imported. Local companies could also find more ways to use recycled products (such as local bottling) instead of continuing to bring in more. In the field of agriculture, certain crops that are shipped to Guam could instead be replaced with locally farmed produce. There are several organizations within Guam that sell locally produced items. For example, the Farm to Table-Guam Corporation is a non-profit organization whose goal is "to encourage and support existing, new, and potential native Chamorro farmers and small business owners, by providing opportunities to expand the distribution of their agricultural products."[608] One project facilitated by this organization is the Community Supported Agriculture Model Farm (CSA), which combines produce from small farms and distributes the produce to subscribers.[609] The organization and its projects facilitate the process of substituting imported goods with locally produced alternatives that reduce reliance on imported foods and promote greater self-sustainability in Guam. The promotion of a

604 Wei Zhao and Patrick Schroeder, "Sustainable consumption and production: Trends, challenges, and options for the Asia-Pacific region," Natural Resources Forum 34, no. 1 (2010): 4-15. accessed at https://doi.org/10.1111/j.1477-8947.2010.01275.x.

605 Aneta Nikolova and Riccardo Mesiano. "Circular Economy - Making Sustainability Part of the Solution in Asia-Pacific," United Nations Economic and Social Commission for Asia and the Pacific, October 4, 2018, accessed at https://www.unescap.org/blog/circular-economy-making-sustainability-part-the-solution-asia-pacific#.

606 Personal Communication with Center for Island Sustainability and University of Guam Sea Grant Director Austin Shelton, July 14, 2020.

607 Personal Communication with Center for Island Sustainability and University of Guam Sea Grant Director Austin Shelton, July 14, 2020.

608 Farm to Table Guam Corp., Tanom, Fatinas, & Sustansia," 2013, 1, accessed at https://farmtotableguam.org/wp-content/uploads/2013/12/FTT-Trifold-Intro-Brochure-12-13-no-bleed.pdf.

609 Farm to Table Guam Corp., "Tanom, Fatinas, & Sustania, 2.

circular economy and buying local goods aids in mitigating the climate change that threatens human security in the Pacific. These existing efforts toward a sustainable and future for the island would be enhanced by a circular economy framework. Self-governance under any of the political status options should allow the island opportunities to further transition toward sustainable consumption and production practices.

Statehood

Under statehood, Guam will be an integral part of the union that joins all fifty states and the US federal government. Becoming a state implies that Guam will adhere to federal policies but may also create laws within the state to combat human security threats.

In terms of natural disasters, Guam will be aided on both a state and federal level. As a state, Guam would continue to be included in the Emergency Management Assistance Compact (EMAC), which is a "national interstate mutual aid agreement that enables states to share resources during times of disasters."[610] As a state partnering in the program, Guam would be able to seek additional assistance at a state level. If federal assistance is needed, the government of Guam can request aid from the federal government as permitted under the Robert T. Stafford Disaster Relief and Emergency Assistance Act.[611] Aside from preparing and responding to natural calamities, it is also important to continually work on environmental regulations as a pre-emptive measure to mitigate drastic climatic changes, further decreasing the agitation of natural disasters.

As a state, Guam would also be subject to the federal laws in place to regulate the land, water, and air. Some of the most prominent laws include the National Environmental Policy Act (NEPA), Clean Air Act, and Clean Water Act. The island will continue to follow these laws should it become a state. In relation to threats associated with waste management, the allocation of funds from the federal government may be used for programs to enforce environmental regulations that directly or indirectly aid in combating this insecurity.

As a state, Guam would follow federal interpretation. As part of this, the enforcement of laws could change, based on the presidential administration. Notably, in July 2020, President Donald Trump took momentous action when his administration revised the requirements of the National Environmental Policy Act (NEPA). Reasoning that "the increased costs and complexity of NEPA reviews and litigation make it very challenging for businesses and communities to plan, finance, and build projects in the United States," the Trump Administration revised NEPA regulations to take actions such as reducing the time for preparing environmental impact studies (EIS) and environmental assessments (EA) as well as reducing their page limits.[612] Under the Biden administration, this will likely change. This helps to illustrate aspects of potential instability of federal regulations with successive shifts in partisan, political control

610 Federal Emergency Management Agency, "Emergency Management Assistance Compact (EMAC)," accessed at https://www.fema.gov/pdf/emergency/nrf/EMACoverviewForNRF.pdf.

611 Robert T. Stafford Disaster Relief and Emergency Assistance Act, 42 USC. 5121 (2019 amended).

612 Executive Office of the President Council on Environmental Quality, "Fact Sheet: Modernizing CEQ's NEPA Regulations," 2, accessed at https://www.whitehouse.gov/wp-content/uploads/2020/01/20200716FinalNEPA-Fact-Sheet.pdf.

of the executive and legislative branches. Overall, as a state, Guam would be required to follow revised federal regulations, like the NEPA requirements. Given the current and projected construction projects connected to the military build-up in Guam, this ruling may allow for projects to proceed without thoroughly examining the environmental impacts to the island's land, water, and air.[613]

For disease resilience and prevention, Guam is afforded aid from agencies such as the Centers for Disease Control and Prevention (CDC) which is the national agency that controls the proliferation of diseases "to improve the health of the people of the United States."[614] More specifically, Guam receives financial support from programs such as the Public Health Emergency Preparedness Cooperative Agreement (PHEP) program, which provides funds for "state, local, and territorial public health departments."[615] As a state, Guam would have continued access to the Strategic National Stockpile (SNS) during public health emergencies. The SNS is comprised of "supplies, medicines, and devices for life-saving care" [616]which is used "to supplement state and local supplies during public health emergencies."[617] Furthermore, in the case of future pandemics, Guam will continue to be eligible for federal assistance similar to that of the CARES Act, where Guam received a substantial amount of assistance.

As a state, the government of Guam would have the authority to legislate waste management policies within the island's borders while also adhering to federal laws and federal mandates. With a transformation in political status, agencies such as GSWA and the GEPA may continue to carry out their responsibilities and roles in solid waste management. As a state, Guam would also have voting representation in both chambers of the US Congress who can contribute to legislation on waste management or the environment. Guam would continue to adhere to federal laws. In addition to complying with federal laws, as a state, Guam could be eligible for federal grants to improve waste infrastructure.

Status Example: Florida

There are many differences between Guam and the state of Florida. Guam is not a land mass connected to the continental US. It has a smaller population and land area, and a higher elevation, with the highest point being 1,332 feet above mean sea level.[618] Despite these differences, both entities face similar threats to human security. With their tropical climates and location near oceans, both Florida and Guam face the environmental impacts and subsequent harms due to climate change such as rising sea level, flooding,

613 Lisa Friedman, "Trump Weakens Major Conservation Law to Speed Construction Permits," *The New York Times*, August 4, 2020, accessed at https://www.nytimes.com/2020/07/15/climate/trump-environment-nepa.html.

614 Centers for Disease Control and Prevention, "Centers for Disease Control and Prevention (C)," accessed December 3, 2020, accessed at https://www.cdc.gov/maso/pdf/cdcmiss.pdf.

615 Centers for Disease Control and Prevention - Center for Preparedness and Response, "Public Health Emergency Preparedness Cooperative Agreement (PHEP) Program - Explanation of Data," CS 299046_D, 2019, 1, accessed at https://www.cdc.gov/cpr/pubs-links/2019/documents/Explanation2019.pdf.

616 US Department of Health & Human Services, "About the Strategic National Stockpile," September 1, 2020, accessed at https://www.phe.gov/about/sns/Pages/about.aspx.

617 US Department of Health & Human Services, "About the Strategic National Stockpile."

618 Dirk Anthony Ballendorf and Sophie Foster, "Guam," Encyclopædia Britannica, September 2, 2020, accessed at https://www.britannica.com/place/Guam.

drought, and extreme weather events. The low elevation of Florida makes the state especially vulnerable to sea-level rise. An examination of how the state has responded to climate change allows one to see the capabilities that a state has to address these insecurities as well as the advantages and disadvantages of statehood as a political status option.

Since the early-2000s, Florida's state and local governments have made efforts to adapt, mitigate, and respond to climate change. Rising sea level, ocean acidification, changes in rainfall, extreme weather events, and rising temperatures due to climate change have exacerbated conditions within the state and created problems that affect the quality of life. Due to the low-lying land, the region of Southeast Florida is at the forefront of experiencing the impacts of sea- level rise. Sea-level rise will then impact the Biscayne Aquifer, which is "the primary source of drinking water for South Florida" because "the aquifer is recharged by surface water in the Everglades, so saltier water in the Everglades would reach the aquifer as well."[619] South Florida relies on a source of water that may be impacted by increasing salinity due to sea-level rise. Recognizing these threats, counties within Southeast Florida have taken action. A brief examination of how the government of Miami-Dade County has responded to climate change in recent years allows Guam to understand some of the opportunities and actions possible under the statehood option.

The Miami-Dade County's local government has invested heavily in adaptive and mitigative measures. Most notably, in 2017, the government obtained a $400 million general obligation (GO) bond, known as the Miami Forever Bond, intended to strengthen the community.[620] There are five categories for the bond projects. In relation to climate change, a budget of $192 million is planned to be invested into Sea-Level Rise Mitigation and Flood Prevention. The objective of this investment is to "minimize flooding" and "protect critical infrastructure and high-use areas."[621] As researchers conclude, Florida must protect its beaches, "which are the lifeblood of Florida's tourism industry." These investments in sea-level rise mitigation may help protect the state's beaches.[622] Like Miami, Guam is a tourist destination with coastal infrastructure that is threatened by flooding and inundation.

As a state, a general obligation bond or a series of fisheries grants may be a method for the island to further invest into new or existing adaptive and mitigative projects. For example, coral reefs are a valuable environmental and economic resource that have faced adverse conditions which have led to declines. Investments into adaptive and mitigative measures help to ensure the continuity of industries such as tourism, and the revenue generated from this industry could be used to pay back loans.

Florida has access to federal resources Guam also would have as a state. For example, Florida's Department of Environmental Protection has partnered with NOAA for the Florida Resilient Coastlines Program. This state-federal partnership works with Florida's coastal communities "to offer technical

619 United States Environmental Protection Agency, "What Climate Change Means for Florida," 2, accessed at https://www.epa.gov/sites/production/files/2016-08/documents/climate-change-fl.pdf.

620 City of Miami, "Miami Forever Bond," accessed August 31, 2020, accessed at https://www.miamigov.com/Government/Departments-Organizations/Office-of-Capital-Improvements/Miami-Forever-Bond.

621 City of Miami, "Miami Forever Bond."

622 Thomas Ruppert and Erin L. Deady, "Climate Change Impacts on Law and Policy in Florida," in Florida's Climate: Changes, Variations, & Impacts, ed. Eric P. Chassignet, James W. Jones, Vasubandhu Misra, & Jayantha Obeysekera (Gainesville: Florida Climate Institute, 2017), 209, accessed at https://doi.org/10.17125/fci2017.ch07.

assistance and funding to coastal communities dealing with increasingly complex flooding, erosion and habitat shifts" in part due to "the effects of climate change."[623] Partnerships are not limited to those within the United States. Miami-Dade County is distinguished, as its mayor, Francis Suarez, was appointed to the Global Commission on Adaptation. This international group was formed in 2018 with the goal of encouraging "the development of measures to manage the effects of climate change through technology, planning and investment."[624] The Global Center on Adaptation, which is part of the Global Center on Adaptation, would provide technical assistance in developing "solutions aimed at improving their resilience to the changing climate, such as the rising sea level and prolonged periods of drought."[625] This example supports the idea that states are not completely prohibited from engaging internationally.

However, these partnerships may be limited. As Dr. Shelton, Director of the University of Guam Center for Island Sustainability and Sea Grant explains, "In some instances we are able to join US-focused partnerships where other independent countries cannot… But in organizations like SPREP and SEC community SPC, another big international organization, Guam is rarely eligible for their funds because it comes from the United Nations or international aid programs."[626] Despite this, collaboration with non-US entities in finding solutions for climate change can be achieved.

Independence

An independent Guam would have jurisdiction over all facets of government. This allows the island's government to make decisions related to human security threats in the best interests of Guam's people, without oversight from a higher level of government. However, independence comes with its own set of risks and responsibilities. In terms of the environmental threats of climate change and natural disasters, invasive species, disease and waste management, Guam would have full control over its land and water resources, and would be the primary party responsible during these adverse events.

As an independent country, the island would have the capacity to use international institutions and organizations. Since many international organizations promote and offer technical assistance for global environmental sustainability, Guam can commit to this goal while concurrently benefitting the island's ecosystem. Furthermore, as an independent country, Guam will have an international platform to advocate for the continual preservation of our global environment, which is primarily at stake by the impending devastation of climate change.

Climate change will continue to impact how Guam experiences natural hazards, as the intensity of natural disasters may increase due to rising global temperatures. Climate change will adversely impact

623 Florida Department of Environmental Protection, "Florida Resilient Coastlines Program," accessed August 31, 2020, accessed at https://floridadep.gov/rcp/florida-resilient-coastlines-program.

624 City of Miami, "What is City of Miami doing about climate change?" accessed August 31, 2020, accessed at https://www.miamigov.com/Government/ClimateChange/Climate-Change-Action#panel-1-1.

625 City of Miami, "Global Center on Adaptation to open First US Office in Miami," accessed at https://www.miamigov.com/Notices/News-Media/Global-Center-on-Adaptation-to-Open-First-US-Office-in-Miami.

626 Personal Communication with Center for Island Sustainability and University of Guam Sea Grant Director Austin Shelton, July 14, 2020.

Pacific Islands such as Guam, therefore, it is important to plan proactive and reactive measures in response to the issue. As an independent country, Guam will not likely have access to the types of domestic assistance programs that are currently available to US states. However, the island's government may be able to seek economic and technical cooperation from international institutions. As an independent country, Guam would be further empowered to adapt local policy and join multilateral agreements on climate change that address the specific needs of the island. In addition, Guam could participate in regional organizations and projects (such as the Micronesia Challenge) as a sovereign country, contributing to the sub-regional agenda.

International institutions grant alternative means of economic and technical cooperation, from agencies such as the International Bank for Reconstruction and Development (IBRD), which provide "loans, guarantees, risk management products, and advisory services to middle-income and creditworthy low-income countries, as well as by coordinating responses to regional and global challenges."[627] As a newly independent country, Guam may be able to qualify for technical and economic assistance. Therefore, Guam can potentially gain international economic and technical cooperation for environmental sustainability efforts.

Under the political status of independence, Guam can actively prevent invasive species by having the ability to monitor all entry points and subsequently enact quarantine regulations. This can be done through the renegotiation of basing agreements with the US government to allow Guam to have greater oversight on the entrance of ships and aircraft at military ports and over any invasive species caught. Currently, the Guam Customs and Quarantine Agency and the Guam Department of Agriculture work to prevent the entry and spread of invasive species. In an independent Guam, dependent on the economy and system of government set up, it is important to note that enforcement will be key to the success of policies in the new country.

As an independent country, current US sources of funding to combat the threat of invasive species will likely no longer be available to Guam. As noted by Chelsa Muña-Brecht, the director of the Department of Agriculture, "biosecurity gets a lot of federal funding...our invasive species coordinator currently has four federal grants right now for the Little Fire Ant and the Coconut Rhinoceros Beetle."[628] Independence will most likely result in the loss of these federal funding sources for biosecurity initiatives. However, if the government and people of Guam choose to keep the US military present in the islands, then agreements between the government of Guam and the US government may include stipulations for funding agencies within Guam that focus on biosecurity.

Lastly, it is essential to mitigate disease epidemics in Guam. Under Guam's current status, the island receives assistance from US agencies, primarily the CDC. Locally, the government of Guam has established plans to address a pandemic, such as the *Guam Comprehensive Emergency Management Plan*, which outlines how Guam would respond to a pandemic. Under the status of independence, the island could retain plans on how to respond to disease as well as the established healthcare infrastructure. For example, many of the

627 The World Bank Group, "Who We Are," accessed Aug. 31, 2020, accessed at https://www.worldbank.org/en/who-we-are/ibrd.

628 Personal Communication with Department of Agriculture Director Chelsa Muña-Brecht.

independent Pacific Island countries have more political power to protect their people from COVID, such as control over borders. Assistance from the United States could come in different forms, especially with continued US military presence and historical ties between Guam and the United States. Additionally, international aid from entities such as the World Health Organization (WHO), which aims to "increase the amount of aid provided by rich countries to poor countries' through donors and partnerships," may assist.[629] As a newly independent country, Guam may benefit from this form of assistance.

Status Example: Fiji

Guam and Fiji face similar natural hazards, with conditions that are exacerbated by climate change. Current climatic predictions assert that tropical cyclones in Fiji will generally maintain their frequency but increase in intensity.[630] More intense tropical cyclones are also predicted for Guam. Flooding and storm surge are hazards related to tropical cyclones due to the "heavy precipitation"[631] generated from those events. In moderate and severe climate change scenarios, it is predicted that flooding will "become more frequent and severe."[632] Climate change will impact important staple crops, such as "rice, taro, sweet potato, and (domesticated) yams."[633] As 90% of Fiji's population resides in coastal areas, environmental hazards which are predicted to increase or intensify, including sea level rise, storm surges, tropical cyclones, and flooding, have implications for human security.[634] Fiji's National Adaptation Plan notes that there is a "Lack of climate-resilient housing across and the country"[635] and that infrastructure, primarily located in coastal and floodplain areas, is also "vulnerable to many hazards" that have been previously mentioned. [636] lack of climate-resilient homes and infrastructure unable to withstand the potential impacts of climate change creates vulnerabilities for Fiji's people.

Fiji's government has composed two notable plans in response to climate change and the impacts of natural disasters. They include the National Adaptation Plan (NAP) and the Fiji National Health Emergencies and Disaster Management Plan (HEADMAP). Fulfilling its responsibility of being party to the United Nations Framework Convention on Climate Change (UNFCCC), the NAP is an assessment of how climate change will impact "key sectors as well as adaptation barriers."[637] This plan includes 160 adaptation measures, divided by 10 "systems and sectoral components," which represent, "the actions

629 World Health Organization, "Aid for health," World Health Organization, accessed Aug. 31, 2020, accessed at https://www.who.int/hdp/aid/en/.

630 Government of the Republic of Fiji, "Republic of Fiji National Adaptation Plan - A pathway towards climate resilience," 2018, 20, accessed at https://www4.unfccc.int/sites/NAPC/Documents/Parties/National%20Adaptation%20Plan_Fiji.pdf.

631 Government of the Republic of Fiji, "National Adaptation Plan," 22.

632 Government of the Republic of Fiji, "National Adaptation Plan," 20.

633 Government of the Republic of Fiji, "National Adaptation Plan," 22.

634 Government of the Republic of Fiji, "National Adaptation Plan," 25.

635 Government of the Republic of Fiji, "National Adaptation Plan," 26.

636 Government of the Republic of Fiji, "National Adaptation Plan," 26.

637 Government of the Republic of Fiji, "National Adaptation Plan," iv, vi.

identified as the most urgent according to stakeholders."[638] The NAP enables Fiji to "anticipate, reduce, and manage environmental and climate risks caused by climate variability and change."[639]

If independence is chosen as the political status, a national adaptation plan specific to Guam's potential hazards due to climate change and actions that can be taken to mitigate them would be beneficial. It likely would be required, should Guam be part of international agreements such as the UNFCCC. Fiji's NAP may be used as an outline for how this plan is structured. In addition, the 10 categorical divisions for areas of action are an example of how Guam may classify where vulnerabilities to climate change exist. Aside from the NAP, Fiji has also published the Fiji National Health Emergencies and Disaster Management Plan (HEADMAP). This document is "a guide for the health sector in the management of public health emergencies and disasters" that is applicable to "all health programmes and activities within the National, Divisional and Sub Divisional Health Services that are related to health Emergencies and Disaster Management."[640] Health and disaster management are intertwined within this document and indicate that they are interrelated areas of action.

International and regional partnerships in relation to climate change are another area where Guam could learn from Fiji. Current territorial status and potential statehood status may restrict membership and representation in certain regional and international organizations and related resources to mitigate, prepare, respond, or recover from the impacts of climate change.[641] As a member of the United Nations, Fiji is also committed to sustainable development goals. This is evidenced in its NAP, which outlines how this plan will aid in fulfilling several goals, such as Goal 11, to "make cities and human settlements inclusive, safe, resilient, and sustainable."[642] If Guam were to choose independence, the island would also have the autonomy to enter agreements and partnerships with foreign entities.

The human insecurity posed by communicable diseases is pertinent to address, given the multiple diseases that Guam and other Pacific islands such as Fiji face, and the 2019-2020 pandemic. To reiterate, as a country, Guam would be able to cooperate with foreign entities and international or regional organizations. As an independent country, Fiji is a member state of the World Health Organization (WHO).[643] Being a member state of this organization would also give Guam access to support for "national health strategies and plans as well as collective commitments by the WHO governing bodies."[644] Guam can model these institutions in its response to communicable diseases.

638 Government of the Republic of Fiji, "National Adaptation Plan," vii.

639 Government of the Republic of Fiji, "National Adaptation Plan," 3.

640 Ministry of Health, "Fiji National Health Emergencies and Disaster Management Plan (HEADMAP)," 2013, 11, accessed at http://www.health.gov.fj/wp-content/uploads/2014/05/5_HEADMAP_Health-Emergencies-and-Disaster-Management-Plan_2013-2017.pdf.

641 US Department of State, "US Relations with Fiji - Bilateral Relations Fact Sheet," January 23, 2020, accessed at https://www.state.gov/u-s-relations-with-fiji/.

642 Government of the Republic of Fiji, "National Adaptation Plan," 15.

643 Ministry of Health and Medical Services, "Communicable Disease Surveillance and Outbreak Response Guidelines," Republic of Fiji, 2016, 38, accessed at http://www.health.gov.fj/wp-content/uploads/2018/08/Fiji-Communicable-Disease-Surveillance-and-Outbreak-Response-Guidelines-2016-1.pdf.

644 Ministry of Health and Medical Services, "Communicable Disease Surveillance," 38.

Free Association

Under the political status of free association, Guam can continue its pursuit to ensure human security. A primary feature of this status is the potential establishment of a Compact of Free Association (COFA) or other legal instrument between the government of Guam and the United States. In relation to human security, an agreement between Guam and the US may include US financial assistance for programs that address threats to human security as well as a continuity in services from sources such as the National Weather Service and the Federal Emergency Management Agency. What Guam may leverage as a partner of the US is the established infrastructure for entities, such as the military, which indicates how much the US government has invested in the island.

It is likely that a potential COFA or other legal instrument would include an agreement to continue US defense presence within the island, which implies giving the US military access to the land, air, and oceans of Guam. The continued US military presence could impose obstacles to human security, such as environmental contamination, dredging of reefs, or the prioritization of US national security objectives over genuine Guam security. This should be recognized and addressed in the agreement. By leveraging existing US investments and continued interest in the island given its geopolitical position, the government of Guam can request assistance and cooperation in combating human security threats. As a freely associated state, some forms of US financial and technical assistance may continue and others may no longer be available, unless negotiated. For example, all three COFA countries are entitled to receive, and have already begun receiving, free COVID-19 vaccines under the US's Operation Warp Speed, with distribution in proportion to the populations of those countries relative to populations in the states and territories of the U.S. COFA countries are also entitled to receive, and have already received, financial assistance from the US under the CARES Act, including pandemic unemployment assistance. In addition to this, they were also able to keep COVID-19 out of their islands, all while using their relationship with the US to assist with vaccinations and to address economic impacts. The government of Guam also can seek to join regional and international organizations as well as strike up bilateral partnerships that may be beneficial for addressing threats to human security, given the services and assistance they may be able to provide.

Climate change is a global threat that impacts all countries and peoples, either directly or indirectly. Recognizing this reality, a future free association agreement should address the socioeconomic effects and how both parties, the government of the United States and the government of Guam, will commit to combatting future impacts. The United States has heavily invested into the island of Guam. The *Guam Comprehensive Economic Development Strategy 2020-2025* discusses investments by the Department of Defense (DoD) through the annual National Defense Authorization Act (NDAA) appropriations tied to the military build-up. In 2019, DoD expended approximately $377,211,000 for several military construction projects.[645] The impacts of climate change, particularly sea-level rise, may damage infrastructure or other entities,

645 Guam Economic Development Authority, "Economic Development Strategy," 61.

like Naval Base Guam, that the US government is heavily invested in.[646] The potential damage to US infrastructure and investments can be argued as reasons the US should provide financial and technical assistance to the government of Guam for adaptation, resilience, and mitigation measures.

Aside from its relationship with the United States, under free association, Guam will have the freedom to make environmental commitments. Outside of their relationship with the United States, if following FAS models in the Micronesian sub-region, Guam would be able to form bilateral or multilateral partnerships. Under both independence and free association, Guam could join the region in exploring unique and relevant approaches to issues that impact our shared environment in ways that we are currently unable to as a result of the island's current status.

Invasive species are another human security threat to Guam. A current issue that may continue if free association is the chosen political status is an inadequate amount of resources to properly monitor ports and prevent the potential entry of invasive species. As a freely associated country, the government of Guam will have the capability to create biosecurity laws without adherence to US federal laws and may then create regulations that represent the island's best interests. If potential compact negotiations between the government of the United States and the government of Guam lead to the continued presence of US military bases, then oversight on military installations to prevent the entrance of invasive species should be collaborated between the two governments.

