US Army Corps
of Engineers ®
Honolulu District

Appendix D

American Samoa Final Watershed Plan

Environmental Analysis

July 2022

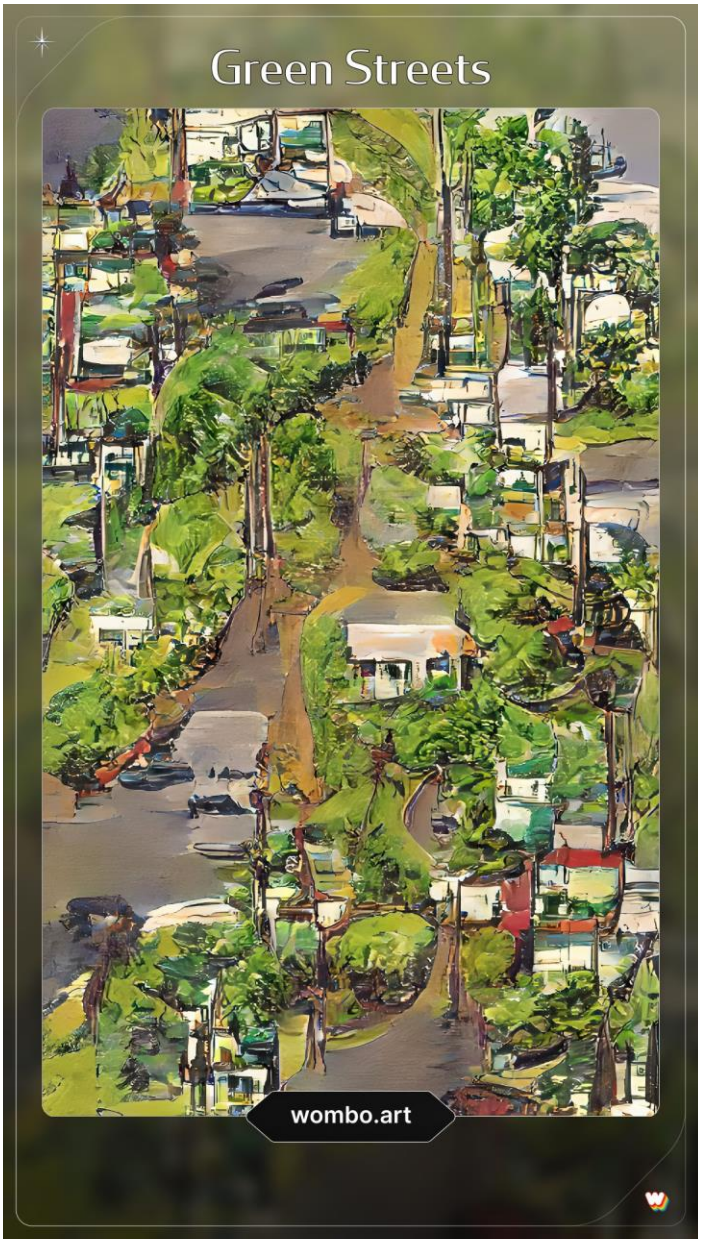


Table of Contents

1 Water Quality

This appendix dives deeper into stressors discussed in the main assessment and describes exiting conditions, problems, and recommendations in greater detail.

Water quality impacts almost all of the problems and opportunities identified in the watershed assessment. Six major stressors identified in the assessment related to water quality include nutrient loading, sedimentation, drought, stormwater management, saltwater intrusion and water-borne pathogens.

American Samoa covers roughly 76.1 sq. miles. Tutuila is the most populated of the Samoan islands and contains 33 of the 41 watersheds. There are two on Anu'u, and six on Ofu, Oosega, and Ta'u. Of the 41 watersheds 28 are classified as impaired by the EPA, Figure 1-1. The ASEPA surface water quality data collection and classification program used in Figure 1-1 can be found at http://www.pacificrisa.org/resources/publications/. Due to the topography (narrow coastal plains and steep volcanic, rocky mountains) land-based sources of pollution are a persistent problem for water quality in American Samoa.