Status Example: The Republic of Palau

Environmental factors that may hinder human security can be addressed in sections such as Article VI, Environmental Protection, of Palau's compact. It includes a mutual agreement "to promote efforts to prevent or eliminate damage to the environment and biosphere and to enrich understanding of the natural resources of Palau."[647] In the case of free association for Guam, US environmental sustainability measures that lead to a growth in human security could be enacted by both political entities involved in the agreement. Guam can also choose to model federal regulations that are already in effect and that have been beneficial to the environment.

If Guam decides to enter into a relationship of free association, it is necessary to ensure an equal relationship through the agreement. Past COFA agreements have included ambiguous language that Guam could avoid. To illustrate, section E of Article VI of the Compact of Free Association in Palau reads:

> (e) The President of the United States may exempt any of the activities of the Government of the United States under this Compact and its related agreements from any environmental standard or procedure which may be applicable under this Article if the President determines it to be in

646 Three feet of sea level rise by 2100 is the current projection, a ten feet scenario was conducted to take into account "potential inundation caused by increased wave-run-up from a typhoon coupled with a high tide,"; Romina King, Kaylyn Bautista, Marcel Higgs, and Edward Leon-Guerrero, "Vulnerability Assessment of Built Infrastructure near Coastal Bays using three Sea Level Rise Scenarios - Guam," 2019, 24, 30, & 32.

647 Article VI, §161 of the Republic of Palau Compact of Free Association, 1986.

> the paramount interest of the Government of the United States to do so, consistent with Title Three of this compact and the obligations of the Government of Palau and the United States under international law.[648]

Using such ambiguous language may give the US government more leeway in taking actions in its interests which may be harmful to Guam's interests, such as the environment. Therefore, Guam needs to be mindful of language from pre-existing compacts in order to limit ambiguous language in any agreement created for free association. As a compromise, provisions should be incorporated for the United States to exempt itself for reasons that should be explicitly enumerated. For example, Guam's potential compact can define conditions for what "paramount interest" should entail.

648 Article VI, §163e of the Republic of Palau Compact of Free Association, 1986.

HUMAN SECURITY	
STATUS	**EFFECTS**
Statehood	• Support before, during, and after natural disasters at the state and federal levels. • Continued federal economic assistance to the island." • Continued guidance and support from the Centers for Disease Control and Prevention (CDC). • Guam would be subject to federal laws, mandates, and executive orders. • Continued presence of US military bases may exacerbate issues pertaining to the environment and invasive species. • Varying stance on climate change by the federal government based on the administration may hinder support for climate change initiatives.

Independence	• Sovereignty and autonomy over Guam's internal and external affairs would allow Guam to combat human insecurities in a manner it desires. • Ability to freely join international and regional organizations. Guam can commit to global climate change agreements and have access to resource support from institutions and individual countries. • The government of Guam would have the power to supervise all entry and exit ports to control the entrance of invasive species, but would have the responsibility of enforcing them. • Island may receive limited financial assistance and/or resources from the US federal government. This assistance may come in other forms.
Free Association	• Guam would have the ability to negotiate an agreement in which it can create stipulations for US aid and support, with infrastructure to address human insecurities. • Ability to join international and regional organizations. Partnerships with other countries may lead to collaboration and sharing of resources. • Likely assistance from the United States. • Potential continuity of US military bases, which may exacerbate existing human security threats such as the introduction of invasive species. • Potential US control over defense and access to Guam's waters may pose obstacles to the island's ability to fully implement plans to address human security threats.

Food Security and Agricultural Expansion

In today's world, the health and well-being of humans is highly dependent on easy, reliable access to safe, healthy, and adequate sources of food. According to the 1996 World Food Summit, food security is achieved when "all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life."[649] Since then, the international community has adopted the term "food and nutrition security" (hereinafter referred to as FNS) to better encompass the nutrition and human health aspect that is inherent in food security.[650] FNS is comprised of four major aspects: food availability; food access; food utilization; and food stability. The Food and Agriculture Organization (FAO) of the United Nations provides the following definitions for these four dimensions:

649 Food and Agriculture Organization of the United Nations, Food Security and the Right to Food, accessed at http://www.fao.org/sustainable-development-goals/overview/fao-and-the-post-2015-development-agenda/food- security-and-the-right-to-food/en/.

650 FAO, IFAD, UNICEF, WFP, and WHO, "The State of Food Security and Nutrition in the World 2019," 2019, accessed at https://www.who.int/nutrition/publications/foodsecurity/state-food-security-nutrition-2019-en.pdf?ua=1.

Dimensions of Food and Nutrition Security.[651]

651 FAO, IFAD, UNICEF, WFP, and WHO, "The State of Food Security."

Physical AVAILABILITY of food	Food availability addresses the "supply side" of food security and is determined by the level of food production, stock levels and net trade.
Economic and physical ACCESS to food	An adequate supply of food at the national or international level does not in itself guarantee household level food security. Concerns about insufficient food access have resulted in a greater policy focus on incomes, expenditure, markets and prices in achieving food security objectives.
Food UTILIZATION	Utilization is commonly understood as the way the body makes the most of various nutrients in the food. Sufficient energy and nutrient intake by individuals is the result of good care and feeding practices, food preparation, diversity of the diet and intra-household distribution of food. Combined with good biological utilization of food consumed, this determines the *nutritional status* of individuals.
STABILITY of the other three dimensions over time	Even if your food intake is adequate today, you are still considered to be food insecure if you have inadequate access to food on a periodic basis, risking a deterioration of your nutritional status. Adverse weather conditions, political instability, or economic factors (unemployment, rising food prices) may have an impact on your food security status.

In order to achieve a successful level of food and nutrition security, all four of these aspects should be met and fulfilled simultaneously.

FNS is not a binary measurement that can be achieved or not achieved. Instead, it exists on a spectrum, varying in intensity. Although extreme hunger and starvation constitute the non-fulfillment of food and nutrition security, dietary intake of insufficient nutritional quality also constitutes food and nutrition insecurity. Thus, FNS is measured on a scale, ranging from intensities of moderate to severe insecurity. FNS is directly related and critical to other areas of societal well-being, to include economic prosperity, community growth, national security, and political stability, among others. FNS has direct impacts on emotional, social, behavioral, and intellectual development, and is considered a social and environmental disruptor. When humans are unable to fulfill their basic health and human needs, communal and societal needs are then put at risk.[652]

Food Security in Guam

The CHamoru people of Guam relied on a combination of fishing, gathering, and subsistence farming to meet their nutritional needs. During ancient times, and continuing up to WWII, CHamorus grew food to sustain their families.[653] The shift from subsistence farming to a reliance on imports occurred after WWII, following the destruction of farmlands and the United States' acquisition of much of the island's arable lands. Today, imported food comprises an alarmingly high portion of Guam's food supply.[654] As mentioned, food security means not only having a sufficient amount of food but having easily accessible, affordable, and nutritious food to support consumer preferences and an active lifestyle.

Several factors contribute to food and nutrition insecurity in Guam, including high prices, limited widespread availability of healthy foods, heavy reliance on food assistance programs, and poor diet and food choices by consumers. Other contributing factors to food insecurity include weather events and the detrimental effects of climate change.[655] The island's food supply is lacking in nutritious products, with many stores lacking an average of five of twelve categories of nutritious foods set by the US Department of Agriculture.[656]

Another compounding factor of food insecurity is the relatively high cost of goods. Although imported goods are cheaper than locally produced goods, locally produced foods are more nutritious than imported goods. Due to these higher prices, many people and households on the island rely on the US federally

652 Alison Decker, "Global Food Security requires a coordinated international response, Aspen Institute, (April 19, 2016): accessed at https://www.aspeninstitute.org/blog-posts/global-food-security-requires-a-coordinated- international-response-on-several-fronts-heres-what-the-experts-say/.

653 Darlene Moore, "Ancient Chamorro Agricultural Practices," *Guampedia*, accessed at https://www.guampedia.com/ancient-chamorro-agricultural-practices/.

654 LisaLinda Natividad and Gwyn Kirk, "Fortress Guam: Resistance to US Mega Military Buildup," Institute for *Policy Studies* (May 12, 2010): accessed at https://ips-dc.org/fortress_guam/.

655 Christie Nicoson, "Positive Peace and Food Security in Guam," November 2016, accessed at http://worldwithoutgenocide.org/wp-content/uploads/2016/09/Food-Security-in-Guam-2016.pdf

656 Nicoson, "Positive Peace."

funded Supplemental Nutritional Assistance Program (SNAP) to provide for their nutritional needs.[657] This inability to purchase food without government assistance is a major factor inhibiting food security.

In regard to agricultural expansion as a means of ensuring FNS, sustainability experts in Guam cite several main inhibiting factors: limited demand for locally grown foods due to limited selection/supply and consumer preferences; limited land suitable for agricultural use; access to labor; and farmer education.[658] Challenges currently faced in Guam are actively being addressed by government agencies such as: the Guam Department of Agriculture; programs out of the University of Guam, such as the College of Natural and Applied Science's Research & Extension program and the Center for Island Sustainability (CIS); and community organizations, such as the Farm to Table Guam Corp and Guåhan Sustainable Culture. By taking advantage of the aspects inherent in Guam's unique environment that promote agricultural expansion, such as adequate available land and favorable climate, several initiatives are being undertaken to address the inhibiting factors.

To address issues related to the limited amount of land available for agricultural use, special agroforestry techniques have been developed that adapt mountainous land in Guam's southern region to be useful for agriculture. In cases where soil lacks the necessary nutrients to support agriculture, methods have also been developed to alter soil composition to be more beneficial to certain crops. Dr. Mohammad H. Golabi, a soil and science professor at the University of Guam, asserts that Guam's lands have potential for agricultural expansion, especially when considering the amount of idle land that is currently unused for any commercial, residential, or public purpose. Dr. Golabi suggests that, through the aforementioned agroforestry and soil re-composition techniques, unused land can be converted into agricultural production land.[659] When asked what steps can be taken to promote Guam's FNS and overall sustainability, Golabi recommended that Guam work toward establishing a slaughterhouse for meat. As Golabi describes, a meat slaughterhouse would promote increased economic activity by allowing island residents and businesses to process locally raised livestock and then sell that meat for local consumption. Golabi further proposes a circular-based economy in which animal feed for locally raised livestock would be provided by locally grown grain and corn products. Waste produced from the slaughterhouse would also be composted and used to support agricultural production. Golabi suggests that there is potential for a local meat industry to export goods off-island for increased economic activity.[660] However, this would require extensive infrastructure development.

In his 2021 Congressional Address to the Guam Legislature, Congressman Michael San Nicolas proposed the establishment of slaughterhouses in Guam to enhance sustainable livestock. He argued that having more slaughterhouses "will help reduce meat prices for consumers and will contribute to

657 Supplemental Nutrition Assistance Program, "State Activity Report: Fiscal Year 2016," 2016, accessed at https://fns- prod.azureedge.net/sites/default/files/snap/FY16-State-Activity-Report.pdf.

658 Personal Communication with Center for Island Sustainability and University of Guam Sea Grant Director Austin Shelton, July 14, 2020.

659 Personal Communication with University of Guam Professor Dr. Mohammad Golabi, July 16, 2020.

660 Personal Communication with University of Guam Professor Dr. Mohammad Golabi, July 16, 2020.

Guam's food security."[661] He said, "In our engagement with the US Department of Agriculture, we found that Guam has nine USDA meat processing facilities on the island, but none of these are actual slaughterhouses. We have no facilities to bring locally raised meats into local supermarkets or onto local restaurant menus."[662] Furthermore, he discussed engaging with the Department of Defense to determine whether DoD land in the island can be used for grazing, which would help provide the inventory for the slaughterhouse at lower costs.

As an existing example of a small-scale circular-based system, the UOG Triton Farm "serves as an integrated farm model that encourages agricultural research and the use of sustainable farming methods" through crop production such as lettuce, grapefruit, lemons, peppers, and other produce, with both aquaponics and hydroponics techniques, and through the raising of animals such as chicken and fish.[663] The farm implements several sustainable practices, including the use of fish waste for fertilizer for plants that are then used to filter fish pond water, and free-range, open pasture chickens, whose manure is used for compost for trees, from which fruits are ground into pellets for chicken feed. The farm then sells the locally produced eggs to the community, along with other fresh produce.[664]

The Need to Address Food Security on Guam

As stated, a community's reliable access to sufficient, affordable, and nutritious foods is essential to its wellbeing. Achieving food and nutrition security enables and promotes the social, economic, and overall growth of the island as a whole. Thus, although Guam, with its current limited agricultural capacity, may not be as greatly affected by disruptions in domestic production, food and nutrition security will undoubtedly be affected by issues in food production in other countries. Guam's current situation requires that the island focus primarily on securing continued and improved access to low-cost, nutritious, imported goods, and secondly, on expanding domestic production, which will have the greatest long-term benefits for the island's FNS. Nevertheless, issues surrounding the uncertainty of global trade and international economic activity require that Guam work toward reducing its level of reliance on food imports. At the same time, the island must take steps toward ensuring access to nutritious food by all people while also promoting positive changes in diet and consumer choice.

While Guam may not see these challenges as pressing issues to address immediately, the negative effects of climate change, which are already being seen throughout the world and especially within the Pacific, will present a complex set of new challenges that will greatly affect both global trade and domestic agriculture. It is therefore in the best interest of the people of Guam to work toward policy and action that

661 Gerry Partido, "Slaughterhouses proposed to reduce meat prices and enhance Guam's food security," Pacific News Center, June 28, 2021, accessed at https://www.pncguam.com/slaughterhouses-proposed-to-reduce-meat-prices-and-enhance-guams-food-security/.

662 Gerry Partido, "Slaughterhouses proposed to reduce meat prices and enhance Guam's food security," Pacific News Center, June 28, 2021, accessed at https://www.pncguam.com/slaughterhouses-proposed-to-reduce-meat-prices-and-enhance-guams-food-security/.

663 Amanda Dedicatoria, "Triton farm promotes natural farming," Triton's Call, April 10, 2017, accessed at https://tritonscall.com/triton-farm-promotes-natural-farming/.

664 Dedicatoria, "Triton farm."

proactively address the challenges discussed, by maximizing the benefits of international trade, expanding domestic agricultural production with sustainable practices, and improving food distribution capacities. This multifaceted synergy of efforts will prove most effective in securing the island's food and nutrition security and overall well-being into the future.

Statehood

Increased Federal Financial/Technical Assistance

As a state, Guam would have an improved, more equitable relationship with the federal government, which would continue or increase the availability of federal programs and financial/technical assistance. Guam receives federal funds from the United States Department of Agriculture (USDA) in support of local agriculture programs such as plant and animal disease, pest control, and animal care, a specialty crop block grant program, and the cooperative forestry assistance program.[665] As a state, there could be a wider range of access to programs that support agricultural expansion. These programs, provided by the USDA, include direct farm ownership loans, which help farmers buy land, equipment, seed, livestock, and other operating necessities, as well as guaranteed farm loans, which assist farmers in purchasing farmland or agricultural equipment. The USDA also has other types of programs which provide protections to farmers, such as price loss coverage, agricultural risk coverage, and marketing assistance loans.[666] This role may become increasingly important as the risks of climate change threaten agricultural production. While some of these programs are available to the territories, there are other programs provided by the USDA that are currently unavailable to the territories, but available to states, programs from which Guam would benefit if it were a state.[667] Ultimately, the USDA's national programs have supported both new and continuing development of agriculture and the expansion of such programs would play a role in Guam's path to agricultural expansion and food security.[668] For Guam, statehood would come with complete inclusion of the island at the federal level, likely in all federal programs.

Being a Part of the United States' Trade Network

The Organic Act of 1950 placed Guam outside of the customs territory of the United States, which is inclusive only of the fifty states, the District of Columbia, and Puerto Rico.[669] Therefore, goods

665 Guam Bureau of Statistics and Plans, "GovGuam Audit," 2018.

666 United States Department of Agriculture, "Farm Programs," Farm Service Agency Hawaii, accessed at https://www.fsa.usda.gov/state-offices/Hawaii/programs/index.

667 National Sustainable Agriculture Coalition, Whole-Farm Revenue Protection for Diversified Farms, accessed at https://sustainableagriculture.net/publications/grassrootsguide/credit-crop-insurance/whole-farm-revenue-protection-for-diversified-farms/#eligible.

668 US Department of Agriculture, "USDA Strategic Plan FY 2018-2022," accessed at https://www.usda.gov/sites/default/files/documents/usda-strategic-plan-2018-2022.pdf.

669 Harmonized Tariff Schedule of the United States, Revision 12, 2020, General Notes, 3, accessed at https://hts.usitc.gov/view/General%20Notes?release=2020HTSARev12.

imported from Guam to the United States are potentially subject to tariffs and quotas.[670]As set forth by the Harmonized Tariff Schedule, goods imported to such areas from Guam are subject to the rates of duty as set forth by the tariff schedule, unless such goods are bona fide products of Guam which do not contain foreign materials valued at more than 70 percent of the total value of goods.[671] Additionally, although bona fide products are not subject to tariffs, they can be subject to federally-set import quotas, which are applied to the quantity rather than value of goods. These special conditions placed on Guam's import and export of goods are exclusive to territories, as trade between states is not subject to bona fide product requirements, and states are not permitted to impose quotas on the products of any other state. It is important to note that being placed outside of the US Customs zone can be beneficial. Guam Senator Pedo Terlaje, writes, "This status has its benefits, including more independent trade with Asia and Australia, by which we have enjoyed the availability of many familiar brands from Asia and Australia in our supermarket and convenience store shelves."[672] Although Guam has the authority to levy tariffs and quotas on imported goods, it has not done so because of the potential impact on prices.

As a state, Guam would be within the customs territory of the United States (which may have repercussions for other economic aspects) and, therefore, would not be subject to the aforementioned conditions. Additionally, as a state of the United States, Guam would be able to take advantage of the mechanisms that promote trade with other states and also foreign countries that are part of the US international trade network.[673]

It must also be noted that agricultural production in the United States is not immune to the challenges faced in agricultural production in other countries, such as fluctuations in production due to climate change, and other factors. Nevertheless, statehood would facilitate the greatest opportunities for trade with other states, therefore enabling Guam to pursue trade that would aid its pursuit of FNS. Under statehood, the Jones Act and its negative effects on the island could remain unresolved until addressed by the federal government.

Specifically, Section 27 of the Merchant Marine Act of 1920, otherwise known as the Jones Act, applies to all US states, Guam, and Puerto Rico.[674] It requires that cargo transported between US ports be carried by ships that are domestically built, domestically flagged, and seventy-five percent owned and crewed by US citizens or permanent residents. Hawai'i and Alaska in particular, due to their greater reliance on maritime transportation when compared to the states of the continental US, have experienced higher transportation costs and inflated prices of imported goods, along with an inability to receive disaster-relief

670 Joseph Bradley, Email, June 9, 2020.

671 Harmonized Tariff Schedule of the United States, Revision 12, 2020, General Notes, 3, accessed at https://hts.usitc.gov/view/General%20Notes?release=2020HTSARev12.

672 https://www.guampdn.com/opinion/letter-allow-guam-to-compete-in-the-world-market/article_55582e31-881b-5a43-af0b-57ab6940781b.html.

673 Sandy Dall'erba, "Why will the coming years see more interest for interstate food supply linkages?," *Policy Matters* (December 8, 2016): accessed at https://policymatters.illinois.edu/why-will-the-coming-years-see-more- interest-for-interstate-food-supply-linkages/.

674 Puerto Rico is subject to the Jones Act due to it being the only territory that is within the US Customs Zone.

aid from foreign ships in the event of natural disaster.[675] Although Guam is exempt from the provision that ships arriving at its port be domestically built, the exemption has provided little relief, as ships coming from the continental US must still pass through Hawai'i, which does not have the same exemption, before heading to Guam. Any ships from the continental US heading to Guam and stopping in Hawai'i must be in full compliance with all provisions of the Jones Act.[676] As stated by the Port Authority of Guam,

> To service Guam, ocean carriers deploy cargo ships between the US or Asia markets and Guam to take advantage of lower operating costs and then use smaller feeder vessels for transporting transshipment cargo between Guam and the Micronesia Islands. Vessels on these trade routes often carry a combination of containers, breakbulk and Roll on/Roll off (Ro/Ro) cargo to reduce service costs and meet the various market demands of the islands.
>
> Carriers with service routes between the US mainland and Guam are exempt from certain US cabotage requirements contained in the Merchant Marine Act of 1920 (P.L. 66-261), also known as the Jones Act. Section 27 of the Jones Act requires that all goods transported by water between US ports be carried on US flag ships, built in US shipyards, owned by US citizens, and crewed by US citizens and US permanent residents.
>
> These carriers are not required to use US built ships (46 USC 12111), effectively allowing the deployment of foreign-owned, foreign-built US flag vessels in the domestic Guam trade. However, the vessels must be US flagged, meaning that the ships must employ a US crew and are subject to US Coast Guard (USCG) inspection. The foreign ownership of a US flag vessel must be arranged through a special purpose US trust.
>
> The historical exemption from the US-build requirement is of limited usefulness to carriers in the domestic Guam trade since the natural westbound trade lane from the West Coast to Guam passes through Hawai'i, which is not exempted from the US build requirement. In the past five years, there have been numerous media reports and a small number of legislative proposals requesting a Jones Act exemption for Hawai'i and other non-contiguous territories. Although a US Territory, CNMI (e.g., Saipan, Tinian, Rota) is exempt from the provisions of the Jones Act due to the international treaty associated with its annexation by the US. Since foreign-flagged vessels are restricted from transferring cargo directly to/from US ports on the mainland and Guam or Hawai'i, these vessels must call a foreign port in between calls to US mainland ports and Guam or Hawai'i.[677]

675 Cecil Bohanon and Nick Curott, "Little-Known Jones Act Is Outdated and Ripe for Repeal," *Indianapolis Business Journal* (March 15, 2019): 30, accessed at https://www.ibj.com/articles/72923-bohanon-curott- little-known-jones-act-is-outdated-and-ripe-for-repeal.

676 Colin Grabow, Inu Manak, and Daniel Ikenson, "The Jones Act: A Burden American can no longer bear," Cato Institute, 2018, accessed at https://www.cato.org/publications/policy-analysis/jones-act-burden-america-can-no-longer-bear.

677 Port Authority of Guam Information for Self-Governance Study, November 2019.

To quantify these effects, a local business owner states that the cost of shipping a container from the West Coast of the United States to Guam costs approximately $7,500, while the cost of shipping the same container from the West Coast of the US to Manila, Philippines, costs about $2,800.[678] With respect to agricultural imports, Guam's government, local companies, and consumers would continue to bear the higher costs of transporting agricultural goods and other associated materials and supplies to Guam. If Guam became a state, the Jones Act would continue to apply, unless the federal government exempted the island partially or entirely from its provisions.

Aside from interstate trade, Guam would also be a part of the US international trade network, which provides advantages and facilitates beneficial trade. With statehood, unlike the situation that exists under the current territorial status, legislative measures from the federal government would no longer be applied selectively to Guam. Guam would instead be subject to laws that apply to the other fifty states.

Limited Land Availability for Agricultural Production

Guam has a limited amount of land currently available for agriculture. The US military occupies approximately twenty-seven percent of the island. Statehood provides the least amount of land return potential, due to the continued and likely expanded military activity that would occur in Guam. Upon becoming a state, Guam could work toward identifying a necessary amount of land to support its domestic FNS and advocate for federal land to be returned to Guam for that purpose. Nevertheless, even without such return, methods of converting land currently unused for agriculture into agriculture-suitable land could enable the state of Guam to have an increased amount of land available for agricultural production. Guam could dedicate local and federal resources toward converting otherwise unused land into land suitable for agricultural production but would need to be cautious about the effects of such conversion on wildlife. A 2020 study found cropland conversion to be of limited gain and disproportionate to the negative effects on wildlife.[679]

Status Example: The State of Hawai'i

Due to Hawai'i's geographic characteristics as an island, it faces challenges similar to Guam. Like Guam, Hawai'i's supply of food and its food and nutrition security are dependent on and vulnerable to factors in the global production and distribution of food, to include: "disruptions in the shipping chain, production fluctuations in the continental United States, severe weather conditions, and sudden spikes in the prices of food products as well as higher prices for fuel, feed, fertilizers, and other agricultural 'inputs'"[680]

678 Public Hearing Testimony, Resolution 138-32, 32nd Guam Legislature, 2014.

679 Tyler Lark, et al., "Cropland expansion in the United States produces marginal yields at high costs to wildlife," Nature Communications 11, (2020), accessed at https://www.nature.com/articles/s41467-020-18045-z.

680 Matthew K. Loke and PingSun Leung, "Hawaii's Food Consumption and Supply Sources: Benchmark Estimates and Measurement Issues," Agricultural and Food Economics 1, no. 10 (August 2013), 2, https://www.researchgate.net/publication/269039132_Hawaii%27s_Food_Consumption_and_Supply_Sources_Benchmark_Estimates_and_Measurement_Issues.

Although Hawai'i was historically self-sufficient in producing some vegetable and fruit crops, along with eggs and milk, as of 2012, it was only self-sufficient in some vegetable and fruit crops. In 2012, the island was also becoming less self-sufficient with egg, milk, livestock, hog, and pig commodities.[681] Hawai'i has found it necessary to increase its food self-sufficiency in order to increase its food and nutrition security. A 2012 report by the Office of Planning in cooperation with Hawai"s state Department of Agriculture outlined the steps to take toward achieving these goals. The report called for "actions to market 'Buy Local/It Matters' and to brand and label local food products,…increasing production by strengthening agricultural infrastructure,…[providing] for food safety, pest prevent and control, workforce training, research and extension services; and policy and organizational support."[682] The report noted that replacing only ten percent of Hawai'i's imported food with locally produced goods would result in a $313 million revenue for the island, which would "generate an economy-wide impact of an additional $188 million in sales, $47 million in earnings, $6 million in state tax revenues, and add more than 2,300 jobs."[683]

In its pursuit of food and nutrition security, Hawai'i's state government has launched the Aloha+ Challenge, a "statewide commitment to achieve Hawai'i's sustainability goals" and a "locally driven framework to implement the United Nations Sustainable Development Goals."[684] The goal of the program is to double the island's local food production by 2030 through an increase in the production, processing, distribution, and consumption of locally produced goods. The Aloha+ challenge makes use of five metrics to gauge local food production and consumption: pounds of food locally produced annually; acres of farmland in use; number of agricultural processing facilities; number of farmers markets statewide; and dollars of agricultural products sold. It remains to be seen, at the time of writing, whether or not Hawai'i is on track to meet each metric's respective targets, as all five metrics were still being measured to establish a baseline.[685] Local food production has taken a downturn in Hawai'i, likely attributed to environmental factors such as "soil conditions, drought, and natural and man-made disasters" or other factors, such as "the availability of farm and labor workers, land for farming, and associated costs of water and electricity." In 2012, Hawai'i experienced its lowest amount of local production in twenty years, however some vegetable and fruit crops have seen an uptick in production in recent years.[686] Hawai'i's precolonial staple crop, kalo (taro), has seen major losses in production over the last century, but there are several community initiatives that seek to restore kalo's important place in Hawaiian culture, agriculture, and food and nutrition security.

Much of Hawai'i's success in building its agricultural capacity and increasing its food and nutrition security can be attributed to its effective synergy of governmental/community/business efforts, as well as funding support from the federal government. In regard to the synergy of governmental/community/

681 Hawaii Department of Business Economic Development & Tourism, "Increased Food Security and Self-Sufficiency Strategy," 2012, ii, accessed at https://files.hawaii.gov/dbedt/op/spb/INCREASED_FOOD_SECURITY_AND_FOOD_SELF_SUFFICIENCY_STRATEGY.pdf.

682 Hawaii Department of Business Economic Development & Tourism, "Increased Food Security," i.

683 Hawaii Department of Business Economic Development & Tourism, "Increased Food Security," ii.

684 Hawaii State Government, "Aloha+ Challenge," accessed at https://aloha-challenge.hawaiigreengrowth.org.

685 Hawaii State Government, "Aloha+ Challenge."

686 Hawaii State Government, "Aloha+ Challenge."

business efforts, several organizations, such as the Kōkua Kalihi Valley Comprehensive Family Services, Sust'āinable Molokai, and MA'O Organic Farms, have successfully connected Hawai'i's indigenous methods of farming with modern day methods of cooking and distribution in order to provide locally produced foods for families. Kōkua Kalihi Valley Comprehensive Family Services, a group that works with eighteen local farms, has undertaken initiatives to increase the number of farmers in Hawai'i, boost the sharing of health knowledge, teach culinary skills to community members, and expand food access. Sust'āinable Molokai has worked to further connect residents and food producers through the creation of a food hub that facilitates the USDA Fresh Fruit and Vegetable Program, as well as a Mobile Market which delivers locally produced goods directly to consumers, who are also able to order food items online.

The USDA Fresh Fruit and Vegetable Program "offers federal reimbursements for local produce served directly to elementary school students, along with a brief lesson on the origin and nutritional value of the food."[687] The Mobile Market also integrates federal funds, as it accepts EBT, allowing consumers to spend their federal nutrition assistance funds on locally produced goods.[688] Another example of this synergy of resources is the Hawaii Food Producers fund, a collaboration between The Kohala Center, The Hawaii Department of Agriculture, County of Hawaii, and Kiva, a peer-to-peer online lending program. The Fund provides zero percent interest business loans, up to $10,000, through crowd funding. Hawai'i farmers and food producers who utilize "at least one Hawaii-grown ingredient is eligible to receive fifty percent of their Kiva loan" from the fund.[689]

Like Guam, funds provided by the US government are crucial to the well-being of residents and the effectiveness of local governments. Many Hawai'i residents rely on the Supplemental Nutritional Assistance Program (SNAP). In FY2019, 157,000 Hawai'i residents, or eleven percent of the state's population received SNAP benefits, with approximately sixty-two percent of residents being families with children. SNAP plays an important role in ensuring food and nutrition security, as eight percent of households reported being "food insecure" or unable to afford a nutritionally adequate diet in FY 2019, and SNAP "kept 65,000 people out of poverty in Hawai'i, including 28,000 children per year between 2013 and 2016, on average.[690] In relation to Hawai'i 's local agricultural industry, in 2016, $1.6 million in SNAP benefits were spent at Hawaii Farmers' Markets, even with only one out of five farmers' markets accepting SNAP as of 2018.[691] The USDA also provides food commodities to Hawai'i residents via USDA's The Emergency Food Assistance Program (TEFAP), which gives surplus food goods to local food banks.[692]

Aside from direct aid to residents, federal funding is also important to local farms, as well as Hawai'i state agencies. In FY2019, the Hawaii Department of Agriculture's operating budget consisted of

687 "Good Food For All: Advancing Health Equity Through Hawaii's Food System," 2018, 13, accessed at http://www.kohalacenter.org/docs/reports/Food_For_All_Book_WEB.pdf.

688 "Good Food For All."

689 The Kohala Center, "Hawaii Food Producers Fund," 2013, accessed at https://hdoa.hawaii.gov/agl/files/2013/02/HFPF-fact-sheet-2017.pdf.

690 Center on Budget and Policy Priorities, "Hawaii Supplemental Nutrition Assistance Program," 1.

691 "Good Food For All," 9.

692 "Good Food For All," 5.

approximately $2.5 million dollars in federal funding, or nearly twenty-one percent of the agency's budget, however information is limited on what programs and initiatives have been supported by this funding.[693] For other community stakeholders, including local farmers, the federal government has provided a significant amount of funding in the form of various grant and loan programs. In 2017, Hawai'i farms received eleven federal grants totaling, $427,000, through the USDA's Specialty Crop Block Grant Program, which supports the competitiveness of specialty crops such as fruits, vegetables, tree nuts, dried fruits, horticulture, and nursery crops. The grants included projects for research, farmer education, agricultural marketing, and increased taro, breadfruit, cacao, mango, cucumber, banana, legumes, Christmas trees, and other specialty crop production.[694]

In 2018, a Hawaiian non-profit, Synergistic Hawaii Agriculture Council (SHAC), received $483,00 in federal funding to help farmers recover from adverse impacts caused by volcanic activity on Hawai'i island.[695] Hawai'i farmers also receive a variety of support, whether in the form of funding or technical assistance, from various federal agencies and programs, to include the USDA's Farm Service Agency, the USDA's Rural Development Agency, the USDA's Cooperative State Research, Education, and Extension Service (CSREES) Grant - Western Region Sustainable Agriculture Research and Education, and the Small Business Innovation Research Program. In addition, the federal government encourages "small businesses to export by offering finance programs through the Export-Import Bank, the Small Business Administration, and the Overseas Private Investment Corp."[696]

Although many of the aforementioned initiatives and opportunities undertaken by Hawai'i can be pursued by Guam in its current territorial status, Guam as a state would benefit from greater integration into the United States system of government by being automatically eligible for all federal programs that are offered to states, thus allowing it greater and easier access to federal funding and programs when compared to the current system, in which programs are selectively made available to Guam. As stated earlier, Guam's current eligibility for federal programs is more of a patchwork of resources, rather than the large, non-discriminatory pool of resources currently offered to states. Statehood would rectify this limited state of eligibility. Again, Guam would therefore be eligible for more technical and financial assistance than it currently receives now.

Programs and funding sources that Guam currently avails of are not guaranteed under continued territorial status and are dependent on decisions made by US federal agencies and the US Congress. If Guam were to become a state, the continuance of these programs and funding assistances would be dependent on nationwide continuance rather than the individual extension of the programs to Guam. In addition, increased representation at the federal level would provide Guam greater political power to

693 Hawaii Department of Agriculture, "Department of Agriculture Factsheet," 2019, 223, accessed at https://budget.hawaii.gov/wp-content/uploads/2016/12/09.-Department-of-Agriculture-FB17-19-PFP.pdf.

694 Hawaii Department of Agriculture, "Hawaii Receives $427,000 in Federal Grants for Agriculture," October 4, 2017, accessed at http://hdoa.hawaii.gov/blog/main/nr17-17scbgpgrants/.

695 Nina Wu, "Nearly $500K in federal funds will help Hawaii farmers rebuild, *Star Advertiser*, October 1, 2018, accessed at https://www.staradvertiser.com/2018/10/01/breaking-news/nearly-500k-in-federal-funds-will-help-hawaii-farmers-rebuild/.

696 State of Hawaii Agricultural Loan Division, "Other Funding Sources," accessed at http://hdoa.hawaii.gov/agl/other-funding-sources/.

advocate for policies that further advance its FNS.

Independence

As an independent country, Guam would have control over the entirety of its affairs, both internal and external. This level of sovereignty and decision-making provides many opportunities, but also comes with the challenge of not being directly affiliated with any country and thus not automatically receiving any assistance. Prior to achieving independence, Guam would need to work toward establishing relationships with regional neighbors within Micronesia, the Pacific, and Asia.

Governmental Policy

As an independent country, Guam's sovereignty would allow the island to implement governmental policies that directly bolster its FNS. The government of Guam could implement comprehensive policy reforms, ranging from land use, to education, to tariffs and duties, etc. In regard to land, the government of Guam could make ownership and/or taxation dependent on how the land is used. With education, an independent Guam could offer, or continue to offer, agricultural courses/programs that teach students sustainable agricultural practices. Lastly, with tariffs and duties, the government of Guam would have the ability to implement and enforce trade policies that either encourage or discourage the import and export of goods, dependent on domestic food availability conditions. While these examples may be possible under the other two status options, independence comes with a minimal level of limitations and potential conflict, as Guam would be able to control the laws within its borders. Overall, independence offers the most free-ranging authority to implement policies that are specially tailored to Guam's unique needs and advantageous to its FNS situation. An independent Guam will have to develop an understanding of the global economic system of agriculture and trade.

Exercise of External Affairs

As is the case with domestic policy, control over an independent Guam's foreign affairs would rest in Guam's hands. Guam would have the range of authority to select which countries it interacts with on the international stage, as well as the terms of those interactions. In specific regard to FNS, Guam would be able to seek involvement in various regional and international organizations as a full-fledged member state (country) if it meets the eligibility requirements. The most notable of such organizations is the United Nations. As an independent country, Guam would be eligible to join the UN as a member state and be able to advocate for its own interests. Moreover, Guam would have the opportunity to negotiate various types of agreements, such as free trade agreements, mutual assistance treaties, etc., with other countries. The independent country of Vanuatu provides several examples of trade agreements that Guam could pursue. In 2012, Vanuatu became a member of the World Trade Organization (WTO), and is currently a

member of the organization's various groups, to include the ACP (African, Caribbean and Pacific countries with preferences in the European Union), G-90 (African group + ACP + least developed countries), and the Least Developed Countries group.[697] Vanuatu is a party to reciprocal and non-reciprocal regional trade agreements. The former are agreements in which Vanuatu receives preferential treatment and provides the same to a partnering country, and the latter are agreements in which Vanuatu is afforded preferential trade treatment without providing the same treatment in return.[698]

As of 2018, Vanuatu is member of three reciprocal regional trade agreements: the Melanesian Spearhead Group Trade Agreement (MSG); the Pacific Island Countries Trade Agreement (PICTA); and the Pacific Agreement on Closer Economic Relations Plus (PACER Plus). PACER Plus has not yet been entered into force, meaning it has not yet been implemented to have legal force and effect.[699] With the MSG Trade Agreement, tariffs are waived on all products originating and exported from other parties, with some exceptions for wine, spirits, and tobacco. Vanuatu's largest trading partners under this specific agreement are Fiji, followed by Papua New Guinea and the Solomon Islands.[700]

Land Use

As discussed, the US federal government currently controls/occupies roughly thirty-one percent of Guam's land area (around twenty-seven percent being DoD). If Guam were to become independent, the return of land to the government of Guam would have to be negotiated. This is especially important, considering that much of Guam's arable land is currently controlled by the federal government. Although highly unlikely, if the entirety of this land were to be returned to Guam, there would be potential for agricultural expansion. Nevertheless, any possible return would still provide opportunities for the expansion of local agricultural production. Upon return of any land, the government of Guam could possibly limit how the land is used, potentially restricting its use to activities that further agricultural or economic development. There is the likelihood that Guam will negotiate a defense agreement with the United States that would result in the continued existence of US military bases. However, in negotiating this defense agreement, Guam could ensure that a set amount of land is reserved for the local government for agricultural purposes.

The Loss of Federal Programs

Many of Guam's residents currently rely on the federally funded nutrition programs to meet their food needs, specifically the Supplemental Nutritional Assistance Program (SNAP). As of 2019, there were

697 World Trade Organization, Trade Policy Review: Report by the Secretariat: Vanuatu, 2018, 21, https://www.wto.org/english/tratop_e/tpr_e/s378_e.pdf.

698 World Trade Organization, "Trade Policy Review: Vanuatu," 22.

699 World Trade Organization, "Trade Policy Review: Vanuatu," 22.

700 World Trade Organization, "Trade Policy Review: Vanuatu," 23.

15,518 households receiving SNAP benefits in Guam.[701] Another program, funded by the USDA, is the Special Supplemental Nutritional Program for Women, Infants, and Children (WIC). The program supports the healthy development of low-income or nutrient-at-risk women, infants, and children up to age five by subsidizing the purchase of certain healthy foods. While some of the administrative costs associated with these programs are locally funded, the actual program costs and benefits provided to recipients are paid for entirely by the USDA. If Guam were to be independent, Guam citizens would not be eligible to receive SNAP and WIC benefits for its citizens in the long run, even if there is some continued funding during a transition. An independent Guam would have to work to ensure that people currently on these programs receive an alternate service or food source that will meet their nutritional needs. Failure to provide a similar, alternative program would have devastating effects on the FNS of thousands of families, as well as the FNS of the island overall. The local government would also have latitude to reform food and housing assistance programs to prioritize the growth and purchase of local foods through these programs, providing demand and leading to more jobs.

As an independent country, Guam would likely be able to avail of some programs from regional and international organizations.[702] The presence of both international/regional technical support could have a positive effect on the island's overall FNS. International/regional technical and financial support could provide direct assistance to agricultural expansion efforts, as discussed in the status example below. Such assistance would be most effective if paired with a comprehensive, multi-sectoral plan, strategic government policy supports, and synergy among local organizations. Such combination of internal capacity-building efforts and external assistance would positively support the development of an agricultural sector that could contribute to domestic FNS.

Treaties and free trade agreements could also have a positive effect on domestic FNS, by enabling Guam to supplement its domestic supply of food with reliable, nutritious, low-cost locally produced and imported goods. Similarly, Guam could import foods that are not grown in Guam, but wanted by consumers, while potentially exporting goods grown in Guam that are wanted by consumers in other countries. Trade can play a role in ensuring a country's FNS.

Status Example: The Kingdom of Tonga

The Kingdom of Tonga, or Tonga, is an independent Pacific Island country that has a population of 106,398 people. Its people are spread out over four island groups with a combined total land area of 288 square miles. Like Guam, Tonga faces similar food security challenges, such as having a high dependence on imported foods and high levels of obesity. Unlike Guam, however, seventy-five percent of Tonga's population lives in rural areas, and the country has one of the highest levels of subsistence food production

701 Oyaol Ngirairikl, "SNAP change affects 2,000," *Guam Daily Post*, September 12, 2019, accessed at https://www.postguam.com/news/local/snap-change-affects/article_de46ee7a-d484-11e9-8c26-abfa3b8f13a8.html.

702 United Nations, "Country Classification: Data sources, country classifications and aggregation methodology," 2014, 150, accessed at https://www.un.org/en/development/desa/policy/wesp/wesp_current/2014wesp_country_classification.pdf.

among Pacific Island countries.[703] Nevertheless, Tonga stands as an example of how an underdeveloped country can make use of policy, technology, and external supports to successfully grow its agricultural production capabilities while effectively combatting the detrimental effects of climate change.

External Supports

Tonga receives a variety of financial and technical assistance support in the agricultural sector from international organizations, regional organizations, and individual countries. Most notably, the International Fund for Agricultural Development (IFAD), a specialized agency of the United Nations, provided a total of $16.74 million in financing costs, which supported five projects and benefited 17,209 households in Tonga. In Tonga, IFAD's focus is primarily centered on helping the rural population produce local food crops. This direct support assisted much of Tonga's rural population who are dependent on agricultural production and fisheries.[704]

An example of a regional organization that aids Tonga is the Asian Development Bank (ADB), with several programs that directly assist Tonga's agricultural development. The most extensive of these is the Outer Islands Agriculture Development Project (OIADP), a $4.6 million project which sought to increase agricultural productivity on the outer islands of Tonga, reduce income disparities between households on the different island groups, and stimulate Tonga's agricultural exports.[705] The ADB also provided two technical assistance grants, for a total of $910,000 in support of the project.

Additionally, Australia, through its AusAid Pacific Horticultural & Agricultural Market Access (PHAMA) project, contributed $8.2 million to support and encourage increased trade between Tonga and other Pacific Island countries. The project was successful, with Tonga's watermelon exports increasing from eighty-six tons in 2010 to 271 tons in 2013, along with the creation of a "Kingdom of Tonga" food label, and the upgrade of a crucial export facility.[706]

Combatting Specific Problems

In 2016, in hopes of addressing the many complexities posed by the effects of climate change on Pacific islands, Tonga developed a four-year Tonga Agriculture Sector Plan. Through its four areas of change: climate resilient environment; enabling environment; sustainable livelihoods and healthy foods; and sustainable growth and foreign exchange earnings, the comprehensive plan provides a multi-faceted approach to sustainably increasing the agricultural capacity of Tonga while growing the agricultural

703 The World Bank, "Tonga Agriculture Sector Plan: 2016-2020, accessed at https://pafpnet.spc.int/attachments/article/574/Tonga%20Agriculture%20Sector%20Plan%202016-2020.pdf.

704 International Fund for Agricultural Development, "Tonga," accessed at https://www.ifad.org/en/web/operations/country/id/tonga.

705 Asian Development Bank Operations Evaluation Department, "Project Performance Evaluation Report for the Outer Islands Agriculture Development Project in the Kingdom of Tonga," Asian Development Bank, July 2006, accessed at https://www.adb.org/sites/default/files/evaluation-document/35122/files/26028-ton-pper.pdf.

706 Pacific Horticultural & Agricultural Market Access Plus Program, "Creating Export Opportunities for Tonga," 2018, accessed at http://phama.com.au/wp-content/uploads/2018/02/PHAMA-in-Tonga.pdf.

sector's contributions to economic development and trade.

For specific challenges, such as addressing labor shortages, the plan calls for the recruitment and training of young farmers through training programs in Tonga's schools that focus on climate-resilient subsistence and commercial farming. The plan also calls for public awareness campaigns that raise community knowledge of specific challenges such as soil fertility and how farmers can better protect Tonga's soil. The plan also seeks to implement local institutional policy, export and import policy, and land and rural finance policy that will work in synergy to bring the greatest level of production, efficiency, and self-sustainability to Tonga.[707]

While most aspects of this plan can be implemented under statehood and free association, independence provides the highest degree of autonomy and decision-making power (but with the highest degree of responsibility and risk) to implement a similar comprehensive plan in Guam. Barring the negotiation of a defense agreement with another independent country, an independent Guam would likely not be limited by any potential conflict with US political/national security interests and would instead have the complete ability to negotiate agreements, both in trade and financial/technical support, with any and all countries, including the United States. This ability includes the possibility of negotiating Free Trade Agreements with regional and international partners that could possibly provide greater benefits than the FTAs of the United States.

Free Association

Duty-Free Trade with the US

As part of the Compact of Free Association, "many categories of US imports from the FAS can enter the United States free of duty. Certain rules of origin apply, and an article, to receive duty-free treatment, must be imported directly from a freely associated state."[708] This helps allow for the export of domestically produced FAS goods to the United States. This ability creates an avenue of trade by encouraging the import of goods from the FAS to the United States due to their potentially cheaper, more competitive prices, when compared with other non-duty-free imports. This trade was comprised of frozen fish meat and other products. If Guam were to expand its agricultural capacity to exportable levels, the implementation of similar provisions in a potential compact or other legal instrument could potentially provide Guam an established, reliable trade partner and provide opportunities for the sale of domestically produced goods.

707 Pacific Agriculture Policy Project, "Tonga Agriculture Sector Plan 2016 - 2020," accessed at https://pafpnet.spc.int/attachments/article/574/Tonga%20Agriculture%20Sector%20Plan%202016-2020.pdf.

708 Office of the United States Trade Representative, "Palau: Duty-Free Treatment under the Compact of Freely Associated States (FAS)," accessed at https://ustr.gov/archive/assets/Trade_Development/Preference_Programs/GSP/GSP_in_Use_Country_Specific_Information/Palau/asset_upload_file641_14837.pdf.

Availability of Land for Agricultural Production

The limited availability of land would be a considerable barrier to the expansion of agricultural production. At thirty-two miles long and twelve miles wide at its widest point, Guam has an area of 212 square miles. As a freely associated state, the potential return of federally held land to the government of Guam would have to be negotiated. However, it is helpful to analyze the land use mechanisms that exist in other freely associated states to determine what may happen in Guam. A freely associated Guam would have to ensure that its agreement with the United States reserves for Guam the appropriate amount of land and the necessary freedom to develop on that land, in order to expand its agricultural capacity.

Status Example: The Republic of Palau

Palau is at the forefront of climate change, as it is highly vulnerable to sea-level rise and the effects of El Niño. In fact, Palau is already seeing a decline in its food production due to the negative effects of climate change, such as increased periods of drought and greater frequency of cyclones.[709]

Regional/International Supports

To counter this and to continue its path toward food security, Palau has benefited from economic and technical cooperation with several regional and international organizations, as well as individual foreign countries, to support the expansion of its agricultural/aquacultural capacity. As an example of international support, the Pacific Adaptation to Climate Change (PACC) Project, which is funded by the Global Environment Facility and the Government of Australia, has provided Palau with financial and technical assistance to implement modern agricultural technology into the traditional farming practices of Palauan culture. Beginning in 2010, the program began testing different types of taro, a Palauan staple crop that is of great cultural significance and a key source of sustenance, to identify which types are best suited to resist the inundation of saltwater that comes with rising sea levels. The project identified three variants that proved highly tolerant to high salinity levels. The variants are now being distributed across Palau and other parts of the Pacific to be grown in places where traditional taro plants have not been surviving.

The program also aided Palau in increasing farming in upland areas of Palau by reclaiming areas that were formerly not farmed due to poor soil quality or a lack of accessibility. With the help of the project, several acres of land not previously used for farming are now being used to grow various crops, to include different varieties of saltwater-tolerant taro, as well as clams and crabs.[710] Aside from the PACC project, Palau has also received a significant amount of assistance from the Food and Agriculture Organization

709 Pacific Adaptation to Climate Change Project, "The Palau PACC Food Security Project: A Benefit Cost Analysis," 2011, accessed at https://www.adaptation-undp.org/sites/default/files/downloads/palau_pacc_cba_final_report.pdf.

710 Secretariat of the Pacific Regional Environmental Programme, "Food, Glorious Food: Climate Change Adaptation Project Enhances Food Security in Palau," July 30, 2014, accessed at https://reliefweb.int/report/palau/food-glorious- food-climate-change-adaptation-project-enhances-food-security-palau.

(FAO) of the United Nations, an organization it has been a part of since 1999. The FAO has aided Palau in the areas of policymaking, food quality/safety, and the production of sustainable agricultural goods. Through other projects, it has also strengthened the cooperation between farmers and the local market, along with the tourism industry.[711] Aside from the United States, Taiwan is Palau's second largest development partner. To support agricultural development, Taiwan maintains a technical mission in Palau which runs a research station and has committed to developing and providing new agricultural technologies to promote the self-sufficiency of Palau while also gaining valuable research information.[712] Under free association with the United States, in addition to direct US financial support, Guam could potentially make use of similar opportunities to join organizations and receive technical and financial assistance in support of the island's agricultural development.

Support from the United States

Through the Compact of Free Association with the United States, the Republic of Palau receives a significant amount of economic assistance to support a variety of development areas in Palau. Palau avails of several federally funded programs, such as the US Forest Service's State Fire Assistance Program, which helps Palau prevent, control, and suppress fires that may be damaging to residents or agricultural crops. Other programs include the USDA's Natural Resource Conservation service, which provided Palau with soil studies and helped create a reforestation plan for Palau. As a freely associated state, Guam may be able to avail of the same programs, and possibly more, if negotiated.

If Guam were to become freely associated with the United States, it could take advantage of the potential financial and technical assistance provided by the US, as well as a greater ability to engage in international affairs. Guam could bolster its agricultural development by receiving funds from the US and seeking supplemental investment opportunities from other countries. By securing domestic FNS, Guam would be better equipped to deal with challenges that would later come as a result of climate change and other uncertainties that would affect agricultural production.

711 Olivia Cyr, "Seven Ways the FAO is Tackling Hunger in Palau," Borgen Project, September 18. 2017, accessed at https://borgenproject.org/tackling-hunger-in-palau/.