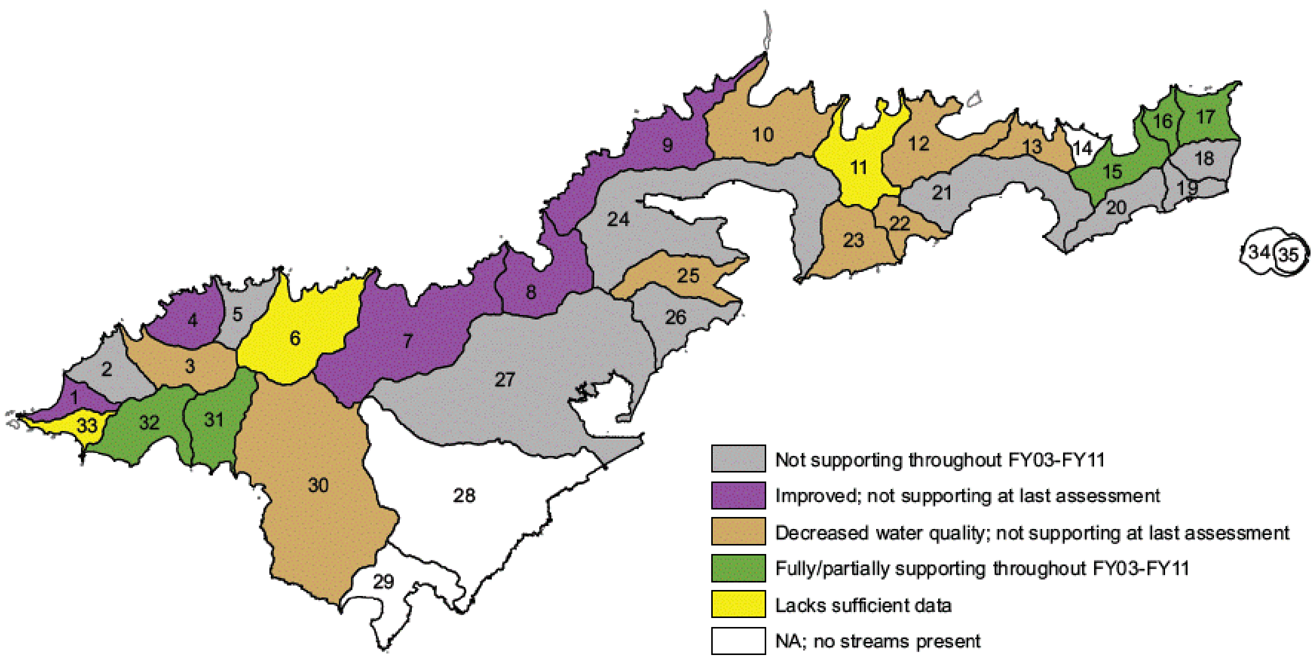


Figure 1-1. Tutuila Watersheds Water Quality Classification (PRISA, 2016)

One challenge associated with water quality is on-site disposal systems (OSDS) and cesspools. Cesspools are bottomless concrete containers open to the ground, Figure 1-2. OSDS rely on soil-based treatment systems through percolation of wastewater to remove contaminants, Figure 1-3. Cesspools have been used for many years in American Samoa for managing human residential waste and are widely used for piggeries on the Tafuna coastal plain and in many of the valleys. Figure 1-4 shows the approximate location for OSDS in Tutuila and Anu'u.

Animal waste facilities and piggeries historically were built near waterbodies, Figure 1-5. When these areas were cleaned, polluted water was directly discharged into the local waterways leading to high bacteria loading in streams and ultimately in bays or the ocean.