712 Food and Agriculture Organization of the United Nations, "Pacific Multi County CPF Document 2013-2017," 2012, accessed at http://www.fao.org/3/a-az134e.pdf.

FOOD AND NUTRITION SECURITY	
STATUS	**EFFECTS**
Statehood	• Potential for increased federal financial/technical assistance. • Access to US trade network with minor barriers to trade among US states and trading partners. • Continued eligibility in federal programs that are currently crucial, such as SNAP. • Complete application of federal law, with potential detrimental effects dealing with costs. • US federal government sets US trade policy.
Independence	• Potential return of arable land which could be used for increasing domestic agricultural capacity. • Greater control over local policies and trade with foreign countries. Guam could negotiate trade deals with its closer neighbors in Asia and the Pacific. • Membership in country-only organizations, to potentially include funding supports and mutually beneficial partnerships.

	• Eventual end to federal funding and support, especially programs that provide assistance to low-income families, such as SNAP.
Free Association	• Possible duty-free trade opportunities with the US if negotiated. • Potential funding and technical assistance from US, other countries, and organizations. Funding from various sources could be combined for maximum benefit to grow Guam's domestic agricultural capacity. • Potential land-use conflict with US interests. With defense agreement and no return of land, Guam would have to adapt current land to be more conducive to agriculture.

Aquaculture Development

According to the Food and Agriculture Organization (FAO) of the United Nations, aquaculture is "the fastest food-producing sector and now accounts for fifty percent of the world's fish that is used for food."[713] The aquaculture industry is rapidly developing, as countries seek alternative options for food production in order to sustain their population growth and to further economic development. In 2019, at the FAO International Symposium on Fisheries Sustainability, the Director General of FAO stated that the "land alone will not feed us."[714]

Aquaculture is defined by the United Nations FAO as, "the farming of aquatic organisms in both coastal and inland areas involving interventions in the rearing process to enhance production."[715] Multiple types of aquaculture exist, such as marine aquaculture and freshwater aquaculture. The National Oceanic and Atmospheric Administration (NOAA) defines marine aquaculture as "the culturing of oceanic species (as opposed to freshwater)," this type of aquaculture includes oysters, clams, mussels, shrimp, salmon, and algae.[716] Aquaculture generally includes the production of aquatic plants and animals such as fish, crustaceans and shellfish, which are among the fastest-growing animal food sector in the world.[717] Indeed, fish is the "primary source of protein for some 950 million people worldwide and represents an important part of the diet of many more."[718] Given the significant need for fish, the aquaculture industry has attempted to fill the gap between supply and demand.[719]

713 Food and Agriculture Organization of the United Nations, "Aquaculture," accessed at http://www.fao.org/aquaculture/en/.

714 Food and Agriculture Organization of the United Nations, "Need for new vision for fisheries amidst growing concerns over state of oceans," November 18, 2019, accessed at http://www.fao.org/news/story/en/item/1251653/icode/.

715 Food and Agriculture Organization of the United Nations, "Aquaculture."

716 National Oceanic and Atmospheric Administration, "What is Aquaculture?" accessed at https://www.noaa.gov/stories/what-is-aquaculture.

717 Michelle Allsopp, David Santillo, and Paul Johnston, "Challenging the Aquaculture Industry on Sustainability: Technical Overview," January 10, 2018, 3, accessed at https://www.oceanfdn.org/sites/default/files/Aquaculture_Report_Technical.pdf.

718 Jangampalli Adi Pradeepkiran, "Aquaculture role in global food security with nutritional value: a review," Translational Animal Science 3, no. 2 (March 2019): 903-910. Accessed at https://doi.org/10.1093/tas/txz012.

719 Christopher L. Delgado, Nikolas Wada, Mark W. Rosegrant, Siet Meijer, and Mahfuzuddin Ahmed, "The Future of Fish: Issues and Trends to 2020," International Food Policy Research Institute, 1.

This subsection of the study addresses the general characteristics of the aquaculture sector by focusing on the role of aquaculture in food security/nutrition; disease risks; climate change and environmental impacts; and technology. This section then more directly addresses the current policy efforts toward developing an aquaculture industry in Guam and examines the possibilities for aquaculture under each of the political status options.

Role of Aquaculture

Fisheries play an important role within the global food economy. They provide a source of employment for about 200 million people who are dependent upon ocean fishing for their livelihoods.[720] The fisheries referenced in this sub-section are farmed, rather than wild-caught-or-captured, seafood resources. Fish production contributes to overall food supply for the general population and is generally considered to make a positive contribution to a society.[721] To consider these potential contributions, one must understand the particular role of aquaculture as a component of food production, access, and development in relation to human and environmental impacts of food.

Although aquaculture is often seen as improving economic efficiency and increasing fish production, aquaculture practices and systems are increasingly raising public concern. Aquaculture systems have been known to cause "negative environmental impacts, pressure on certain resources (e.g. water, land, fish meal, etc.) and increased vulnerability of small farmers."[722] In a variety of countries there have been human rights abuses associated with commercial aquaculture.[723] For example, "the positioning of shrimp farms has often blocked land access to coastal areas that were once common land in use by many people."[724] According to the Environmental Justice Foundation, nonviolent protests against the shrimp industry have often been met with threats, intimidation, and violence by people associated with the industry. Global data reported in 2003 indicates that protesters linked to aquaculture disputes have been arrested on false charges, and eleven countries have reported that protesters have been murdered.[725] With a lack of formalized land rights in these locales, shrimp farm development has led to "large scale displacement of communities, often without financial compensation or alternative land made available on which to live."[726] In 2014, research revealed that the Southeast Asian seafood processing industry, in places like Bangladesh, was criticized for human rights abuses and not complying with labor laws.[727] As of 2019, local governments

720 Gareth, P., Fisheries and the environment. Fisheries subsidies and overfishing: towards a structured discussion." UNEP, 2001.

721 Pradeepkiran, "Aquaculture role in global food security."

722 FAO. 2016. Sustainable intensification of aquaculture in the Asia-Pacific region. Documentation of successful practices. Miao, W. and Lal, K.K. (Ed.), Bangkok, Thailand, xi, accessed at http://www.fao.org/3/a-i5362e.pdf.

723 Allsop, et al., "Challenging the Aquaculture," 3.

724 Allsop, et al., "Challenging the Aquaculture," 8.

725 Environmental Justice Foundation, "Smash & Grab: Conflict, Corruption and Human Rights Abuses in the Shrimp Farming Industry," 2003, accessed at www.ejfoundation.org.

726 Allsop, et al., "Challenging the Aquaculture," 8.

727 M Nuruzzaman, Selim SUM, and Miah MH, "Rights, benefits and social justice: Status of women workers engaged in the shrimp processing industries of Bangladesh." *Asian Fisheries Science* 27S (2014): 151–163.

and export industries have developed efforts to address implementation and assess compliance of labor laws to achieve justice.[728] These examples highlight the importance of governance structures to address challenges that may be associated with aquaculture development. The Second International Conference on Nutrition (ICN2) also noted the "importance of aquaculture while recognizing its many challenges: the impact of climate change and variability, urbanization and related social and economic changes, increasing intra-regional trade and increasing concern over the environment and food safety to the public."[729]

Food Security & Nutrition

According to the United Nations Population Division (UNDP), food security is a pressing global issue as the human population is projected to reach between 7.5 and 10.5 billion by 2050.[730] Capture fisheries have been considered as food production systems that can contribute to food and nutrition security. The 2020 United Nations *System of Environmental-Accounting for Agriculture, Forestry, and Fisheries (SEEA AFF)* explains that "Capture fisheries can be defined as an activity leading to the harvesting of fish in a defined area, a broad concept covering all aspects of human fisheries activity, including economic, managerial, biological, environmental and technological viewpoints."[731] This definition illustrates that capture fisheries can be classified as all kinds of harvesting of naturally occurring living resources within both freshwater and marine environments. A measurement issue with capture fisheries is accounting for fish caught in a country's exclusive economic zone (EEZ) by foreign vessels.[732] Given that capture fisheries are considered to be increasingly unsustainable due to overfishing, aquaculture is often considered as an alternative system to provide an adaptive solution for food security.[733] Declining marine and freshwater fish stocks affect food and nutrition security, therefore aquaculture is considered a potential solution to easily and cheaply provide animal source foods to populations around the world.[734] Aquaculture has already demonstrated its "crucial role in global food security, with its production growing at 7.5 percent per year since 1970."[735]

Recognizing the current capacity and potential of aquaculture for future growth requires considering the challenges that the sector faces as it intensifies production. As research cautions, "aquaculture may

728 Roel H. Bosma, Thi Dien Nguyen, Lorna M. Calumpang, & Sef Alba Carandang, "Gender action plans in the aquaculture value chain: what's missing?" *Reviews in Aquaculture*, 11 2019): 1297-1307. Doi: 10.1111/raq.12293.

729 FAO. 2014. The Second International Conference on Nutrition: Committing to a future free of Malnutrition." accessed at http://www.fao.org/3/a-i4465e.pdf.

730 United Nations Development Programme, "World Population Projections, the 2006 Revision. 2006, accessed at https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/files/documents/2020/Jan/un_2006_world_population_prospects-2006_revision_volume-i.pdf.

731 FAO and UN. "System of Environmental-Economic Accounting for Agriculture, Forestry and Fisheries (SEEA AFF)," 2020, 72, accessed at https://doi.org/10.4060/ca7735en.

732 FAO and UN, "Environmental-Economic Accounting."

733 Food and Agriculture Organization of the United Nations, "The State of World Fisheries and Aquaculture,", 2012.

734 Christopher D. Golden, Edward H. Allison, William W. L. Cheung, Madan M. Dey, et al., "Nutrition: Fall in fish catch threatens human health," *Nature News* 534, no. 7607 (2016): 312-320. accessed at https://doi.org/10.1038/534317a;
Mimako Kobayashi, Siwa Msangi, Miroslav Batka, Stefania Vannuccini, Madan M. Dey, and James L. Anderson, "Fish to 2030: the role and opportunity for aquaculture." *Aquaculture Economics & Management* 19 (2015): 282–300, doi: 10.1080/13657305.2015.994240.

735 FAO, "The State of World Fisheries and Aquaculture 2020." Sustainability in action (2020): vi, accessed at https://doi.org/10.4060/ca9229en.

not be a panacea for food security."[736] Considerations of food security explicitly emphasize the need to understand connections between fisheries, diet, and human health.[737] There is a considerable potential for capture fisheries to contribute nutrient-dense food. Seafood resources, fish and shellfish, provide the potential to alleviate global and regional micronutrient deficiencies and thus, play a key role in alleviating food insecurity.[738] Because fish and fisheries products are recognized as some of the least impactful on the natural environment, as well as some of the healthiest foods on the planet, they have to be considered in food security and nutrition strategies.[739] Throughout much of the world, overfishing and the need to restrict fishing levels in order to sustain stocks is a primary factor affecting peoples' access to fish as a nutritious food. It is also important to address accessibility to the populations that need healthy food the most.[740]

Small-scale aquafarms have been promoted as a way to make aquaculture more equitable. However, the concern is that in a market economy, large-scale aquafarmers and industrialists do not coexist well with small-scale productions. Therefore, aquaculture may require strong governance that focuses on people-centered approaches to address regulatory frameworks that are suitable for the regional and local situation in Guam.

Disease Risk & Outbreaks

Infectious disease is a problem for aquaculture because intensification of aquaculture can generate high levels of environmental problems, making fish susceptible to infections and disease. In aquaculture production, diseases caused by bacteria, parasites, or viruses are a key threat, although the underlying global epidemiological patterns are unknown.[741] Infectious diseases can become problematic in aquaculture, even if they may not otherwise affect wild hosts. For example, local *Streptococcus iniae* (bacterial) strains tend to be more pathogenic to imported fish than to local wild fish.[742] Additionally, new aquaculture species may be susceptible to disease over time. One historical example is from the aquaculture development of Japanese yellowtail in 1961. The fish experienced a series of infectious diseases: "vibriosis became a problem in 1963, nocardiosis andichthyphoniasis in 1967, pseudotuberculosis in 1969, streptococcosis

736 Kobayashi, et al., "Fish to 2030."

737 Golden, et al., "Nutrition: Fall in fish cat."

738 John Z. Koehn, "Fishing for nutrition-improving the connection between fisheries, the food system and public health," Doctoral dissertation, University of Washington, 2019. Cited in FAO, "The State of World Fisheries and Aquaculture 2020," *Sustainability in action* (2020): 17, https://doi.org/10.4060/ca9229en.

739 FAO, "The State of World Fisheries and Aquaculture 2020."

740 Christopher D. Golden, Katherine L. Seto, Madan M. Dey, Oai L. Chen, et al., "Does Aquaculture Support the Needs of Nutritionally Vulnerable Nations?" *Frontiers in Marine Science* 4, no. 159 (2017): accessed at https://doi.org/10.3389/fmars.2017.00159.

741 T.L.F. Leung & A.E. Bates, "More rapid and severe disease outbreaks for aquaculture at the tropics: Implications for food security," *Journal of Applied Ecology*, 50, no. 1 (2013): 215–22. Doi: 10.1111/1365-2644.12017.

742 Colorni A, Diamant A, Eldar A, Kvitt H, Zlotkin A. 2002, "Streptococcus iniae infections in Red Sea cage-culturedand wild fishes," *Diseases of Aquatic Organisms* 49:165–70. Kevin D. Lafferty, C. Drew Harvell, Jon M. Conrad, Carolyn S. Friedman, Michael L. Kent, Armand M. Kuris, Eric N. Powell, Daniel Rondeau, and Sonja M. Saksida, "Infectious diseases affect marine fisheries and aquaculture economics," *Annual Review of Marine Science*, 7, no.1, (2015): 476.

in 1974, lymphocystis in1975, and so on."[743] There are many bacterial aquaculture diseases worldwide, with too many to provide in full here, though many are relevant for tropical regions.[744]

Indeed, marine diseases are a natural part of the world's ocean ecosystems, with many having economic consequences for aquaculture systems. Waterborne pathogens have the capacity to spread at faster rates than terrestrial systems. [745]Furthermore, processes of oceanic transport have the potential to transmit diseases over vast geographic regions.[746] The threats of infectious disease are particularly devastating, with disease being the number one killer of farmed fish. Outbreaks are capable of wiping out entire stocks and require costly decontamination.[747] Additionally, given the high densities of fish within fish farming facilities, there is a higher frequency of disease overall. As captive fish often escape into the surrounding environment, these marine animals can spread disease or even prey on wild fish populations.[748] Therefore, ocean aquaculture requires environmental regulation to address threats to marine life, fisheries, and overall ocean health.

Aquaculture in tropical regions has been found to have greater economic loss compared with temperate regions "due to climate change mediated disease mortality" and "increasing frequency of extreme weather events."[749] Tropical countries and locales "suffer proportionally greater losses in aquaculture during disease outbreaks and have less time to mitigate losses."[750] This role of disease in limiting aquaculture-based production of fish/shellfish has been considered in relation to empirical calculations of vulnerability to climate change. Furthermore, because climate change is likely to cause changes in aquatic ecosystems and oceans, these changes may "further exacerbate the susceptibility of aquaculture to disease."[751] In sum, climate change is a primary threat factor for the aquaculture sector.

To address these vulnerabilities, there are a variety of management approaches, including investing in environmental monitoring infrastructure and steering toward sustainable production.[752] Management frameworks will need to consider potential economic losses from diseases.[753] Biosecurity provides a "preventive practice for the exclusion of specific pathogens from cultured aquatic species at various levels

743 Kevin D. Lafferty, C. Drew Harvell, Jon M. Conrad, Carolyn S. Friedman, Michael L. Kent, Armand M. Kuris, Eric N. Powell, Daniel Rondeau, and Sonja M. Saksida, "Infectious diseases affect marine fisheries and aquaculture economics," *Annual Review of Marine Science*, 7, no.1, (2015): 476.

744 FAO & the UN (2017). "Major bacterial diseases affecting aquaculture," Olga Haenen, Aquatic AMR Workshop 1, 10-11 April 2017, accessed at http://www.fao.org/fi/static-media/MeetingDocuments/WorkshopAMR/presentations/07_Haenen.pdf.

745 McCallum, H., Harvell, D. & Dobson, A. "Rates of spread of marine pathogens." *Ecology Letters*, 6, (2003): 1062–1067.

746 Leung, "More rapid and severe disease outbreaks."

747 Pillay, T.V.R. & Kutty, M.N., *Aquaculture: Principles and Practices*, 2nd edition, (Oxford: Wiley-Blackwell, 2005).

748 Oceana: Protecting the World's Oceans, "Aquaculture," accessed at https://eu.oceana.org/en/eu/our-work/more-projects/aquaculture/overview.

749 Leung, "More rapid and severe disease outbreaks," 219. ; N. Handisyde, L. Ross, M.C. Badjeck, & E.H. Allison, "The Effects of Climate Change on World Aquaculture: A Global Perspective," Department for International Development, 2009.

750 Leung, "More rapid and severe disease outbreaks," 219. ; Handisyde, "The Effects of Climate Change."

751 Kobayashi, et al., "Fish to 2030." ; Leung, "More rapid and severe disease outbreaks."

752 S.R. Bush, P.A.M.V Zwieten, L. Visser, H.V. Dijk, R. Bosma, W.F.D. Boer, and M. Verdegem, "Scenarios for resilient shrimp aquaculture in tropical coastal areas," *Ecology and Society* 15, art 15 (2010).

753 Karim, M., R.H. Sarwer, A.C. Brooks, R. Gregory, M.E. Jahan, & B. Belton, "The incidence of suspected white spot syndrome virus in semi-intensive and extensive shrimp farms in Bangladesh: implications for management." *Aquaculture Research* 43 (2012): 1357–1371.

from facility/farm level to regional and country levels."[754] In Guam, however, biosecurity measurements are relatively relaxed and the region lacks in "health monitoring and regulatory control programs."[755] Therefore, an increase in biosecurity measures at the individual farm level as well as system-wide health management will be crucial to protect the region from pathogens.

Climate Change & Environmental Impacts

In terms of general environmental impact, "aquaculture facilities can be significant sources of pollution, including excess feed, fish waste and dead fish."[756] Waste generated by the aquaculture sector can also contribute to excessive algae growth, clouding coastal waters and altering seafloor ecosystems. Furthermore, there is a global concern about the effect climate change will have on aquaculture and fisheries. The maintenance of these systems is made more complex by the impacts of climate change, particularly as the ocean may affect food webs, habitats, and stocks that are the foundation of aquaculture in the region.[757] Fisheries and aquaculture in the Pacific are impacted by climate change in two major ways: global warming; and ocean acidification.

Global Warming

With regard to global warming, the effects of climate change are altering the patterns of fish distribution and production. In terms of production, climate change can be expected to "mediate fish production through the effects on reproductive success, recruitment processes, survival and growth of target species and/or their prey."[758]

Ocean Acidification

Under anticipated conditions in the twenty-first century, ocean acidification will "compromise carbonate accretion, with corals becoming increasingly rare on reef systems."[759] If there are less-diverse reefs, the carbonate reef structures will also be difficult to maintain. Therefore, Pacific locales must consider management intervention and take divisive action on global emissions in order to avoid the loss of coral-dominated ecosystems. Numerous studies have concluded that "coral reefs, mangroves and seagrasses

754 Hui Gong, "Promoting health management of shrimp aquaculture on Guam and Commonwealth of Northern Mariana Islands." *Asian Fisheries Society*, 23 (2010): 447-461.

755 Gong, "Promoting health management of shrimp aquaculture."

756 Oceana: Protecting the World's Oceans, "Aquaculture."

757 Johann D. Bell, et al. "Mixed responses of tropical Pacific fisheries and aquaculture to climate change," *Nature Climate Change* 3, (2013): 591-599.

758 Bell, et al., "Mixed responses," 4.

759 O Hoegh-Buldberg, et al., "Coral Reefs under rapid climate change and ocean acidification," *Science* 318 (2007):1737-42, accessed at https://pubmed.ncbi.nlm.nih.gov/18079392/.

that support coastal fisheries in the tropical Pacific are under threat."[760] This threat manifests in particularly destructive ways, with the threat of ocean acidification, which refers to changing ocean chemistry.[761] Indeed, frequent bleaching events and "reduced ability of coral to calcify are projected to reduce the biological and physical complexity of coral reefs."[762] The impacts of climate change on coral reefs pose serious consequences for reef-associated fisheries, tourism, coastal protection, and people.[763]

Aquaculture Industry in Guam

Guam previously explored aquaculture for the island. In 1986, the Bureau of Planning presented a report entitled "An Introduction to Aquaculture on Guam: Prospects, Permits and Assistance" to the US Department of Commerce. This report examines the possibilities of establishing aquaculture activities in Guam in order to achieve economic self-sufficiency. It also considers assistance in an import substitution method of economic development and evaluates future exports to other islands in the region to assist in their aquaculture industries.[764]

The 1986 document outlined the infrastructure development and aspects that would allow for an aquaculture industry in Guam. One of the most important aspects that the island can depend on is the year-round warm climate that allows for rapid growth of many cultured species. At the time of the publication, land was available for the development of an aquaculture industry. However, to advance these aquaculture plans today would require that Guam identify sufficient land area and a robust water supply in order to develop the industry. Most importantly, the island needs to consider the economic effects that an aquaculture industry may have on creating jobs as well as the ability for the industry to employ and sustain new jobs for the long term.

Guam previously experimented with ponds located in Talo'fo'fo'. Species that were considered during this experiment were the following: Malaysian giant prawn, freshwater eel, Chinese and common carp, milkfish, hybrid tilapia, catfish, mangrove crab, and the Pacific oyster.[765] Not much information is published on the lifespan and success of the hatchery at the time, or why farming of the species seems to have ceased until recently. With many roadblocks in the way for an industry that was considered new on the international scale at the time, it might have been hard to set up and sustain here.

760 Bell, et al. "Mixed responses of tropical Pacific fisheries," 594.

761 Johann Bell, et al. "Preliminary assessment of the effects of climate change on fisheries and aquaculture in the Pacific," 3, https://www.sprep.org/att/irc/ecopies/pacific_region/433.pdf.

762 J. D. Bell, J. E. Johnson, & A. J. Hobday (eds) "Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change (Secretariat of the Pacific Community)," 2011.

763 O Hoegh-Buldberg, et al., "Coral Reefs."

764 William J. Fitzgerald, Jr., "An Introduction to Aquaculture of Guam: Prospects, Permits, and Assistance," Guam Coastal Management Program Bureau of Planning - Government of Guam, 1986, accessed at https://www.govinfo.gov/content/pkg/CZIC-sh133-g8-f58-1986/html/CZIC-sh133-g8-f58-1986.htm.

765 Fitzgerald, "An Introduction to Aquaculture of Guam."

Guam's Aquaculture Development Today

On April 30, 2020, Governor Lou Leon Guerrero signed Executive Order 2019-12, which established the Guam Aquacultural Task Force to lead efforts to plan, develop, and implement a sustainable industry for Guam. This task force is motivated, in part, by the governor's desire to "provide food security, generate revenue, and create local jobs" through aquaculture.[766] While attempts have been made in the past for Guam to develop an aquaculture industry, more data and infrastructure are necessary to build an aquaculture industry that is sustainable and economically feasible.

In July 2020, Governor Leon Guerrero requested federal funding from the US Economic Development Administration for a study on Guam's aquaculture feasibility.[767] The study will look into market demand in the region, growth opportunities, and needed investments for development. The push for the study stems from her concerns about food security and economic security for the island, considering Guam imports approximately $10 million worth of seafood products annually.[768]

The Guam Aquaculture Development and Training Center (GADTC), better known as the Fadian Hatchery, is the "largest and oldest aquaculture center in the Western Pacific."[769] It operates under the University of Guam's College of Natural and Applied Sciences (UOG-CNAS) Research and Extension Branch. In 2018, UOG-CNAS received funding through a long-term public-private partnership to upgrade the Fadian Hatchery and restart research into aquaculture in Guam.[770] The goals of the center are:

- To conduct applied research in aquaculture
- To be the center for public information on the aquaculture industry, its products and its potential
- To serve the needs of farmers regarding technology transfer and extension service including environmentally sound practices
- To produce fish fry and shrimp post-larvae on island to support a growing and promising aquaculture industry, reducing the reliance on imported stocks of animals[771]

In August 2020, the center announced that "locally and sustainably raised seafood is now regularly available for Guam residents and restaurants to purchase, contributing to food security on island as well as the local economy" through a subsidiary, CoreSeed Aquaculture.[772] CoreSeed Aquaculture (Guam)

766 Post Guam Staff, "Task force to help develop aquaculture industry," *Guam Daily Post*, May 2, 2019, accessed at https://www.postguam.com/business/local/task-force-to-help-develop-aquaculture-industry/article_cf9de864-6bdf-11e9-8c82-4364c7ac7039.html.

767 Pacific Daily News, "Governor pushes for study on aquaculture industry on Guam,"*Pacific Daily News*, July 26, 2020, accessed at https://www.guampdn.com/story/news/local/2020/07/25/gov-lou-leon-guerrero-guam-aquaculture-industry-study/5484874002/.

768 Pacific Daily News, "Governor pushes for study on aquaculture industry on Guam."

769 University of Guam College of Natural and Applied Sciences Research and Extension, "Fadian Hatchery," accessed at https://cnas-re.uog.edu/fadian-hatchery.

770 Liza Mayer, "Revamp of Fadian Hatchery gets green light," February 1, 2018, Hatchery International, accessed at https://www.hatcheryinternational.com/revamp-of-fadian-hatchery-gets-green-light-3033/.

771 University of Guam College of Natural and Applied Sciences Research and Extension, "Fadian Hatchery."

772 Bruce Lloyd, "UOG Program provides shrimp, prawns and tilapia to island," *Pacific Daily News*, August 25, 2020, accessed at https://www.guampdn.com/story/life/2020/08/25/uog-program-produces-commercial-seafood/3427747001/.

Corporation is a small business that is classified as a 26203g tax exempt organization with the Department of Revenue and Taxation.[773] According to the University of Guam financial statements and auditors' report, effective January 2020, the Research Corporation of the University of Guam (RCUOG) entered a lease agreement with CoreSeed "for the use of the land and improvements on Lot No. 2517-17/Lot No. 5412—12-1 (the property) commonly known as the Guam Aquaculture Development and Training Center (GADTC)."[774] This lease began on January 1, 2020, and will end at "midnight on the 31st day of December 2049."[775] The GADTC operates under the University of Guam and is providing locally and sustainably raised shrimp and tilapia for Guam residents and restaurants to purchase.[776]

The Center and CoreSeed Aquaculture are now capable of sustainably producing white marine shrimp, prawns, black tilapia and saltwater tolerant red tilapia. These products are available on a wholesale basis through CoreSeed, and retail consumers can purchase jumbo-sized Pacific white shrimp and red tilapia through the Guam Fisherman's Co-operative Association.[777] The retail and wholesale orders total about 400 to 500 pounds of shrimp per month, with the anticipation of increased production to more than 1,000 pounds per month by the end of 2020.[778]

While the Center and CoreSeed Aquaculture are able to produce these products for sale, the Guam Comprehensive Economic Development Strategy 2020-2025 states "the facility is in dire need for significant amounts of renovations and new infrastructure in order to meet the demands of this growing industry."[779]

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773 Department of Revenue and Taxation, "Tax Exempt Organizations," 2020, 14, accessed https://www.guamtax.com/notices/Tax-ExemptListingforpublicationasamended11-11-2020.pdf; see also Guam Economic Development Authority, "Guam Small Business Pandemic Assistance Grant Program 0 Grant application number May 19 2020 – July 8 2020," July 8, 2020, accessed at https://www.investguam.com/wp-content/uploads/GSBPAG/GSBPAG%20Application%20Number_%20May%2019%20-%20July%2008%20Submissions.pdf.

774 University of Guam, "Financial Statements, Additional Information and Independent Auditors' Report Years Ended September 30, 2019 and 2018," 54, accessed https://www.opaguam.org/sites/default/files/uog_fs19.pdf.

775 University of Guam, "Financial Statements."

776 The Guam Daily Post, "'We need to produce food here' UOG, CoreSeed boost local food security by farming shrimp, prawns, saltwater tilapia," August 25, 2020, accessed at https://www.postguam.com/entertainment/food/we-need-to-produce-food-here/article_93dc1f12-e5c8-11ea-aa7d-373d7066972a.html.

777 Jackie Hanson, "UOG, CoreSeed boost local food security by farming shrimp, prawns, and saltwater tilapia," *Stars and Stripes Guam*, August 24 2020, accessed at https://guam.stripes.com/education/uog-coreseed-boost-local-food-security-farming-shrimp-prawns-and-saltwater-tilapia.

778 Hanson, "UOG, CoreSeed boost local food security."

779 Guam Economic Development Authority, "Guam Comprehensive Economic Development Strategy 2020-2025."

TABLE 1.1 : REGULATION FOR AQUACULTURE ACTIVITIES

AQUACULTURE RELATED ACTIVITIES	REGULATORY GOVERNMENT AGENCIES
IMPORT/EXPORT OF LIVE AQUATIC ANIMALS/PLANTS	GUAM DEPARTMENT OF AGRICULTURE
REGISTERED FARM	US WILDLIFE AND FISHERIES SERVICES (FROM/TO NON-US DESTINATIONS)
LAND ZONING	
CONSTRUCTION - PONDS (EARTHEN & CONCRETE) - DRAINAGE SYSTEM	GUAM PUBLIC WORKS
PUMPING WATER FROM WELLS	GUAM LAND MANAGEMENT
DISCHARGE OF EFFLUENT THROUGH INJECTION WELL	US ARMY CORPS OF ENGINEER
PUMPING WATER FROM STREAMS OR LAKE OR OCEAN DIRECTLY	GUAM ENVIRONMENTAL PROTECTION AGENCY
DISCHARGE OR EFFLUENT TO SURFACE WATER	GUAM PULIC UTILITY COMMISSION

Source: Guam FY2019 Comprehensive Economic Development Strategy
from University of Guam; Interview with Dr. Hui Gong on September 17, 2018

A table from Guam's FY2019 Comprehensive Economic Development Report illustrates the relationship between aquaculture-related activities and the regulatory government agencies.[780] As shown in the table, this process includes review by local and federal government agencies.

When discussing the growth of a new industry in Guam, the government will have to consider the amounts of resources that the island has to spread across industries it is considering developing.

Statehood

The United States is the largest importer of seafood products[781], but at the same time "domestic marine aquaculture has increased in volume and value since 2009."[782] Under statehood, Guam has the potential to further increase the industry's value and lessen its own seafood imports by exploring aquaculture development. As previously mentioned, there are two main types of aquaculture: marine and freshwater. Both types of aquaculture present benefits and difficulties for development under statehood.

According to the Food and Agriculture Organization, "the lead agency for freshwater aquaculture in

780 Guam Economic Development Authority, "Guam FY2019 Comprehensive Economic Development Strategy," accessed at https://www.investguam.com/wp-content/uploads/2019/CEDS%20-%20FINAL%20Update%20as%20of%201.4.19%20_%201112pm.pdf.

781 Congressional Research Service, "US Offshore Aquaculture Regulation and Development," October 10, 2019, accessed at https://crsreports.congress.gov/product/pdf/R/R45952.

782 Alexandra Carter and Miriam Goldstein, "American Aquaculture: An Overview of the Current Status, Environmental Impacts, and Legislative Opportunities," *Center for American Progress*, May 13, 2019, accessed at https://www.americanprogress.org/issues/green/reports/2019/05/13/469730/american-aquaculture/.

the United States of America is the Department of Agriculture (USDA). The lead agency for marine aquaculture is the National Marine Fisheries Service (NMFS) which is administratively housed in the National Oceanic and Atmospheric Administration (NOAA) under the Department of Commerce (DOC)."[783] As a state, Guam would have access to the funds and resources from these agencies and regulatory programs that apply to aquatic or marine activities like aquaculture. For example, "USACE for activities in navigable waters, the Environmental Protection Agency (EPA) for protection of environmental quality, and the Food and Drug Administration for regulation of drugs used to treat fish diseases."[784]

The island will also adhere to the National Aquaculture Act of 1980 for its regulations. The Aquaculture Act was partially established to "[encourage] aquaculture activities and programs in both the public and private sectors of the economy."[785] At least six federal agencies currently regulate different aspects of the US aquaculture industry: Food and Drug Administration, National Oceanic and Atmospheric Administration (NOAA), US Army Corps of Engineers, US Department of Agriculture, US Environmental Protection Agency, and US Fish and Wildlife Services.[786] These regulations are designed "to protect the consumer and the environment [with] primary concerns regarding navigation, land and water use, food safety, water quality and effluent discharge, environmental impacts, aquatic animal health, production, and marketing."[787]

With so many different agencies having oversight over aquaculture development, it creates regulatory uncertainty due to overlapping regulations. Regulatory uncertainty creates one of the biggest barriers to entry under statehood, which affects current states as well, and can hurt US growth potential in aquaculture, specifically with developing facilities dedicated to marine aquaculture practices. A Congressional Research Service Report on open-ocean aquaculture states,

> Development of commercial aquaculture facilities in federal waters is hampered by an unclear regulatory process for the EEZ, and technical uncertainties related to working in offshore areas. Regulatory uncertainty has been identified by the administration as the major barrier to developing open ocean aquaculture. Uncertainties often translate into barriers to commercial investment.[788]

The federal government is involved in aquaculture regulations through several different means, such as the US Department of Agriculture and the Department of Interior. The current regulatory framework requires federal permits to conduct aquaculture within federal waters. It also requires a federal consultation and review. Overall, the process of aquaculture development faces a system of federal permits,

783 Food and Agriculture Organization of the United Nations, "National Aquaculture Sector Overview: United States of America," accessed at http://www.fao.org/fishery/countrysector/naso_usa/en#tcN70118.

784 Congressional Research Service, "US Offshore Aquaculture Regulation and Development."

785 "National Aquaculture Act of 1980," September 26, 1980 accessed at https://www.agriculture.senate.gov/imo/media/doc/National%20Aquaculture%20Act%20Of%201980.pdf.

786 Carter and Goldstein, "American Aquaculture."

787 Food and Agriculture Organization of the United Nations, "National Aquaculture Sector Overview: United States of America."

788 Harold F. Upton and Eugene H. Buck, "CRS Report for Congress: Open Ocean Aquaculture," *Congressional Research Service*, June 12, 2008, accessed at https://digital.library.unt.edu/ark:/67531/metadc93997/m1/1/high_res_d/RL32694_2008Jun12.pdf.

consultation, and review requirements.

Other types of assistance would be available to Guam under statehood. The Subcommittee on Aquaculture (SCA), as assigned under the National Aquaculture Act, serves as the interagency coordinating body to "increase the overall effectiveness and productivity of federal aquaculture research, regulation, technology transfer, and assistance programs."[789] It provides a guide to federal aquaculture programs and services and is tasked with cataloging programs and activities that "encourage, support, or assist US aquaculture."[790] These mechanisms are also available to Guam under its current status as an unincorporated territory, although primarily occur in the form of subsidies allocated to US territories. If Guam should be admitted as a state, a benefit may be the added support that aquaculture provides to commercial and recreational fisheries.

As a state, Guam could establish better relationships by having a stronger voice, in the form of representation in voting bodies. The US also supplies a variety of advanced technology, equipment, investment capital, and food around the world. As a state, Guam would have access to the variety of national supplies from the federal government while also enjoying the benefit of establishing laws at the state level that determine how the aquaculture sector may best serve the people. Guam could also develop opportunities to support land-based or marine-based aquaculture projects throughout the island.

Beyond the economic potential of aquaculture, there are also a variety of risks that the sector poses if Guam becomes a state. Federal laws that may make sense for one state with fisheries and aquaculture might not support the needs of Guam under statehood. For example, Alaska has been advocating for a change in an old statute that is hindering the permitting process. The statute is considered vague and open ended and does not reflect the needs of the people since it was signed over sixty years ago.[791] Regulatory uncertainty in the realm of aquaculture development in the US could pose a barrier for Guam under statehood. For example, the US Congress has yet to take action to provide "statutory authority to develop aquaculture in offshore areas."[792]

Independence

When it comes to developing an aquaculture industry in an independent Guam, most regulations will be those selected and crafted by the people and the government in place. There is a possibility some regulations may come from international standards. At present, there are a minimum of thirty certification schemes and eight international agreements that are relevant to aquaculture. These standards and certification schemes also work with at least nine other initiatives that are identified to address sustainability issues

789 Subcommittee on Aquaculture, "Homepage," accessed at https://www.ars.usda.gov/SCA/.

790 Subcommittee on Aquaculture, "Guide to Federal Aquaculture Programs and Services," accessed at https://www.ars.usda.gov/SCA/Documents/Federal_aquaculture_resource_guide_2014.pdf.

791 Lucy Towers, "Alaska Fish Factor: Fishery Advocates call for review of fish habitat law." January 9, 2017, accessed at https://the-fishsite.com/articles/alaska-fish-factor-fishery-advocates-calling-for-review-of-fish-habitat-law.

792 Congressional Research Service, " US Offshore Aquaculture Regulation and Development."

and to consider appropriate frameworks for distinguishing among various sources of aquatic products.[793]

There are also regulations the US federal government established before the change in political status that an independent Guam may want to continue, such as the NOAA's regulatory activities that authorize marine aquaculture and overseas federal regulatory requirements that apply to aquaculture.[794] The National Aquaculture Act of 1980 and the National Aquaculture Improvement Act of 1985 are two public laws that established the authorizing legislation for federal government oversight of this sector. For example, the Subcommittee on Aquaculture (SCA) is a federal interagency that seeks "to increase the overall effectiveness and productivity of federal aquaculture research, regulation, technology transfer, and assistance programs."[795] These examples of federal aquaculture programs and services also reveal the possibilities that Guam would have should it decide to become independent. The island would be able to establish its own working groups, subcommittees, programs, and public laws to make decisions about the aquaculture sector.

With the adoption of international standards, such as the FAO Code of Conduct for Responsible Fisheries (FAO CCRF), the United Nations Convention on the Law of the Sea (UNCLOS), the ASEAN Shrimp Alliance, and the Convention on Biological Diversity (CBD), the independent country of Guam would be able to provide its own government representatives to participate in decision-making about schemes relevant to the aquaculture sector. Under the UNCLOS, Guam would have the authority to join the international community to decide upon "procedures to regulate all aspects of marine resources and ocean uses."[796] As an independent country, the island would stand to gain help from the international community and from organizations that assist countries with their development.

As explained above, the development of an aquaculture industry on island provides the possible benefit of sustaining the population's use and consumption of fish and other marine life. If production, support, and labor grow to a significant extent, the possibility exists that the industry could support the export of aquaculture products. From this potential, Guam would also benefit from international support mechanisms such as the Convention on Biological Diversity, an agreement signed in 1992 by 150 governments that is "dedicated to promoting sustainable development" and addressing "the transboundary movement of aquatic organisms."[797]

One of the most important steps to furthering development of an aquaculture industry is to have an aquaculture development plan. The FAO has helped multiple countries develop a plan. Other regional and international organizations have also offered technical expertise and assistance in the development of an aquaculture plan.

National governments have a range of regulations that could be used to improve water use by

793 Food and Agriculture Organization of the United Nations, "Overview of current aquaculture standards and certification schemes," accessed at http://www.fao.org/3/ai388e/AI388E08.htm.

794 NOAA, "Regulating Aquaculture," accessed at https://www.fisheries.noaa.gov/regulating-aquaculture.

795 United States Department of Agriculture, "The Subcommittee on Aquaculture (SCA)," accessed at https://www.fisheries.noaa.gov/regulating-aquaculture.

796 Food and Agriculture Organization of the United Nations, "International standards and intergovernmental agreements of relevance to aquaculture certification," accessed at http://www.fao.org/3/ai388e/AI388E10.htm.

797 "Convention on Biological Diversity," accessed at https://www.cbd.int/.

aquaculture. For example, countries can introduce legal frameworks, licensing and registration, and pollution controls.[798] Thailand is an independent country that utilized legal framework to designate a department to be in charge of the aquaculture sector, with the 2015 Fisheries Act of Thailand positioning the Department of Fisheries "as the primary agency for aquaculture development and regulation."[799] This department provides substantial technical support that is key to the aquaculture sector, particularly given the way that technology can be enhanced at the international levels through policies and initiatives that support continued global and international cooperation.[800] Another example is Aotearoa/New Zealand, where ministries play key roles in the regulation of fisheries and aquaculture development.[801] These examples highlight how independent countries have the capacity and opportunity to develop and utilize legal frameworks, as well as technological innovations, when it comes to developing aquaculture.

Given the increasing challenges of climate change and increasing demands for water, aquaculture's role in addressing global food security is expected to increase.[802] Indeed, the role of governance is a fundamental consideration when it comes to aquaculture and possibilities for growth in Guam. Responsible aquaculture governance requires consulting citizens and being informed by research and statistics in making policy that may hold actors accountable for implementation. The cases mentioned above can be instructive exemplars of co-management by state agencies with local resources, "adoption of information-communication technologies," and the significance of aquaculture "as a stakeholder in water, coastal zone and marine management."[803] On the whole, country-led regulation provides long-term resources and formal rules about aquaculture development, zoning allocations, information and innovation sharing, and a spectrum of capacities and innovations for proper implementation.

Overall, an independent Guam can structure its government in a way that lays out regulations and permits for the aquaculture industry. This set up would entail appointing at least one agency for all needed permits, to lessen the amount of needed communication and overlap. Creating an easy and straight forward avenue to building an aquaculture business will not only attract local business owners but possibly the interest of foreign investors. However, this requires the government of Guam to plan accordingly and make appropriate business and other international relationships to bring this to fruition. It will require concerted effort and initiative from the new independent country, as well as a further examination of feasibility, for this to succeed.

798 N. Hishamunda, N. Ridler, & E. Martone, (2014). "Policy and governance in aquaculture: Lessons learned and way forward." FAO Fisheries and Aquaculture Technical Paper No. 577.

799 Louis Lebel, Phimphakan Lebel, and Chong Joon Chuah, "Governance of aquaculture water use," *International Journal of Water Resources Development* 35, no. 4 (2019): 659-681, DOI:10.1080/07900627.2018.1457513.

800 Food and Agriculture Organization of the United Nations, "The state of world fisheries and aquaculture."

801 M.V. McGinnis and M. Collins, "A race for marine space: Science values, and aquaculture planning in New Zealand," *Coastal Management* 41, no. 5 (2013): 401-419, doi:10.1080/08920753.2013.822284.

802 P.J.G. Henrikkson, N. Tran, C.V. Mohan, C.Y. Chan, U.P. Rodriguez, S. Suri, ... and M.J. Philips, "Indonesian aquaculture futures - Evaluating environmental and socioeconomic potentials and limitations," *Journal of Cleaner Production* 162 (2017): 1482-1490.

803 Lebel, et al., "Governance of aquaculture," 675.

Free Association

Similar to the model for an independent Guam, aquaculture development as a freely associated state with the United States will also depend on the direction that its government and people want to take. A compact of free association or other legal instrument with the United States may only impact these developments if it is found in the language of the document. Examples of the relationship's impact would be found in aspects such as foreign affairs, but the Compacts of Free Association do not hinder industry development.

The Compacts of Free Association governing the relationships between freely associated states and the US do not specifically mention aquaculture. According to the 2019 Federated States of Micronesia Aquaculture Management and Development Plan, there is a need for aquaculture development, particularly given the timeliness of the forthcoming expiration of core economic provisions of the Compact of Free Association. Under the terms of the compact, financial assistance from the US to the FSM decreases every year. This money goes into a trust fund to help run the country after 2023.[804] The report continues to outline the opportunities and potentials for aquaculture within the FAS, indicating the issues of pristine environment, high biodiversity, large sheltered lagoons, access to technical assistance and technology, market access, etc.[805] The current status of aquaculture in the FSM is instructive here as it highlights the present focus on regional connections with Pohnpei and Kosrae.

In Pohnpei, the COM Land Grant continues to operate the pearl oyster and sea cucumber hatchery at Nett Point. In addition, MERIP is expanding the sponge and marine ornamental aquaculture programs with communities around the island.[806] The aquaculture sector is considered a viable activity to develop the FSM economy. Given the political status of free association, the country must consider the set expiration of the economic assistance components of the Compact of Free Association with the US, in 2023, and the need for an aquaculture development plan. The success of an aquaculture industry does not have to depend on the freely associated relationship with the U.S, but rather it might affect (positively or negatively) its foreign affairs, its funding sources, and its imports and exports of aquaculture products. In Guam's case, military security and other agreements may affect the location of aquaculture facilities, inland and offshore.

804 Federated States of Micronesia National Government Department of Resources and Development & Pacific Community (SPC), "Federated States of Micronesia Aquaculture Management and Development Plan: Federated States of Micronesia" 2019, Accessed at https://www.spc.int/.

805 Federated States of Micronesia National Government Department of Resources and Development & Pacific Community (SPC), "Federated States of Micronesia Aquaculture Management and Development Plan: Federated States of Micronesia," 4.

806 Federated States of Micronesia National Government Department of Resources and Development & Pacific Community (SPC), "Federated States of Micronesia Aquaculture Management and Development Plan: Federated States of Micronesia," 5.

AQUACULTURE DEVELOPMENT	
STATUS	**EFFECTS**
Statehood	• Guidelines to further develop and regulate an aquaculture industry. • Barriers to entry in the form of regulations and permits from different US government agencies, which is a common complaint from sources regarding aquaculture development in the US. • Access to federal programs.
Independence	• Eliminating some difficulties of regulations over industry. • Ability to receive help, if eligible, from international organizations to further develop an aquaculture industry. • Would have to create an inspection service for exports of food products. • Opportunity to operate as a new industry in the global trade market. • Loss of US federal funding for development and research.
Free Association	• Eliminating some difficulties of regulations over industry due to lack of US federal government oversight. • Ability to receive help, if eligible, from international organizations to further develop an aquaculture industry. • Opportunity to operate as a new industry in the global trade market.

Water Resources

Guam obtains its potable water from two major sources: surface water and groundwater. These sources come from two provinces and are separated by the Pago-Adelup Fault. The southern geographic province of the island, which collects surface water, is dominated by volcanic uphills and sloping foothills.[807] Limestone plateaus bordered by steep cliffs[808] collect groundwater in the northern province. Groundwater contributes to eighty percent of the island's drinking water. These plateaus are commonly referred to as Guam's northern aquifer.

One major component to the maintenance of Guam's water supply is the conservation of the island's limestone forests. According to the Food and Agriculture Organization of the United Nations, "the loss of forest cover and conversion to other land uses can adversely affect freshwater supplies."[809] This makes integrated water resources management (IWRM) important, no matter what Guam's political status is. IWRM refers to the "process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment."[810]

In July 1996, the oversight of Guam's water resources became the responsibility of the Guam Waterworks Authority after the passage of Public Law 23-119, which designated that the Guam Waterworks Authority would "produce, treat, transmit, store, distribute, and sell water on Guam, and collect, treat and sell or dispose of waste water on Guam."[811] GWA also follows US federal laws, namely the Safe Drinking Water Act (SDWA) 42 USC § 300f et seq. (1974) and the Clean Water Act (CWA) 32 USC § 1251 et seq. (1972). SDWA focuses on all water meant for drinking use. Through the act, the US EPA is authorized "to set minimum standards to protect tap water and requires all owners or operators of public water systems to

807 Gingerich et al., "Water Resources on Guam."

808 Gingerich et al., "Water Resources on Guam."

809 Food and Agriculture Organization of the United Nations, "Loss of forest cover threatens freshwater supplies," 2003, accessed at http://www.fao.org/english/newsroom/news/2003/14880-en.html.

810 Global Water Preservation, "What is IWRM?," accessed at https://www.gwp.org/en/GWP-CEE/about/why/what-is-iwrm/.

811 Guam Public Law 23-119, accessed at http://guamlegislature.com/Public_Laws_23rd/P.L.%2023-119%20(SB%20511(LS).pdf, p.2.

comply with these primary (health-related) standards."[812] Additionally, the CWA "establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters,"[813] meaning that the act deals primarily with the island's wastewater system. GWA is also required to comply with Guam EPA regulations, which are closely associated with federal mandates, especially SDWA. GWA's operations are overseen by the Consolidated Commission on Utilities (CCU), a group with five elected, non-partisan members.[814]

To date, GWA services most of the island. According to GWA, "the island has 120 groundwater wells, Ugum Surface Water Treatment Plant (SWTP) and one active spring. The main water supply source is the deep wells, which are in the northern and central portion of the island."[815] GWA outlined that:

> groundwater supplies about eighty percent of the drinking water for Guam's residents and visitors. In northern Guam, water is obtained from wells that tap the upper part of a fresh groundwater lens in an aquifer composed mainly of limestone. In southern Guam, the main source of fresh-water is from surface water that runs off the weathered volcanic rocks that are exposed over much of the area.[816]

To maintain the current water system and to also plan for an anticipated expansion of the US military presence on the island with the construction of a Marine base, GWA "estimates that thirteen new wells need to be constructed between 2020-2037. They also anticipate that current wells will need a significant overhaul every 15-20 years."[817]

Another issue GWA faces is the ownership of the wells. The agency noted that "privately owned wells continue to provide irrigation, industrial, agricultural, and potable supply to southern and central Guam."[818] Therefore, in its Master Plan, GWA indicated the need to "investigate the viability of acquiring any of those sources for public use" since "springs were utilized to supplement supply in southern Guam as recently as 2006."[819] The protection of Guam's water system is critical. In 2015, GWA conducted a vulnerability study of its wells and unfortunately found that "seventy-six wells have a high risk, thirty-nine wells have a moderate risk, and nine wells have a low risk for potential contamination."[820]

There is also the case of the Fena Valley Reservoir (FVR). Guam's surface water resources primarily reside in the southern region of Guam. The FVR, which is owned by the Department of Defense, provides potable water for Naval Base Guam and nearby villages. It is considered the "largest and most reliable

812 Guam Waterworks Authority, "Guam Waterworks Authority's Information- Self-Determination Study," 2019.

813 Guam Waterworks Authority, "Guam Waterworks Authority's Information- Self-Determination Study," 2019.

814 Guam Waterworks Authority, "GWA History," accessed at http://guamwaterworks.org/gwa-history/.

815 Guam Waterworks Authority, "Water Resources Master Plan Update," ES-1.

816 Guam Waterworks Authority, "Water Resources Master Plan Update," 5-1. GWA also cited Gingerich, 2003 in this quote.

817 Guam Waterworks Authority, "Water Resources Master Plan Update," ES-10.

818 Guam Waterworks Authority, "Water Resources Master Plan Update," 5-54.

819 Guam Waterworks Authority, "Water Resources Master Plan Update," 5-54 - 5-55.

820 Guam Waterworks Authority, "Guam Drinking Water Source Assessment and Protection Program and Wellhead Protection Plan," June 2015, 5-3.

water source in Southern Guam."[821] According to the GWA Master Plan,

> While the reservoir and associated treatment facility are controlled by the Navy, supply necessary to support the Defense mission in Guam will always take priority over GWA requirements. Although an annual allotment from the reservoir has been made to GWA, the DoD has, at times, restricted water delivered to GWA. In addition, although the DoD is mandated to run the facilities on a 'break-even' basis, the rate structure of water purchased from the Navy is not sustainable for a public utility—GWA cannot resell the Navy water for as much as it costs to purchase, and the contract has historically not been negotiable.[822]

Because of this financial limitation, it is unlikely use of the Fena Valley Reservoir can increase if the Northern Guam Lens Aquifer (NGLA), Guam's other major freshwater resource, is unable to meet the island's needs. Doing so could potentially be too costly for the government of Guam.

In terms of wastewater, GWA operates seven wastewater treatment plants which provide "service to approximately 30,000 wastewater customers including civilian accounts island-wide and Andersen Air Force Base (AFB) and other military installations in northern Guam."[823] A significant portion of the island's residents have private septic tanks. GWA reported that:

> of the 55,567 housing units tabulated for the 2010 US Census, only 36,624 were indicated as connected to the public sewer. In addition to residential properties, many commercial and industrial operations are also not connected to the GWA collection network. These unsewered properties utilize septic or cesspool systems, and discharge from these systems can percolate down through the limestone of northern Guam towards the water table.[824]

These issues need to be addressed, especially with the anticipated increase in Guam's population due to the US military buildup.

Population Increases

A major upcoming issue that GWA contends with in its Water Resources Master Plan, is addressing the US military buildup. Since the buildup is not yet completed, numbers could change over time. For this section, the projections show the number of people GWA is planning for. In the Master Plan, it reported that it is planning its infrastructure for:

> an additional 5,000 Marines and 1,600 dependents [who] will be transferred to the island from

821 Guam Waterworks Authority, "Water Resources Master Plan Update," 5-54.

822 Guam Waterworks Authority, "Water Resources Master Plan Update," 5-54.

823 Guam Waterworks Authority, "Water Resources Master Plan Update," ES-3.

824 Guam Waterworks Authority, "Water Resources Master Plan Update," 5-21.

> Okinawa, Japan, increasing the military population by nearly fifty percent over 2014 levels. In addition to the increase in active-duty military and dependents, Guam's population is expected to fluctuate due to construction activity related to the military buildup and civilian jobs created by buildup activities.[825]

To address the needed improvements to Guam's water system, in 2010, GWA and the Department of Defense (DoD) signed a Memorandum of Understanding (MOU) to "evaluate opportunities towards integrating military and civilian water systems in Guam. The original intent of the MOU was to address expected water and wastewater needs for the proposed military buildup."[826]

With the updated 2016 MOU, GWA and DoD agreed that they would "facilitate changes to both systems in a manner that is mutually beneficial and maximizes the effectiveness of the overall Department of Defense (DoD) and GWA utility systems as a whole."[827] As part of this integration, it was negotiated that the Tumon-Maui Well, one of the highest capacity wells of NGLA, would be part of a pilot program where GWA would be given a temporary license to operate it. GWA will also be responsible for the maintenance of the surrounding property and security of the well. As stated in the MOU, GWA's operation of the Tumon-Maui well would grant the agency the "opportunity to demonstrate their ability to operate and maintain DoD owned water treatment facilities and provide sustainable, reliable, compliant and secure potable water generation."[828] The agreement also stated that:

> The delivery of the USMC cantonment [one of the sites of the buildup] will be a water for water trade. The amount GWA delivers to the USMC cantonment will be counted as a credit toward purchases made by GWA from the Navy to provide water service to customers at other locations.[829]

Meaning that GWA would have the opportunity to reduce the amount it pays to the Navy for water given to Guam residents from the FVR if it continues to provide water from the Tumon-Maui well to residents of the USMC base. Preparing Guam's water resources for the impending population increase is critical to ensuring that it can provide enough freshwater to the island's residents.

Climate Change and Availability of Future Water Resources

GWA projects are not necessarily done to address climate change, but the improvements they make to the water system will allow the island to be more resilient to the effects of climate change. Currently,

825 Guam Waterworks Authority, "Water Resources Master Plan Update," ES-8.

826 Guam Waterworks Authority, "Water Resources Master Plan Update," 5-58.

827 Guam Consolidated Commission on Utilities, "Resolution No. 04-FY2017: Memorandum of Understanding of the Tumon Maui Well" 6, accessed at http://guamccu.org/wp-content/uploads/2015/12/Resolution-04-FY2017-MOU-Between-GWA-and-DoD.pdf.

828 Guam Consolidated Commission on Utilities, "Resolution No. 04-FY2017: Memorandum of Understanding of the Tumon Maui Well," 3.

829 Guam Consolidated Commission on Utilities, "Resolution No. 04-FY2017: Memorandum of Understanding of the Tumon Maui Well," 4.

GWA is planning additional projects to line and rehabilitate the pipes along the shoreline. Therefore, if ocean levels rise and cause an appreciable difference in storm surge, the island will be protected from the type of storm surge that it sees during typhoons.

The environmental consequences of climate change, including drought and sea level rise, will inevitably impact Guam's water resources in the future. Recognizing the potential adverse effects, the United States Department of the Interior and United States Geological Survey conducted a comprehensive investigation and produced a report entitled *Water Resources on Guam - Potential Impacts of and Adaptive Response to Climate Change*. A summary of this report will aid in understanding how climate change may negatively affect Guam and mitigative action that can be adopted in order to prevent the adverse impacts. This report is the product of a scientific study conducted by experts who used "downscaled regional climate models, informed by a multimodal ensemble of global climate models provided projections of future climate conditions for Guam."[830] Future projections are for the years 2080-2099.[831] Factors included in simulations to test the potential effect of climate change on Guam's ground and water resources included: temperature; amount of rainfall; the presence or absence of a two-year drought; and occurrence or non-occurrence of sea-level rise. The findings from this research can be broken down into two parts, the first discussing the impacts to surface water resources, and the other addressing the effects to groundwater resources.

Regarding FVR, the USGS study found that from 2010 to 2014, the average water supply was about 5.5 Mgal/day.[832] USGS explored the FVR and revealed that climate models predicted a twelve percent to thirty-six percent decrease in streamflow "relative to the streamflow in the historic period."[833] A decrease in water provided to the FVR was based on projections of "decreased future rainfall and increased actual evapotranspiration."[834] Climate models took into consideration an increase in demand for water from the current withdrawal rate of 5.5 Mgal/day to estimated withdrawals up to 11.4 Mgal/day.[835] USGS found that based on the maximum withdrawal rate with a decrease in streamflow due to less rainfall, a consequence of climate change, the FVR "would maintain water levels above the pump intake elevation"[836] which implies that even with withdrawals that double the current rate, the FVR is still able to supply water without irreparably damaging the system.

While running simulations, the survey found FVR's potential limit. In one simulation, the water withdrawal rate being eleven Mgal/ d coupled with a "two-year drought" found that "the reservoir will not recover after the dry season and the water level decreases to the elevation of the pump intake after twenty months in the twenty-four-month period simulated."[837] A situation of maximum withdrawal that is accompanied by a large decrease in streamflow due to drought would be more damaging to Guam.

830 Gingerich et.al., "Water Resources on Guam," pg. 1.

831 Ibid, pg.1.

832 Gingerich et.al., "Water Resources on Guam," pg. 2; Mgal/d means million gallons per day.

833 Ibid, pg. 18.

834 Ibid, pg.18.

835 Ibid.

836 Ibid, pg. 20.

837 Guam Waterworks Authority, "Water Resources Master Plan Update," 21.

The simulation was set for the year 2088.

Aside from drought, another factor to consider for the island's freshwater resources is sedimentation, which decreases streamflow. Streamflow, which refers to the amount of water flowing, is measured to determine how a water system is performing. The study found that "future sediment load discharged into the reservoir will decrease by about thirty-two percent relative to the modeled sediment load for the historic period"[838] which is attributed to "the decrease in streamflow"[839] in part due to less rainfall. Less sediment flowing into the FVR means the reservoir is expected to lose 0.46% of storage capacity, in comparison to the current 0.68% that has been lost annually from 1951 to 2014.[840]

However, the study recognizes that another historical factor in sedimentation has been the occurrence of "intense storms." Due to climate change, the frequency of tropical cyclones is expected to decrease, but the intensity may increase, creating stronger storms which may lead to greater amounts of "sediment load discharged into the FVR."[841] Overall, climate change may lead to decreased rainfall, the occurrence of long-term drought and intense storms which may lead to a decrease in streamflow of water as well as an increase in the sedimentation rates in the FVR, a primary source of potable water for southern Guam.

Simulations for Guam's future groundwater availability took into consideration a 6.6 ft. rise in sea level and found only a "small impact on the chloride concentration of water pumped from the production wells in the NGLA."[842] This means that sea-level rise by itself would have a minor impact on Guam's NGLA. A second model simulation did not include sea-level rise but did take into consideration a decrease in recharge, which is feasible given the projected decrease in rainfall. This simulation found a rise in "composite concentration of 282 mg/ L, which is more than double the composite concentration simulated for 2012 recharge and sea level conditions...and above the 250 mg/ L chloride concentration secondary standard established by the US Environmental Production Agency."[843] The implication is that a decline in rainfall would be impactful because less freshwater would be available to replenish the NGLA and to ensure a lower concentration composite.

Overall, simulations on future surface and groundwater resources for Guam from the 2019 study found that the impacts of climate change will be significant. Additional effects of climate change on Guam's water resources are explained in the table below. The table is from GWA's Master Plan.

838 Guam Waterworks Authority, "Water Resources Master Plan Update," 21.

839 Guam Waterworks Authority, "Water Resources Master Plan Update," 21.

840 Guam Waterworks Authority, "Water Resources Master Plan Update," 21.

841 Guam Waterworks Authority, "Water Resources Master Plan Update," 21.

842 Guam Waterworks Authority, "Water Resources Master Plan Update," 23.

843 Guam Waterworks Authority, "Water Resources Master Plan Update," 23.

Climate-Related Impacts for GWA Source Water[844]

844 Guam Waterworks Authority, "Water Resources Master Plan Update," 5-54.

CLIMATE-RELATED EVENT	RESULT	POTENTIAL IMPACT	SOURCE
Rising sea level	Increase in elevation of the freshwater lens and fresh to salt transition zone	May raise the freshwater lens above well screen and put saltier transition water at the screen elevation, increasing chlorides.	Australian Bureau of Meteorology & CSIRO, 2011
ENSO-related drought	High inter-annual rainfall variability	Prolonged and extended dryness occurring in the year following El Niño.	
Increase in number of heavy and extreme rain days	Larger volume of runoff and/or infiltration over a shorter period	Increased potential for pollutant transport into aquifer with runoff infiltration. Increased sediment transport and resultant turbidity and pollution into surface water.	Australian Bureau of Meteorology & CSIRO, 2011
Increase in evapotranspiration	Less infiltration	Decrease recharge, well water levels drop.	Australian Bureau of Meteorology & CSIRO, 2011
Tidal fluctuations		In wells closest to the coast, water levels fluctuate daily as much as 0.5 feet in response to ocean tides. Wells in the high-hydraulic-conductivity limestone in the island's interior typically show much smaller daily fluctuations.	
Climate change in the South Pacific	Climate-related migration	People displaced by rising sea levels may migrate to Guam, adding to infrastructure requirements.	

Many of the effects mentioned in the GWA report mirror what was concluded in the simulations run by USGS. A lack of water due to a decline in rainfall or drought, rising temperatures and sedimentation rates as well as sea-level rise are all factors that may create vulnerabilities to Guam's water resources. Under the different political status options, the Government of Guam must consider these vulnerabilities and what resources can be obtained and what actions should be taken to mitigate the situation and ensure safe water resources for the island's population.

Statehood

Under statehood, little change may be required regarding Guam's water resources. The island currently follows federal water laws and is structured like some US states. One required change is that the state of Guam will need to establish formal state water laws to address how water is distributed and managed.[845] As it currently does, the state of Guam will still have to adhere to the provisions set in the US federal laws, namely the Safe Drinking Water Act (SDWA) and the Clean Water Act (CWA). State water laws must also acknowledge and respect the federal government's reserved water rights.

Additionally, the state of Guam will continue to have access to federal grants (i.e., Clean Water State Revolving Fund-CWSRF and the Drinking Water State Revolving Fund- DWSRF) for sustainably managing water resources. The DWSRF is a grant that provides low-interest loans to states, territories, and American Indian/Alaskan Native tribes in the United States. In the past, the grant funded projects related to improving drinking water treatment; fixing leaky or old pipes (water distribution;) improving source of water supply; replacing or constructing finished water storage tank; and other infrastructure projects to protect public health.[846] A report written by the Congressional Research Service outlined the complex funding structure of these grants, stating,

> The law directs EPA to allot DWSRF funds among the states based on the results of the most recent quadrennial needs survey, except that each state (including the Commonwealth of Puerto Rico and the District of Columbia) must receive at least 1% of available funds. SDWA authorizes EPA and the states to reserve portions of the available funds for specified purposes.
>
> Before distributing funds among the states, EPA reserves two percent of the appropriated amounts for grants to Indian tribes and Alaska Native villages for water infrastructure projects. For FY2017, Congress authorized EPA to set aside as much as $20.0 million for these grants. The law also directs EPA to allot grants to the US Virgin Islands, the Commonwealth of the Northern Mariana Islands, American Samoa, and Guam, using not more than 0.33% of the funds available for grants

845 National Agricultural Law Center, "Water Law: An Overview," accessed at https://nationalaglawcenter.org/overview/water-law/.

846 United States Environmental Protection Agency, "How the Drinking Water State Revolving Fund Works," accessed at https://www.epa.gov/dwsrf/how-drinking-water-state-revolving-fund-works.

to the states. Congress has regularly increased this amount to 1.5% in appropriations acts.[847]

As a state, Guam will get access to federal loan funding, but it will have to provide matching funds to secure certain grants. In FY2017, GWA was given $5 million through CWSRF and $3.5 million through DWSRF.[848] Based on an "in-kind technical services contract," US EPA granted money to GWA to "increase the technical, financial, and managerial capacities."[849] With the five-year grant, it was reported that GWA was able to "improve operations and management of their water and wastewater systems and implement standardized procedures and tracking for a more effective and efficient capital improvement program."[850]

Lastly, as a state, the military presence in Guam will remain and possibly expand. This will require the state government to address the impacts associated with military activity as it relates to population and the possible chemical contamination of the island's water resources. This will also apply to a freely associated Guam or independent Guam if basing agreements are established with the United States.

Independence

As an independent country, Guam would have full autonomy and exclusive control over its water resources. As a result, Guam will no longer have access to federal funding to complete its capital improvement projects. GWA currently relies on the revenue it receives from consumers. An independent Guam may continue to use a similar revenue source when it establishes its water system (contingent on the economic state of the island at the time). An independent Guam will have to look for other sources of funding to make up for the loss in federal funds. Guam can look to other countries or international organizations for assistance or aid, in the form of grants and low-interest loans to fund improvements to the island's water infrastructure. If Guam and the United States negotiate to maintain US military bases in the island, Guam could obtain support and funding for its water system. The government of Guam can then use this money to manage water and other resources.

In terms of control, Guam will need to enforce stricter regulations around water. An independent Guam could also redesign laws that best suit the needs of the island. For example, based on simulations run by USGS, climate change can impact the quality of Guam's freshwater resources. An independent Guam could create robust water laws to address the potential impacts of climate change. The country could also create programs and initiatives that adequately tackle development and address the potential impacts of climate change. This will depend on the strength and cohesion of governance, enforcement mechanisms, economy, and national pride of the time to ensure Guam's water resources are protected.

847 Congressional Research Service, "Drinking Water State Revolving Fund (DWSRF): Overview, Issues, and Legislation," October 2, 2018, accessed at https://fas.org/sgp/crs/misc/R45304.pdf.

848 US Environmental Protection Agency, "Clean Water and Drinking Water Grants to US Territories and Washington, D.C. FY 2017 Annual Report," July 2018, 4, accessed at https://www.epa.gov/sites/production/files/2018-08/documents/cwsrf_dwsrf_territories_and_dc_joint_annual_report_final.pdf.

849 US Environmental Protection Agency, "Clean Water and Drinking Water Grants," 4.

850 US Environmental Protection Agency, "Clean Water and Drinking Water Grants," 4.

These are difficult things to establish, at first, and will take considerable effort. As stated by the Guam Environmental Protection Agency,

> It is likely not feasible for Guam to develop its own drinking water regulations due to the cost and scientific research needed to develop standards such as drinking water maximum contaminant levels (MCLs). In terms of technical effectiveness, the USEPA Safe Drinking Water Act and associated SDWA regulations remain one of (if not the) most comprehensive and effective drinking water regulatory schemes in the world. GEPA would be hard-pressed to come up with a more effective regulatory scheme. However, the federal SDWA has been slow to adapt to emerging contaminants in recent years, due political and funding factors at the national level. Some states have begun to establish maximum contaminant levels on their own as a result. GEPA is in the process of working with the Guam Legislature to amend Guam's SDWA to allow for the establishment of "interim action levels" for unregulated contaminants prior to federal regulation. However, GEPA is recommending only that such standards be adopted on the basis of risk assessments produced by the USEPA or other states. GEPA does not believe Guam has, or will ever have the resources necessary to determine such standards on our own. As an example, the state of California maintains a staff of over fifty toxicologists and an annual budget in excess of $25 million to develop their risk assessments which are used to establish such limits.[851]

An independent Guam would need to find a way to navigate around this obstacle to develop proper water standards for the benefit of the country and its people.

Status Example: Indonesia

Gaining independence in 1945, the Republic of Indonesia currently stands as "the world's third most populous democracy, the world's largest archipelagic state, and the world's largest Muslim-majority nation."[852] As of July 2020 the population was estimated to be 267,026,366.[853]

Economic activity and related urbanization, coupled with a growing population, has placed stress upon the water resources in Indonesia. It is significant to note that the country's water resources are also unevenly distributed throughout the islands. Despite over half the population living in Java, the island has only "4.2% of the country's water resources."[854]

The government of Indonesia deals with the challenge of providing safe freshwater to its citizens. To resolve this issue, Indonesia sought international development assistance to improve its sanitation and

851 Guam Environmental Protection Agency, Water Division, Self-Governance Answers.

852 Central Intelligence Agency, "Indonesia," August 19, 2020, accessed at https://www.cia.gov/library/publications/the-world-factbook/geos/id.html.

853 Central Intelligence Agency, "Indonesia."

854 Association of Southeast Asian Nations, "Overview of IWRM in Indonesia," accessed August 31, 2020, accessed at https://aseani-wrm.water.gov.my/iwrm-in-indonesia/.

freshwater systems. For example, the Indonesian Government's program Penyediaan Air Minum dan Sanitasi Berbasis Masyarakat (PAMSIMAS) is funded by money contributed by the central Indonesian government as well as regional governments for a total of $537.4 million. In addition to domestic funding, between 2006-2018, the program also received $102 million from the Australian government to carry out its initiatives. The Indonesian government was also granted World Bank funding through a $137.5 million International Development Association (IDA) credit and a $399.9 million International Bank for Reconstruction and Development (IBRD) loan.[855] With the millions invested into the program, PAMSIMAS reported that it has already helped "Indonesia's low-income rural and peri-urban population, spread across almost 23,000 villages, by providing improved water supply to 17.2 million people, and access to better sanitation facilities for 15.4 million people."[856]

In addition to securing finances for water resource management, the government of Indonesia also needed to formalize which entity would have the authority to oversee the country's water resources. On Feb. 18, 2015, Indonesia's Constitutional Court revoked Law No. 7/2004 on Water Resources[857] which was the "framework law"[858] for water resources and the basis for further government regulations. To replace this, the government reinstated The Law of the Republic of Indonesia Number 11 of the Year 1974, because the "2004 Law had permitted private sector companies to sell packaged tap water."[859] By reinstating Law No. 11/1974, the government of Indonesia reclaimed control over water resources that may have been lost under the previous law.

Article V of Law No. 11/ 1974 specifies that the "Government shall formulate specific water resources management policies"[860] for activities such as "the determination of the conditions and procedures for general and project planning and for water and water resources utilization, exploitation, policing, and licencing"[861] as well as "the permanent regulation and implementation of water and water resources development as well as of waterworks management…"[862] This indicates that the government of Indonesia has a majority of control over managing freshwater resources.

Like Indonesia's Law No. 11/1974, a framework law can be established to give the government of Guam primary control over managing water resources through activities, such as the creation of regulations and plans, enforcement of regulations, as well as the collection, treatment and distribution of water to the public. Doing so would allow the government to ensure that freshwater resources remain available for the benefit of the people of Guam without having to deal with the potential privatization of the island's

855 The World Bank, "Indonesia: Expanding Access to Clean Water for the Rural Poor," accessed at https://www.worldbank.org/en/results/2019/07/29/indonesia-expanding-access-to-clean-water-for-the-rural-poor.

856 The World Bank, "Indonesia: Expanding Access to Clean Water."

857 John Constance, "Indonesia: Water Law Overturned by Court," The Library of Congress Law Library, March 3, 2015, accessed at https://www.loc.gov/law/foreign-news/article/indonesia-water-law-overturned-by-court/.

858 Asian Development Bank, "Indonesia Country Water Assessment," 2016, 58, https://www.adb.org/sites/default/files/institutional-document/183339/ino-water-assessment.pdf.

859 Constance, "Indonesia: Water Law Overturned by Court."

860 President of the Republic of Indonesia, "The Law of the Republic of Indonesia Number 11 of Year 1974 on Water Resources Development," 9, accessed at http://extwprlegs1.fao.org/docs/pdf/ins1336.pdf.

861 President of the Republic of Indonesia, "The Law of the Republic of Indonesia," 9.

862 President of the Republic of Indonesia, "The Law of the Republic of Indonesia," 9.

water resources. The government of Guam could also consider the same funding streams that Indonesia used, such as negotiating with other countries or pursuing money from international organizations.

Free Association

As a freely associated state (FAS), Guam will have sovereignty over its water resources, meaning that the island will have the authority to enable water laws for the country. A FAS Guam will likely also participate as its own country in regional and international organizations (if following the blueprint of already existing FAS with the US) that address environmental impacts.

The ongoing partnerships the freely associated states of the Micronesia sub-region have with the United States can serve as an example for the kind of assistance a freely associated Guam can receive and allocate toward improving and maintaining its water resources. For example, if a COFA or other agreement is negotiated, Guam could potentially receive financial assistance to strengthen the island's freshwater resources or even ask to use the services of US federal agencies such as the US Environmental Protection Agency (USEPA) or the Federal Emergency Management Agency (FEMA).

Additionally, as part of a potential compact or other legal instrument between Guam and the US, it is virtually guaranteed the United States will want to continue having its military bases in the island to protect US interests. If this occurs, Guam will have to negotiate with the United States over who will be responsible for maintaining and protecting the water resources that sit within the US bases and are used by the US military. Senator Sabina Perez raised this concern when she commented on the infrastructure of Guam's water system. She emphasized that:

> one of the big issues about our municipal water supply is that it was meant to be a residential water supply not an industrial water supply. Meaning that the military counts as part of that because they are a big producer of industrial wastes. Our municipal water supply or water system was not designed for that. We want to strengthen our municipal water system. There must be perhaps in the presence of a military, the US military. There really should be more of a community advocacy presence.[863]

Under the status of free association, Guam may have the opportunity to clearly outline the responsibilities of each respective institution, yet the power difference between Guam and the United States in the negotiations will be a factor in the results.

As indicated in Section 161 of the Compact of Free Association with the Republic of the Marshall Islands and the Federated States of Micronesia, the US is required to "prevent or eliminate damage to the environment and biosphere and to enrich understanding of the natural resources of the Marshall Islands and the Federated States of Micronesia."[864] It is further outlined in subsections A3 and A4 that an

863 Personal Communication with Senator Sabina Perez, May 2021.

864 Republic of the Marshall Islands, "Compact of Free Association Act of 1985", accessed at https://www.doi.gov/oia/about/compact.

Environmental Impact Statement (EIS) must be performed, wherein the US government shows that all of its activities comply with federal environmental laws and that it has mechanisms in place to mitigate any potential environmental damage. The EIS can only be amended if both governments agree. Section 161 Subsection D, states,

> in the event that an Environmental Impact Statement is no longer required under the laws of the United States for major federal actions significantly affecting the quality of the human environment, the regulatory regime…shall continue to apply to such activities of the government of the United States until amended by mutual agreement.[865]

However, it is important to note that there is a clause in which the US government does not to have to adhere to environmental regulations under special circumstances. Section 161, subsection E states,

> the President of the United States may exempt any of the activities of the Government of the United States under this Compact and its related agreements from any environmental standard or procedure which may be applicable under Sections 161(a)(3) and 161(a)(4) if the president determines it to be in the paramount interest of the government of the United States to do so, consistent with Title Three of this Compact and the obligations of the government of the United States under international law.[866]

This means US government activities can be exempt from following federal and local environmental regulations if the President of the United States deems it necessary. This provision is important to consider for a freely associated Guam if US military bases are negotiated into the potential compact. Senator Perez stated there is a, "national security interest, so a lot of policies that the US government puts forth has a heavy weight on national defense. So, when you are talking about environmental laws, national security interest will trump a lot of these environmental laws."[867]

Status Example: Republic of the Marshall Islands

Water security is a concern in the RMI as there are multiple obstacles to ensuring the provision of fresh water to its growing and increasingly urban population. One critical threat to RMI's water resources is climate change, which is projected to lead to a sea level rise of 1.2-6.3 inches by 2030, as well as "increase the impact of storm surges and coastal flooding."[868] In the capital of Majuro, rising sea levels may impact the main sources of capturing freshwater, the airport rainwater catchment and the Laura groundwater

865 Republic of the Marshall Islands, "Compact of Free Association Act of 1985."

866 Republic of the Marshall Islands, "Compact of Free Association Act of 1985."

867 Personal Communication with Senator Sabina Perez, May 2021.

868 Mathew Johnston, "Republic of the Marshall Islands Water & Sanitation Sector Final Report," 11.

lens, as they "can become polluted or structurally damaged by over-wash of saltwater during storms."[869]

In response to these recognized threats, the government of the RMI worked with several countries and international organizations to address water security issues exacerbated by climate change.[870] One example is the Green Climate Fund, an entity of the United Nations Framework Convention on Climate Change that invests in "low-emission and climate-resilient development."[871] It is engaged in a project with the Marshall Islands. This project aims to reduce the vulnerability of the RMI's water sector by helping to improve "household rainwater harvesting systems," improving "community building rainwater harvesting systems," constructing "new storage tanks" and "new community-based roof structures in combination with new storage tanks."[872]

As a freely associated state, the RMI is eligible to receive US federal funding for disaster relief efforts through the US Agency for International Development (USAID) office of US Foreign Disaster Assistance. There were multiple instances in recent history when drought in the RMI has led to Presidential Disaster Declarations and subsequent aid from the US government. For example, from late-2012 to 2013, a severe drought hit the RMI and led to water storage facilities emptying, damages to crops, and a scarcity in food supplies.[873] On April 19, 2013, the government of the RMI "declared a state of emergency for the drought"[874] which led to the US ambassador issuing "a disaster declaration due to humanitarian needs" [875]and an initial $100,000 being provided from USAID and the International Organization for Migration for "emergency relief commodities, such as water containers and hygiene kits, from a USAID-funded warehouse in the RMI capital of Majuro."[876] In total, USAID provided more than $5.5 million for relief efforts and assistance to the country for nine months, which entailed activities such as installing "twenty solar-powered reverse osmosis portable units"[877] and delivering "1.47 million pounds of food to people in thirteen atolls."[878] Assistance from the US helped the country provide essential resources during a time of great scarcity. This example highlights what a future relationship with the US may entail.

Potential agreements between the US and Guam may include stipulations to ensure that the US will provide assistance in the form of federal funds, resources, and technical assistance to Guam during freshwater resource emergencies, such as drought or saltwater intrusion into the Northern Guam Lens Aquifer. Like the amended COFA between the US and RMI governments, Guam's potential COFA

869 Christine Burchette, "The Freshwater Cycle in the Marshall Islands," United States Environmental Protection Agency, 2013, accessed at https://blog.epa.gov/2016/12/01/the-freshwater-cycle-in-the-marshall-islands/.

870 Burchette, "The Freshwater Cycle."

871 Green Climate Fund, "About GCF", August 31, 2020, accessed at https://www.greenclimate.fund/about.

872 Green Climate Fund, "Funding Proposal FP112: Addressing Climate Vulnerability in Water Sector (ACWA) in the Marshall Islands," 24.

873 USAID, "Marshall Islands survives prolonged drought with disaster assistance," January 2015, accessed at https://2012-2017.usaid.gov/results-data/success-stories/usg-provides-drought-relief-republic-marshall-islands.

874 USAID, "Republic of the Marshall Islands- Drought," 1, accessed at https://www.usaid.gov/sites/default/files/documents/1866/05.16.13%20-%20USAID-DCHA%20Republic%20of%20the%20Marshall%20Islands%20Drought%20Fact%20Sheet%20_1.pdf.

875 USAID, "Republic of the Marshall Islands- Drought."

876 USAID, "Republic of the Marshall Islands- Drought."

877 USAID, "Marshall Islands Survives Prolonged Drought."

878 USAID, "Marshall Islands Survives Prolonged Drought."

agreement could include a Disaster Assistance Emergency Fund which the US contributes to annually for an agreed upon amount of time.[879] This type of fund could allow Guam to have financial resources readily available if threats to freshwater resources lead to scarcity. In addition to the United States, a freely associated Guam could establish diplomatic relations with other countries and international organizations.

879 USAID, "Marshall Islands Survives Prolonged Drought."

WATER RESOURCES	
STATUS	**EFFECTS**
Statehood	• Under statehood, little change may be required regarding Guam's water resources. The island currently follows federal water laws and is structured like some US states. • Guam will establish formal state water laws to address how water is distributed and managed. • Guam will continue to have access to federal funding and grants. • Federal funding could increase, to improve the island's water system, with a funding match.
Independence	• Guam will have sovereignty over its water resources, meaning the island will have the authority to enable water laws for the country.

	• Guam will no longer have ready access to US federal funding. • Guam can establish diplomatic relations with other countries and international organizations to find funding for water resource management and development.
Free Association	• Guam will have sovereignty over its water resources, meaning the island will have the authority to enable water laws for the country. • Guam can establish diplomatic relations with other countries and international organizations to find funding for water resource management and development. • Potential compact agreements between the US and Guam may include stipulations to ensure that the US will provide assistance in the form of federal funds, resources, and technical assistance to Guam for its freshwater resources. • If Guam negotiates a Compact of Free Association or other legal instrument with the United States, Guam and the United States will have to negotiate for provisions that ensure the protection and maintenance of Guam's water resources.

Renewable Energy

Electricity in Guam

Electricity generation, transmission, and distribution in Guam (aside from US Department of Defense facilities) is solely provided by the Guam Power Authority, a public corporation overseen by the Consolidated Commission on Utilities (CCU), an elected body which is then regulated by the Guam Public Utilities Commission (PUC).[880] GPA operates and manages the island's electric grid, including several power plants for energy production. GPA also partners with private corporations through Energy Conversion Agreements (ECAs), where GPA provides fuel to Independent Power Producers (IPPs) and purchases the electricity produced.[881] As of April 2021, GPA reported Guam's power system to have 311MW of available capacity for peak demand in a single day. The highest peak demand for a single day in 2021 was 249MW. GPA continues to work to ensure that generation production exceeds demand. Currently, ten percent of Guam's energy production comes from renewable energy sources, primarily from the Dandan solar farm, with the remainder coming from conventional methods of energy production. GPA's baseload generation comes from the combustion of fossil fuels, primarily residual fuel oil (RFO) and ultra-low sulfur diesel (ULSD). Because the island does not have any local fossil fuel resources, fuel used for energy production must be imported.

This makes the island's energy production vulnerable to price and availability fluctuations in the global market, which ultimately affect reliability and contribute to high utility rates. Fuel oil costs total more than half of GPA's budget and are the largest portion of a customer's electricity bill. The high cost of energy is also compounded by Guam's relative remoteness from fuel production and distribution areas. In 2015, 6.1 percent of Guam's GDP was spent on importing fuel for use in energy production. To address this reliance on fossil fuels, the local government has established several initiatives to reduce the use of fossil

880 US Energy Information Administration, "Profile Analysis Guam," last modified October 18, 2018, accessed at https://www.eia.gov/state/analysis.php?sid=GQ#32.

881 Energy Transition Initiative, "Energy Snapshot: Guam," National Renewable Energy Laboratory, 2015, 1.

fuels and increase the use of renewable energy sources. Most recently, with Public Law 34-56, the island's Renewable Portfolio Standards aim to make renewable energy account for fifty percent of total electricity sales by the end of 2035 and one hundred percent of total electricity sales by the end of 2045.[882]

Renewable Energy in Guam

The Guam Power Authority (GPA) currently obtains its renewable energy-produced electricity from two renewable energy production facilities: a solar PV farm owned by a private company, from which GPA purchases electricity; and a wind turbine owned and operated by GPA. The single solar PV farm, classified as a grid-connected, central distribution system, is the Dandan solar farm located in southern Guam. The twenty-five MW farm has proven successful in providing approximately 4,300 MWh of renewable energy each month, which accounted for about three percent of total energy sales in 2019.[883] The single 275KW wind turbine, classified as an onshore wind turbine, was constructed in 2016 through a $2.1M grant from the US Department of the Interior and is currently operated by GPA. The wind turbine produces enough electricity to power approximately fifty homes. This wind turbine has proven successful in providing GPA with technical experience with wind energy that may guide future wind energy projects.[884] Aside from these two facilities, GPA also receives a significant amount of energy production from its net metering program, in which GPA purchases and feeds into the grid excess solar PV energy produced by small-scale solar PV systems installed at residential/business facilities. In March 2021, GPA began operating a twenty-four MW battery storage system at the Hagåtña substation and a sixteen MW battery storage system at the Talo'fo'fo' substation, which will assist in alleviating short outages caused by generator trips, mitigating the intermittency of renewable energy resources generated by existing facilities, and reducing GPA's reliance on expensive, imported diesel fuel.[885] In recent years, GPA and the government of Guam have undertaken several efforts to further incorporate renewables into Guam's energy system. On the policy side, as mentioned above, with the recently passed Public Law 34-56, the island's Renewable Portfolio Standards mandate that energy sales produced from renewable energy account for fifty percent of total electricity sales by the end of 2035, and one hundred percent of total electricity sales by the end of 2045.[886]

GPA is working toward integrating additional renewable energy sources (even in light of the current system's limited capacity for integrating renewables), executing projects to improve renewable integration, and evaluating technology development and costs. Since GPA's initial acquisition of renewable energy contracts, the prices of storage systems have lowered. Within the next five to ten years, GPA expects

882 Pacific Island Times, "Guam eyes 100% renewable energy production by 2045," *Pacific Island Times*, last modified November 1, 2019, accessed at https://www.pacificislandtimes.com/single-post/2019/11/01/Guam-eyes-100-renewable-energy- production-by-2045.

883 Personal Communication with Guam Power Authority (GPA) General Manager John M. Benavente and GPA Assistant General Manager Tricee Limtiaco, Interview, January 21, 2020.

884 Guam Power Authority, "Briefing for Commissioner Limtiaco," 2019, 20.

885 Guam Power Authority, "Monthly Update," 2021, 39-40.

886 Guam Power Authority, "Briefing for Commissioner Limtiaco," 53.

to add over 160MW of installed solar PV capacity to its power production capacity, which will reduce operation costs. The 160MW figure refers to the production capacity at the end of the contract term, as solar PV capacity degrades over time. The initial PV capacity upon first commissioning the PV system will be over 220MW.

Guam Power Authority Primary Generating Units, April 2021

Primary Generating Units					
	Unit	Year Installed	Owner	Operator	Capacity Available (MW)
Baseload	Cabras Unit 1	1974	Authority	TEMES/Authority	55.0
	Cabras Unit 2	1975	Authority	TEMES/Authority	55.0
	MEC - Piti Unit 8 [1]	1999	Authority	MEC	44.2
	MEC - Piti Unit 9 [1]	1999	Authority	MEC	44.2
Intermediate	Macheche - CT	1993	Authority	Authority	20.0
	Yigo – CT	1993	Authority	Authority	20.0
	Piti Unit 7	1997	Authority	Authority	40.0
	Dededo CT Plant	1993	Authority	Authority	**40.0**
	Aggreko [2]	2016	Authority	Authority	**40.0**
Peaking	Diesel Units (10 units)	1993	Authority	Authority	40.0
				Subtotal:	**398.4**
Renewable	Dandan Solar Project	2015	GPS Solar	GPS Solar	25.0
	Wind Turbine	2016	Authority	Authority	0.3
				Total:	**423.7**

1. BOT expired in January 2019; ownership reverted to GPA.
2. Lease expired in 2020; ownership reverted to GPA.

GPA's Phase II Renewables Project includes the nominal sixty MW Mangilao project, expected to come online by Summer 2022, and the nominal sixty MW Malojloj solar project, expected to come online by the end of 2023. In addition, GPA issued a solicitation for a Phase III Renewable Energy contract, which will be a partnership between GPA and the US Navy to develop over forty-one MW of solar PV, including full energy shifting Energy Storage Systems, to be installed on US Navy land leased to GPA. As of April 2021, the award of this contract is pending resolution of a procurement protest.

Renewable energy consists of systems of energy that make use of naturally occurring, locally found sources that are inexhaustible. The major types of renewable energy include solar, hydropower, wind power, ocean energy, geothermal energy, and biomass, among others. These sources have proven to have fewer negative impacts on human life and the environment than traditional sources of energy such as fossil fuels like oil, coal, and natural gas.[887] Within the past two decades, countries throughout the world have taken a significant interest in renewable energy. This shift in energy production is brought on by the desire to move away from fossil fuels due to record-breaking oil and natural gas prices and the projected

887 Alice Meyers, Renewable Energy (Salem Press Academy of Science, 2018), 1.

scarcity of fossil fuels in the near future.[888] Other factors, such as the production of greenhouse gases caused by burning fossil fuels, and major growth and competition in the areas of renewable energy technology and production, have further compelled countries to pursue renewable energy as an alternative source of energy production.[889]

Types of Renewable Energy

This section will primarily focus on the major types of renewable energy as well as their subtypes, to include direct solar, wind power, ocean energy, hydropower, geothermal energy, and bioenergy.

Solar Energy

Direct solar, herein referred to as solar, is a family of technologies, such as solar thermal, photovoltaic (PV) generation, concentrated solar power (CSP) and solar fuels, that collect energy from the sun and use that energy directly or convert it into electricity. Although unevenly distributed throughout the entire globe, solar is the most abundant of all renewable energy sources. Solar energy sources vary in application, with some using the sun's energy to provide natural lighting, heating, and cooling to buildings, and others converting the sun's energy into electricity.[890]

Active systems are also of great utility in reducing a building's energy consumption. Solar heating is one example of an active use of solar energy. A solar heating system consists of a collection element that absorbs the sun's thermal energy and a transfer liquid which is heated up and then stored in a storage tank until needed. Other examples include solar water heating systems, which provide water heated by the sun to buildings, reduce and sometimes eliminate the need for traditional water heating, and greatly reduce the building's energy consumption.[891]

Photovoltaic generation, commonly referred to as solar PV is the most common application of solar energy and involves the direct conversion of sunlight into electricity through the use of photovoltaic cells. Solar PV is then divided into two types: grid-connected solar and off-grid solar. The latter consists of generation systems that are not connected to the greater grid and instead provide electricity directly to un-electrified areas. This specific technology may not be of widespread use in Guam as the island is reported to be one hundred percent electrified, meaning that all areas have access to power utility connections. Nevertheless, off-grid solar may be helpful for certain commercial and residential applications.[892]

888 Volker V. Quaschning, *Renewable Energy and Climate Change*, 2nd ed., (West Sussex: John Wiley & Sons Ltd., 2019), 11.

889 Misty D. Conrad and Sean Esterly, *Guam Strategic Energy Plan* (Golden, CO: National Renewable Energy Laboratory, 2013), 1.

890 Edenhofer, et al., Renewable Energy Sources and Climate Change Mitigation: Special Report of the Intergovernmental Panel on Climate Change (New York: Cambridge University Press, 2011), 337-343.

891 Edenhofer, et al., "Renewable Energy Sources and Climate Change, 337-343.

892 Edenhofer, Renewable Energy Sources," 351-354.

Wind Energy

Wind energy consists of technology in which the kinetic energy of the earth's winds is converted into usable power. The power of the wind is harnessed through the use of wind turbines, which take the energy from the movement of the wind and convert it into mechanical energy, and finally into electrical energy. Wind turbines and wind energy are divided into two categories: onshore and offshore. With onshore wind technology specifically, the average wind turbine size has grown significantly, producing a greater amount of energy, increasing efficiency and cost-effectiveness. Onshore wind turbines have almost reached peak efficiency with the current constraints of a technological and logistical nature, such as manufacturing materials and transporting large components. These onshore wind turbines are most commonly found together in wind power plants, otherwise known as wind projects or wind farms.[893]

Offshore wind turbines are less developed than their onshore counterparts but have potential to provide electricity while also avoiding some of the drawbacks of onshore wind turbines such as environmental noise and clutter. The main function of offshore wind energy is to provide additional areas for wind power generation, especially those in which onshore wind turbines are technically or environmentally limited. Advantages of offshore wind energy also include access to the often more powerful and less intermittent wind resources that are located offshore, along with the ability to use larger wind turbines to create larger wind farms and to provide easier access to energy than that of long-distance onshore wind farms.[894]

The production of wind energy does not emit any greenhouse gases and has very limited negative environmental effects. These negligible effects, however, are site-specific and thus hard to predict with any meaningful precision. The most notable effects are of an ecological nature and include such things as bird and bat collisions, as well as other habitat destruction and species avoidance of certain areas. Because these concerns are highly dependent on the specific site of the wind facility, considerations must also be site-specific and zoning policies must be implemented to prevent any detrimental impact to ecosystems. Offshore wind energy facilities face the same concerns with marine life, which may be impacted by underwater sounds, vibrations, and habitat loss.[895]

Guam currently has a single small-scale 275 kW wind turbine that became operational in March 2016 and was funded by a $2.1 million US Department of the Interior grant. The wind turbine produces enough electricity to power approximately fifty homes.[896] The turbine, located in southern Guam, is primarily used as a pilot program for Guam's potential widespread use of the technology. The wind project has been helpful to the Guam Power Authority in providing valuable experience and lessons that can be applied to potential future wind energy projects. Guam has not explored any offshore wind energy possibilities. However, a 2011 feasibility study found viable but unverified sites for up to twenty MW of wind

893 Edenhofer, "Renewable Energy Sources," 539-549.

894 Edenhofer, "Renewable Energy Sources," 553-554.

895 Edenhofer, "Renewable Energy Sources," 570-576.

896 Guam Power Authority, "Briefing for Commissioner Limtiaco," 2019, 20.

energy, as well as sites for one MW-to- five MW small-scale projects throughout the island.[897] In regard to the potential expansion of the overall wind resource, Guam's unique climate must be considered in the context of wind energy. Of great concern is the survivability and operational capability of wind turbines during extreme weather events such as tropical cyclones. The turbine has been inoperable since June 2020 due to COVID-19 pandemic-related limitations with the contractor operating the turbine. Under normal operations, GPA periodically takes the wind turbine down to protect against damage from high-speed sustained winds associated with tropical cyclones.

Hydropower

Hydropower includes technology in which power is generated from the energy of water moving from higher to lower elevation. Hydropower can be used in both centralized and distributed/isolated applications. The three main types of hydropower technologies are: run-of river-systems—there is no storage element and generation is dependent on the natural cycle and structure of the watershed; storage systems—a storage component is used to contain water and regulate its flow often serving a secondary purpose by acting as a regulator of water for such things as flood control or irrigation; pumped storage systems—water is pumped into a storage reservoir and the water's flow is reversed to create energy; and in-stream systems using existing facilities—turbines can be installed at natural/existing water streams such as weirs, barrages, canals, or falls, to capture energy. Despite hydropower's proven track record and relatively advanced technological status, there still remain areas of improvement, especially in regard to optimization, increased efficiency, and greater cost-effectiveness. Some concerns remain over its potential environmental effects, specifically water quality, biodiversity, the transportation and deposition of sediment, and microlevel ecological impacts.[898]

The negative effects of climate change are expected to have subsequent effects on hydropower sources. These effects come in the form of changes in river flow due to precipitation or temperature, increases in the frequency of extreme weather events, and changes in the composition of sediment in bodies of water. Although these effects may have a limited impact globally, they have the potential for a greater detriment at the regional or local level. The availability of water resources due to climate-change induced increases in water demand of irrigation, household, and industrial users is also a concern.[899]

Ocean Energy

Although there currently exists no application of ocean energy operating in Guam due to the lack of commercial-scale applications, the energy of the Pacific Ocean may potentially be a source for energy

897 Ian Baring-Gould, et al., Guam Initial Technical Assessment Report, 2011, 30, accessed at https://www.nrel.gov/docs/fy11osti/50580.pdf.

898 Edenhofer, et al., "Renewable Energy Resources," 474-476.

899 Edenhofer, "Renewable Energy Sources," 437-496.

production in Guam. Ocean energy refers to energy derived from technologies that either utilize seawater as their main source of power or harness the water's chemical or heat energy. There are six main classes of ocean energy technologies: wave energy; tidal range; tidal currents; ocean currents; ocean thermal energy conversion; and salinity gradients. Regardless of type, wave energy offers significant potential for long-term carbon emissions reduction but has not achieved widespread use due to its various technologies being in the very early stages of development.[900]

Wave energy is a type of ocean energy derived from the transfer of the kinetic energy of wind to the upper surface of the ocean. During this energy exchange, some kinetic energy from the wind is transferred to ocean water, producing waves that carry potential energy. This potential energy is then captured by wave energy technologies, which vary in design, but achieve the same effect of generating energy from the motion of ocean waves.[901]

Tidal range is quite similar to wave energy but instead of capturing energy from the movement of waves, tidal range energy is dependent on changes in the height of the ocean, which are caused by natural gravitational and rotational forces along with other forces. Most tidal range developments are centered around shallow-watered areas such as estuaries or tidal lagoons. As these coastal basins fill and empty, energy is collected from the changing height of the water level. Tidal currents and ocean currents follow very similar concepts, taking advantage of the horizontal movement of water which is itself affected by the tide. Tidal current and ocean current energy differ from wave energy in that the latter captures the energy from the movement of surface water while the former captures energy from any movement of the water, including movement well below the surface. Tidal current energy refers more to the movement of water close to the shore found near coasts or other constrictions, such as islands, while current energy refers to the flow of currents found on the open ocean farther away from the coast.[902]

Unlike the previously mentioned types of wave energy, which focus on the movement of the oceans waters, ocean thermal energy conversion (OTEC) takes advantage of the fifteen percent of total solar output that is retained as heat by the oceans. This heat energy is mostly absorbed by the top layers of the ocean, with less and less heat energy penetrating the ocean as depth increases. Due to the relative newness of wave energy, there are limited studies on both short-term and long-term harmful environmental impacts. Nevertheless, ocean energy development may affect things such as available ocean space for competing users and marine habitats. All of the aforementioned technologies are currently undergoing development to increase their feasibility, efficiency, and cost-effectiveness.[903]

In regard to the potential effects of climate change on ocean energy resources, although studies are limited, it is expected that changes in the temperature and temperature gradient of ocean water, as well as salinity, sea level, and wind patterns will have some effect on the effectiveness and productivity of ocean energy technologies.[904]

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900 Edenhofer, "Renewable Energy Sources," 501-528.

901 Edenhofer, "Renewable Energy Sources," 501-528.

902 Edenhofer, "Renewable Energy Sources," 501-528.

903 Edenhofer, "Renewable Energy Sources," 497-534.

904 Emilio Cerdá and Kerpa Solaun, "Climate change impacts on renewable energy generation. A Review of quantitative projections," Renewable and Sustainable Energy Reviews 116 (2019: 2-16, https://reader.elsevier.com/reader/sd/pii/S1364032119306239?token=53B99597C4D45D3F87527F6843F1DEAF88F5F75ECBCE92FEBE87CCA1707FABE27FB5FEF601EC84FFDEB6244AC100179B.

Geothermal Energy

Geothermal energy consists of thermal energy from within the Earth's interior that is stored in rock and trapped steam or liquid water. Thermal energy is used for either direct heating or electricity generation. Sources used by geothermal energy production are naturally replenished by earth processes. When combined with modern management techniques, this natural replenishment makes geothermal energy a reliable, sustainable, and low-emission renewable resource. Geothermal energy is a very mature and reliable resource, with certain types of technologies having been in use for over a century. In addition, geothermal energy is currently used in twenty-four countries as a baseload electric generation source. There are two main types of geothermal electrical generation technologies, hydrothermal and enhanced geothermal system/engineered geothermal systems (EGS), both of which harness energy by extracting geothermal energy through wells or other means that produce hot fluids. The main difference between hydrothermal and EGS technologies is the method of extracting the energy from the Earth, with the former only making use of areas of naturally occurring near-surface heat with high rock permeability and the latter making use of artificially created pathways that improve the natural permeability of rock by injecting water into the subsurface.[905]

Direct use geothermal energy provides heating and cooling for various applications including buildings, fishponds, greenhouses, bathing and wellness facilities, swimming pools, and industrial facilities. This direct heating is provided through either an open loop system or a closed loop system. With the former, the steam itself is extracted and circulated through radiators. The former uses a heat exchanger to circulate heated freshwater through radiators. Direct use geothermal has wider use throughout the world, with seventy-eight countries using the technology as of 2009. Like all renewable resources, geothermal energy comes with some potential negative environmental impacts, including the possibility of the release of harmful gases from the earth into the atmosphere and surrounding environment, along with local hazards, such as microearthquakes, steam eruptions, and ground subsidence. In addition, emissions of CO2 from geothermal energy come from naturally occurring sources. These potential impacts, however, are manageable and avoidable with good implementation and maintenance practices and are site and technology specific.

There currently exist no applications of geothermal energy technology in Guam. A reconnaissance assessment of Guam's geothermal potential was conducted in 2010 by a team from the National Renewable Energy Laboratory and the US Navy's Geothermal Program Office. The assessment found that although Guam lies on "a regional trend of high heat flow…Guam is not, and has not been [active], for millions of years." Nevertheless, the assessment found evidence that suggests that "geothermal fluids are present in the subsurface in Guam."[906] A further feasibility assessment is required to understand the potential application of geothermal technology.

905 Office of Energy Efficiency & Renewable Energy, "How an Enhanced Geothermal System Works," accessed at https://www.energy.gov/eere/geothermal/how-enhanced-geothermal-system-works.

906 Baring-Gould, et al., "Guam Initial Technical Assessment Report," 38-39.

Bioenergy

Bioenergy consists of the conversion of the organic material from plants and animals into usable energy. Sources of biomass include wood and wood processing wastes, agricultural crops and waste materials, food, yard, and wood waste, and animal manure and human sewage.[907] Biomass energy is divided into three distinct categories, based on energy efficiency and sector of use. First, low-efficiency traditional biomass includes wood, straws, dung and other manures which are used for cooking, lighting, and space heating. This use of bioenergy is mostly found among poorer populations in developing countries and comes with several effects on health due to its use as a combustion material.

The next category of bioenergy is high-efficiency modern energy. This type makes use of more convenient solids, liquids, and gases which are used to generate heat, electricity, combined heat and power (CHP), and transport fuels. Liquid biofuels such as ethanol and biodiesel are utilized in the global transport industry and other industry sectors. Lastly, high energy efficiency biomass conversion is primarily found within the industry sector, specifically the pulp and paper industry, forest products, food, and chemicals. Overall, the deployment of bioenergy is currently limited by various technological and logistical barriers, including the highly varied properties of bioenergy types and the lack of large-scale supply chains.

In regard to the potentially harmful environmental effects of bioenergy, there are some drawbacks that also come with conventional agricultural and forestry systems. Like these traditional systems, bioenergy can increase soil and vegetation degradation due to over intensive crop and forest residue removal and water overuse. The increased output of bioenergy sources can also lead to habitat loss. These harmful effects can be prevented with strong protection policies and effective management techniques, which can then lead to positive benefits such as increased species diversity, greater soil productivity, lessened landslides, flashfloods, wind erosion, and water erosion. Bioenergy can also have negative effects on both air and water quality. However, these vary by differences in technology and bioenergy source, as well as the presence of emission reduction technologies. In addition, bioenergy is not a CO2-free source of renewable energy, as the processes of bioenergy are a part of Earth's carbon cycle. Aside from this, bioenergy consumption also emits CO2 from auxiliary energy use and small-scale bioenergy use.

A 2011 feasibility study found municipal solid waste, landfill gas, anaerobic digestion, and biomass feedstocks to be potential sources of bioenergy for Guam. The feasibility study recommended further exploration of waste-to-energy, biodiesel/vegetable oil, and to a lesser extent, landfill gas, as the most feasible sources of bioenergy for the island.[908]

Challenges of Renewable Energy

Despite its many benefits, the implementation and use of renewable energy has its challenges. These challenges include adapting technology to the unique island environment; transporting the necessary

907 US Energy Information Administration, "Biomass explained," accessed at https://www.eia.gov/energyexplained/biomass/.

908 Baring-Gould, et al., "Guam Initial Technical Assessment Report," 37-46.

resources; and having the technical experience to implement and manage renewable energy systems. Unique conditions such as storms, floods, and salt-heavy winds will require more frequent maintenance and replacement.[909] Currently, research is being conducted by renewable energy companies to find new materials that work best in an island environment. Lastly, the lack of a specialized workforce with the technical knowledge to manage renewable energy systems can also be prohibitive to the greater expansion of renewables.[910]

Guam's geographical location makes the island subject to the many extreme weather phenomena that are found in the region. These include heavy rains, tropical storms, typhoons, El Niño-Southern Oscillation (ENSO), etc. Since 1962, Guam has been hit by seven category four[911] hurricanes, or tropical cyclones commonly referred to as typhoons, and six category-five hurricanes).[912] When combined with Guam's geographic isolation, the need for electrical infrastructure that can withstand the effects of these extreme weather and geological events is foundational for infrastructure sustainability. This infrastructure includes all aspects of the electrical grid, including generation, transmission, and distribution. Any upgrades to Guam's power system must take into account the resiliency needs of the island as well as the numerous efforts by public utilities to strengthen the power system and ensure the delivery of electricity to consumers. In the event of extreme weather events or the harmful effects of climate change, failure to consider resiliency in the implementation of renewable energy systems will prove ultimately detrimental to the island's overall power system and its path toward becoming one hundred percent renewable.[913]

Statehood

If Guam were to be a state, this would mean a closer relationship with the federal government, with continued federal funding and access to federal programs. The federal government offers support for utility-scale electricity production in four different ways: providing funds through grants and incentives; assuming risk by offering direct loans; forgoing revenues through tax deductions and credits; and providing federal assistance in the event of disasters.[914] Reducing developers' costs to build renewable projects has had the effect of lowering utility prices for ratepayers. It is important to note that the beneficial effects were brought on by the use of federal assistance programs in conjunction with state assistance programs.[915] As a state, and in order to achieve the same effects, Guam would have to rely upon ratepayers as an additional funding source that can be used in combination with federal assistance initiatives.

If Guam were to become a state, the potential increase in military activity is another important factor

909 Robert Kay and Charlotte Cherry, Empowering Renewable Energy Development in Pacific Island Countries *Climate Links*, 2018, 1.

910 Kay and Cherry, "Empowering Renewable Energy Development," 1.

911 Hurricanes/tropical cyclones are ratted according to the Saffir-Simpson Hurricane Wind Scale, as follows: Category 1- 74-95 mph; Category 2- 96-110 mph; Category 3- 111-129 mph; Category 4- 130-156 mph; Category 5- 157 mph or higher

912 Guam Power Authority, "Resiliency of Guam's Electric Utility," 2019, 4.

913 Guam Power Authority, "Resiliency of Guam's Electric Utility," 2019, 4.

914 Joy Baudin, "State and Federal Supports for Utility-scale Electricity Generation and Renewable Energy Projects: An Examination," (New York, NY: Nova Science Publishers, 2016), 11.

915 Baudin, State and Federal Supports for Utility-scale Electricity,"11.

to consider, as the island's power system would need to accommodate any increase in the military's energy needs. Currently, the military consumes about twenty percent of the island's energy and is GPA's largest customer.[916] With the planned transfer of five-thousand marines and their families to Guam as part of the US Department of Defense's Military Relocation program, this demand for electricity is expected to increase. The Department of Defense (DoD) anticipates that the island's power system will not require upgrades in order to sustain the increased demand. DoD, in the 2015 Final Supplemental Environmental Impact Statement (SEIS), anticipated that "current generation capacity on Guam would be adequate and no power generation upgrades would be required."[917] This likely remains the case, as Guam's energy production capacity has expanded since the publication of the report.

Although upgrades may not be necessary, "to comply with Marine Corps sustainability goals, a portion of the power demand would be satisfied by power generated from renewable energy sources, to include photovoltaic solar panels on rooftops and approximately twenty acres"[918] within the newly planned facilities. In addition, the military also projects upgrades to transmission infrastructure to ensure compatibility of new generation systems with the existing power system.[919] DoD has also committed to several sustainable practices on the demand side, such as "smart metering and controls, solar street lights and parking/playground lighting, low flow fixtures, and new and retrofitted buildings to LEED Silver design standards."[920] The Department of the Navy plans to construct solar panels in about twenty acres of land in military housing areas, growing the island's renewable portfolio and overall energy production.[921] Although such increases in energy production capacity will likely be exclusively used by the military, the increase may reduce the military's demand for energy supplied by GPA.

By becoming a state, Guam would be grouped with the other states in terms of applicability of federal legislation. The applicability of US laws to Guam is an important aspect to consider, especially in regard to renewable energy, as Guam has unique geographic and natural resource characteristics. Legislation that might be effective in all or most of the states may prove ineffective and detrimental to Guam's unique situation.

916 Deloite & Touche LLP, "Financial Statements, Additional Information, and Independent Auditors' Report," last modified April 16, 2018, 1.

917 Naval Facilities Engineering Command Pacific, "Guam and CNMI Military Relocation: Final Supplemental Environmental Impact Statement," July 2015, accessed at http://guammarines.s3.amazonaws.com/static/SEIS/Download%20Final%20SEIS%20as%20a%20Single%20Document.pdf.

918 Naval Facilities Engineering Command Pacific, "Guam and CNMI Military Relocation: Final Supplemental Environmental Impact Statement," July 2015, accessed at http://guammarines.s3.amazonaws.com/static/SEIS/Download%20Final%20SEIS%20as%20a%20Single%20Document.pdf.

919 Naval Faciliteis Engineering Command Pacific, "Final Supplemental Environmental Impact Statement: Guam and Commonwealth of the Northern Mariana Islands Military Relocation 2012 Roadmap Adjustment," 2015, 2-12, accessed http://guammarines.s3.amazonaws.com/static/seis.html.

920 Naval Facilities Engineering Command Pacific, "Final Supplemental Environmental Impact Statement 2012 Roadmap Adjustment," 8-11.

921 Naval Facilities Engineering Command Pacific, "Final Supplemental Environmental Impact Statement 2012 Roadmap Adjustment," 8-11.

Status Example: Hawai'i

State-level Policies: The state of Hawai'i's implementation of state-level policy highlights the role that government-led policies can play in shaping and effectuating a state's energy goals. Although all of Hawaii's electricity is managed and provided by two private corporations, government policies have played a critical role in Hawai'i's pursuit of renewable energy. For example, in 2006, several legislative and executive policies were implemented to make Hawai'i's state agencies spearhead energy conservation and independent generation efforts. This effort, coined the *Lead by Example* (LBE) initiative, led to a 16.1 percent decrease in electricity purchased by state agencies from 2005 to 2018. This significant drop in energy use directly translates into lessened demand and a greater ability to provide more of Hawai'i's electricity from renewable energy sources. Similar to the LBE program is the 2015 decision by the Hawaii State Building Code Council (SBCC) to adopt the International Energy Conservation Code (IECC) 2015, along with the Tropical Climate Zone Code for residential buildings. These changes, inclusive of Hawai'i-specific amendments, were implemented statewide as of April 1, 2019 and are estimated to have saved 12,962 MWh in 2019.[922] The implementation of an international standard stands as an example of how, even as a state, Guam could adopt international standards locally that would contribute to greater renewable energy growth and energy savings.

Assistance from US Government Agencies: As a state, Hawai'i receives various forms of federal assistance in support of its renewable energy goals. This assistance ranges from simple technical assistance programs to large-scale partnerships, tax credits, rebates, and grant opportunities. The Hawaii Clean Energy Initiative (HCEI) of 2008 is the most notable of federal partnerships. This partnership consists of a long-term memorandum of understanding between the Hawai'i and the US Department of Energy. The HCEI is credited with Hawai'i's significant growth in its renewable energy portfolio levels and future growth standards, along with the major goals of reducing electricity by 4,300 gigawatt-hours by 2030 and reducing overall petroleum use in the transportation sector. In 2014, both parties recommitted to the partnership, expanding the program and set the nation's first-ever goal of one hundred percent renewable energy by 2045.[923]

Like Hawai'i, Guam could be included in programs the federal government provides to all states. Statehood, and the increased representation that comes with it, would have the additional benefit of being eligible for state programs unavailable to territories.

922 Dan Cross-Call, J. Prince, and P. Bronski, "Powering Paradise," 2020, accessed at https://website.kiuc.coop/sites/kiuc/files/documents/rmi_powering_paradise%20%28002%29.pdf.

923 Hawaii State Energy Office, "Transforming Power In Paradise: The Hawaii Clean Energy Initiative." 2017, accessed at http://www.hawaiicleanenergyinitiative.org/wp-content/uploads/2015/02/HCEI_FactSheet_Feb2017.pdf.

Independence

If Guam were to become an independent country, the various factors of renewable energy would be dependent on policies and actions by the government of Guam. Independence would give Guam the greatest control over the entirety of its affairs. This full range of decision-making power would provide opportunities for Guam to take advantage of the many benefits of renewable energy.

Guam, as an independent country, would be able to join international and regional organizations as a sovereign country. Beyond the benefits of international organization participation, an independent Guam would be able to participate with other countries on the international stage. Guam would have a wide-ranging ability to form partnerships with other countries in support of its renewable energy goals. These partnerships would be created and defined based on negotiations between sovereign countries and could come in the form of technical assistance, financial assistance, project collaboration, etc.

An independent Guam would have the ability to reform and restructure existing laws and standards surrounding renewable energy, enabling the island to enact policies that promote renewable energy growth. Although legal reform presents an opportunity for Guam to tailor its legal policy and environmental standards to be considerate of the island's unique circumstances, there also remains the possibility that Guam transitions away from current US-based environmental standards. The application of some US standards, such as the US EPA's RICE-MACT and EGU-MACTT emissions standards, have proven critical in furthering Guam's overall environmental sustainability. Under US EPA standards, GPA accrued approximately $600 million in regulatory penalties due to non-compliance, but negotiated a settlement consisting of a one-time penalty fee of $400,000 and a commitment by GPA to construct a new power plant, decommission several aging existing plants, and construct one hundred MW of solar PV production.[924] These US EPA standards were an important driver in the CCU and GPA's decision to build new, energy-efficient, renewable-friendly generation facilities.[925] An independent Guam could also work toward crafting more stringent standards that are considerate of the island's unique situation.[926]

Status Example: Fiji

As is the case with most other Pacific Islands, Fiji's energy production is heavily dependent on imported fossil fuels, subjecting the island to global hydrocarbons price and supply fluctuations. Fiji, however, has an impressive renewable energy portfolio, with energy being produced by hydro, geothermal, wind, biomass, and solar generation sources. As an independent country, Fiji has authority to implement policies in pursuit of renewable energy. Similarly, in terms of external affairs, Fiji is able to engage with regional organizations, international organizations, and other countries as an equal partner in order to gain support

924 Pacific Daily News, "Guam Power Authority to pay $400K in penalties as part of consent decree," *Pacific Daily News*, February 7, 2020, accessed at https://www.guampdn.com/story/news/local/2020/02/06/gpa-guam-power-authority-epa/4685366002/.

925 Guam Power Authority, "Powering the Future: Guam's Energy 2020," 2020, 2-4.

926 Personal Communication with Guam Power Authority (GPA) General Manager Director John Benavente and GPA Assistant General Manager Tricee Limtiaco, January 2020.

for its renewable energy goals.

The success of the renewable energy sector in Fiji is aided by external financial assistance from international organizations, regional organizations, and individual countries. In terms of international financial support, Fiji recently received approximately $21 million from the World Bank's International Development Association (IDA) to support its developmental goals, one of which is renewable energy. In addition, the IDA and the World Bank have reclassified Fiji as a preferred country for funding eligibility, making available finance terms of zero percent interest, a ten year grace period, and a forty year maturity period.[927] Another World Bank-backed program is the Sustainable Energy Financing Project (SEFP), an initiative that provides incentive packages to Fijian banks to encourage investment in the renewable energy.[928] Regional organizations also play a role in Fiji's renewable energy sector. Most notably, the Asian Development Bank (ADB) has provided over $593 million in loans, grants, and technical assistance programs since it began supporting Fiji in 1970. Of that $593 million, $40 million went toward renewable energy developments through programs such as the Pacific Renewable Energy Program.[929] This financial support has encouraged private investment in Fiji's renewable energy field, which has ultimately led to an increased supply of renewable energy and greater self-sustainability among power utility companies.[930]

If Guam were to become an independent country, there would be few limitations on its exercise of external affairs, which would support renewable energy development.

Challenges in Fiji: Fiji faces the same challenges in renewable energy development as many other Pacific Island countries, including the high cost of transportation of renewable energy project materials. Fiji has its own unique challenges, however. The first of these challenges is the limited amount of private investment in the renewable energy sector. This barrier is mostly brought on by a business climate that is unfriendly to investors and the lack of governmental policy aids. In fact, in 2020, Fiji ranked 163 out of 183 countries in the category of "starting a business" in the World Banks 'Ease of Doing Business' survey, scoring a 73.6 rating and placing it well below the Pacific average of 83.9.[931] As part of its unfriendly business climate, Fijian banks offer a limited amount of loans related to renewable energy due to their lack of familiarity with the financial aspects of renewable energy developments. Due to the uncertainty of Guam's economy following a transition to independence, the island may face challenges similar to Fiji's in getting investors and businesses to finance renewable energy initiatives. Guam would require supportive policies in easing this uncertainty and promoting investment in renewable energy and the overall economy.

927 The World Bank, "Major Boost for Fiji with Additional World Bank Support," April 26, 2019, accessed at https://www.worldbank.org/en/news/press-release/2019/04/26/major-boost-for-fiji-with-additional-world-bank- support.

928 The World Bank Sustainable Energy Financing Program, "Restructuring Paper on a Proposed Project Restructuring of Sustainable Energy Financing Program," June 12, 2007, http://documents.worldbank.org/curated/en/609811534978836010/pdf/Disclosable-Restructuring-Paper-Sustainable-Energy-Financing-Program-P098423.pdf.

929 Asian Development Bank, "Fiji: Member Fact Sheet," July 2019, accessed at https://www.adb.org/sites/default/files/publication/27762/fij-2018.pdf.

930 Asian Development Bank, "Regional: Pacific Renewable Energy Program," accessed at https://www.adb.org/projects/52329-001/main#project-pds.

931 World Bank Group, "Doing Business 2020: Economy Profile - Fiji," 2020, 6, Accessed at https://openknowledge.worldbank.org/bitstream/handle/10986/32981/Doing-Business-2020-Comparing-Business-Regulation-in-190-Economies-Economy-Profile-of-Fiji.pdf?sequence=1&isAllowed=y.

If Guam were to become independent, it will be the responsibility of the government of Guam to proactively address these areas of concern and implement policies that enable, encourage, and facilitate the continued development of renewable energy. There currently exist opportunities for assistance from the international community in support of renewable energy efforts, whether from international organizations such as the United Nations or non-governmental organizations such as the Global Climate Fund, that Guam could pursue as an independent country. These funding and technical assistance resources are further discussed in the free association section.

Free Association

Free association may come with both the positive and negative aspects related to renewable energy growth. The primary benefit of free association with the United States would be the possible economic assistance set forth in an agreement with the United States. During initial negotiations, Guam could benefit from prioritizing renewable energy development as a key negotiating item. If Guam were to secure a set amount of funding from the US in support of renewable energy growth, the island could reap long-term benefits beyond immediate financial assistance. By making use of US funds to transition to renewable energy, Guam could save local money while also furthering its environmental sustainability. This could help ensure that Guam receives adequate funding to maintain its power system, even in the event of an upswing in military activity that would likely increase the island's overall electricity demand.

A lesser, but also important aspect of free association, is the continued political and economic relationship between Guam and the US. As discussed in the independence section, a change in status would result in several economic uncertainties that would affect the willingness of businessowners and investors to do business in Guam. Guam would likely benefit from an increased interest in renewable energy projects, especially when considering an increase in US financial assistance. Like independence, Guam, in free association with the US, would likely have the opportunity to negotiate financial assistance, technical assistance, and trade agreements with other countries as an equal partner. However, although the status of free association with the United States would enable Guam to pursue a wide range of cooperative and economic agreements with other countries, the special political relationship with the US created by an agreement could potentially also restrict Guam from other areas of opportunity, such as partnering on specific projects with countries unfriendly to the United States.

Recently, the United States has recognized that, with economic provisions of its Compacts with the FSM and RMI slated to expire in the next few years unless they are renegotiated and extended, failure of the US to provide adequate financial assistance to the FAS may result in an economic and political vacuum that China is likely to fill.[932] Therefore, the nature of the US-China relationship is likely to directly affect a Guam-China relationship and dictate the level of cooperation and assistance of between Guam and China. Free association therefore comes with a potential limitation on the effectiveness of Guam's

932 Laura Sigelmann, "China's Opening to Influence the Freely Associated States," *American Security Project,* July 30, 2019, accessed athttps://www.americansecurityproject.org/chinas-opening-to-influence-the-freely-associated-states/.

international engagement, which could hinder renewable energy growth. In the event of such limitation, Guam would have to work toward rectifying any conflicts with US interests or limitations on Guam's diplomatic relationships with other countries, or alternatively, work toward receiving increased funding from the United States in support of Guam's renewable energy goals.

To understand the range of Guam's free association options, it is helpful to analyze how free association has been both beneficial and detrimental to the development of renewable energy in the Republic of the Marshall Islands.

Status Example: Republic of the Marshall Islands:

Compact Assistance from the United States: Money the RMI receives as part of its negotiated agreement is distributed to a wide range of developmental areas including renewable energy development. As an example of a specific funding project, the FY2009 Compact Infrastructure Grant provided around $1 million to the Marshalls Energy Company (MEC) for the overhaul of several powerplant generators. Additionally, from 2006 to 2013, around $15.9 million in compact funds was spent on fuel, operations, maintenance, and repair in the island of Ebeye. In addition to compact funding, the RMI can also avail of certain US departmental grants and loans. Recently, as part of renewable energy development, the RMI received a $627,000 grant from the US Department of the Interior and a $12.5 million loan to the MEC from the US Department of Agriculture.[933] While the US provides a majority of the renewable energy sector's funding, there are limitations placed on the use of the funds. As part of the grant process, although the RMI selects which projects to fund, the projects themselves must be reviewed and approved by a joint committee of RMI and US officials in an effort to promote management and accountability. Therefore, while US funding has been beneficial to the development of renewable energy in the RMI, the use of the funds comes with conditions that limit the decision-making power of the government of the RMI. Guam, as a freely associated state, would more than likely receive the same type of funding and may also be limited by the same types of restrictions.

Foreign Affairs and International Aid: The RMI is able to conduct its own foreign affairs and negotiate agreements. For this reason, international funding from countries other than the US has made up a large portion of the RMI's budget. Perhaps the greatest example of the RMI's ability to manage its own external dealings is the relationship between the RMI and Australia. The two countries have developed a formalized partnership to develop the RMI through targeted aid, technical support, and cooperative assistance. This program has been successful, achieving the creation of an RMI energy policy and roadmap and the installation of energy efficient streetlights and over 1,900 cost-saving energy meters. As a freely associated state, Guam could pursue the same type of country-to-country cooperative agreement with Australia or another country. Apart from this agreement, the RMI has received additional economic

933 Misty D. Conrad, Dan Olis, J. Ness, and Sean Esterly, *Republic of the Marshalls Islands: Energy Project Development Options and Technical Assessment*, (Golden, CO: National Renewable Energy Laboratory, 2015), 7, 22.

and technical cooperation from a wide range of regional and international organizations, including the European Union, the United Nations Development Programme, and the Asian Development Bank.

Through the 9th European Development Fund program, five Pacific islands, including the RMI received $13.81 million in aid. For the RMI, this aid went toward the installation of home solar systems ($1.5 million) and off-grid solar PV systems for six primary schools ($890,000), as well as the drafting of a national energy policy and action plan ($110,000). Another international program, the United Nations Development Programme, provided $468,000 in direct aid and assisted the RMI with securing an additional $2.7 million for poverty reduction and millennium development goals such as environmental and sustainable management. As far as regional organizations go, the Asian Development Bank (ADB) provides both direct aid and loans, policy dialogue, technical assistance, and equity investments. Since beginning its partnership with the RMI, the ADV has provided $92.63 million in loans and assisted with forty-eight technical assistance projects.[934]

Despite the many benefits of this aid, the RMI has faced challenges in the areas of communication and coordination between the RMI government, the United States, and the different international donors. Specifically, issues have arisen with how projects are funded and completed. In some cases, the efforts of the different organizations are duplicated or funding for a project is intermittent, leaving the project incomplete. To prevent similar shortfalls, a freely associated Guam would have to implement effective policy mechanisms to coordinate and streamline the use of funds in the completion of projects. Additionally, problems have surfaced in the RMI with retaining a skilled local workforce with the knowledge necessary to properly run the renewable energy systems once the international/regional donors stop providing technical assistance. Again, Guam would have to combat this challenge by implementing policies that emphasize the growth of a local technically trained labor force. This applies to independence as well.

934 Government of the Republic of the Marshall Islands, "Navigating Our Energy Future: Marshall Islands Electricity Roadmap," 2018, https://islands.irena.org/-/media/Files/IRENA/Sids/NavigatingourEnergyFutureMarshallIslandsElectricityRoadmapDecem.ashx.

RENEWABLE ENERGY	
STATUS	**EFFECTS**
Statehood	• Possibility for increased federal financial/technical assistance.

	• Membership in national organizations and greater cooperation and potential for partnership among states, such as through technical or financial assistance. • High probability of continued/increased US military activity and demand. • Complete application of federal law, with potential beneficial and detrimental applications and effects.
Independence	• Possible return of land and water and greater control over usage. Potential for increased use of land for energy production needs. • Increased partnerships with foreign countries and regional/international organizations. • Membership in country-only organizations. Possible eligibility for financial supports available to countries. • Greater control over policies and comprehensive changes. • Need for country-level environmental standards to ensure protection of resources. • Highest degree of economic uncertainty. Investment climate may limit growth of renewable energy sector.

Free Association	• Possible funding from US, other countries, and organizations for renewable energy. Great opportunities for funding from multiple sources (US and international community), that could be combined for maximum benefit and expansion of renewable energy. • Potential land/water use conflict with US interests. Further potential for joint use of land and partnership on development of production and distribution infrastructure. • Economic uncertainty/instability. Investment climate may limit growth of renewable energy sector.