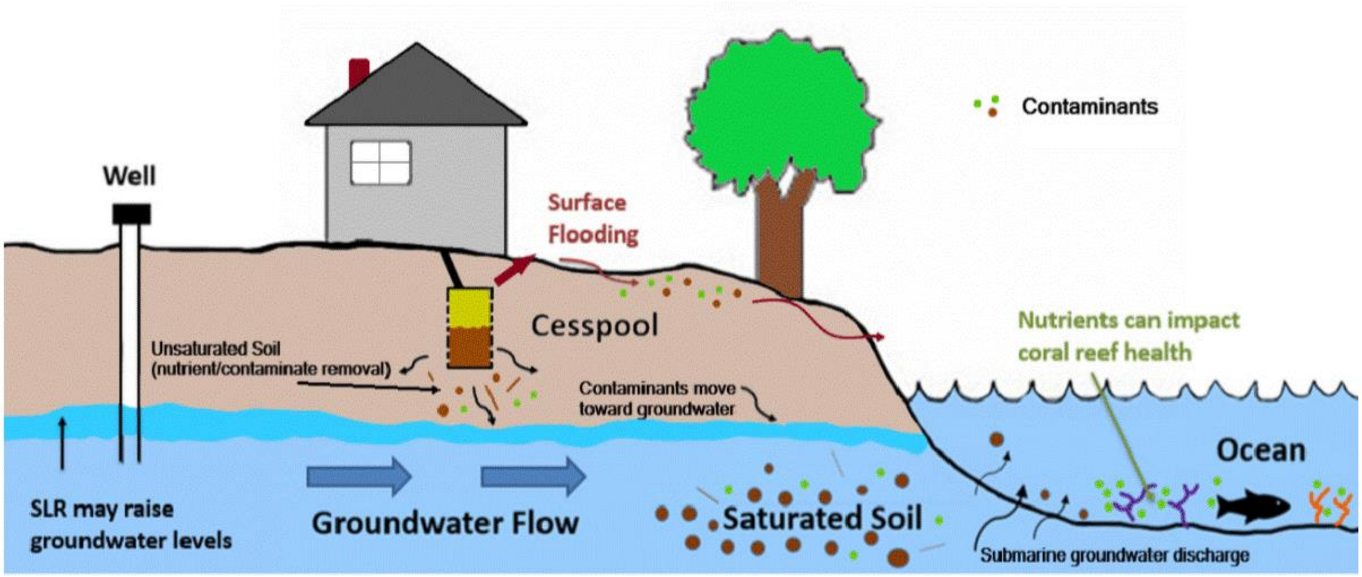


Figure 1-2. Diagram of a Cesspool system

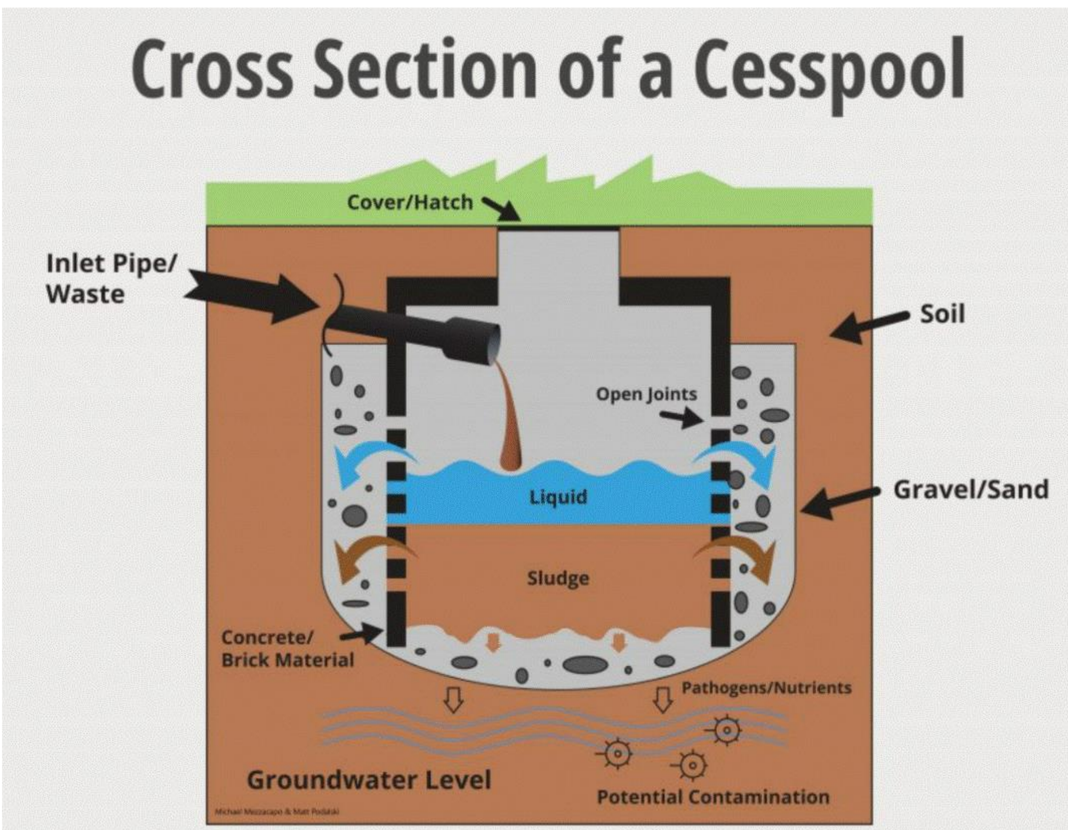


Figure 1-3. Cesspool Cross-Section (Potty Portal — Wastewater Alternatives and Innovations (waicleanwater.org)) (Michael Mezzacapo)

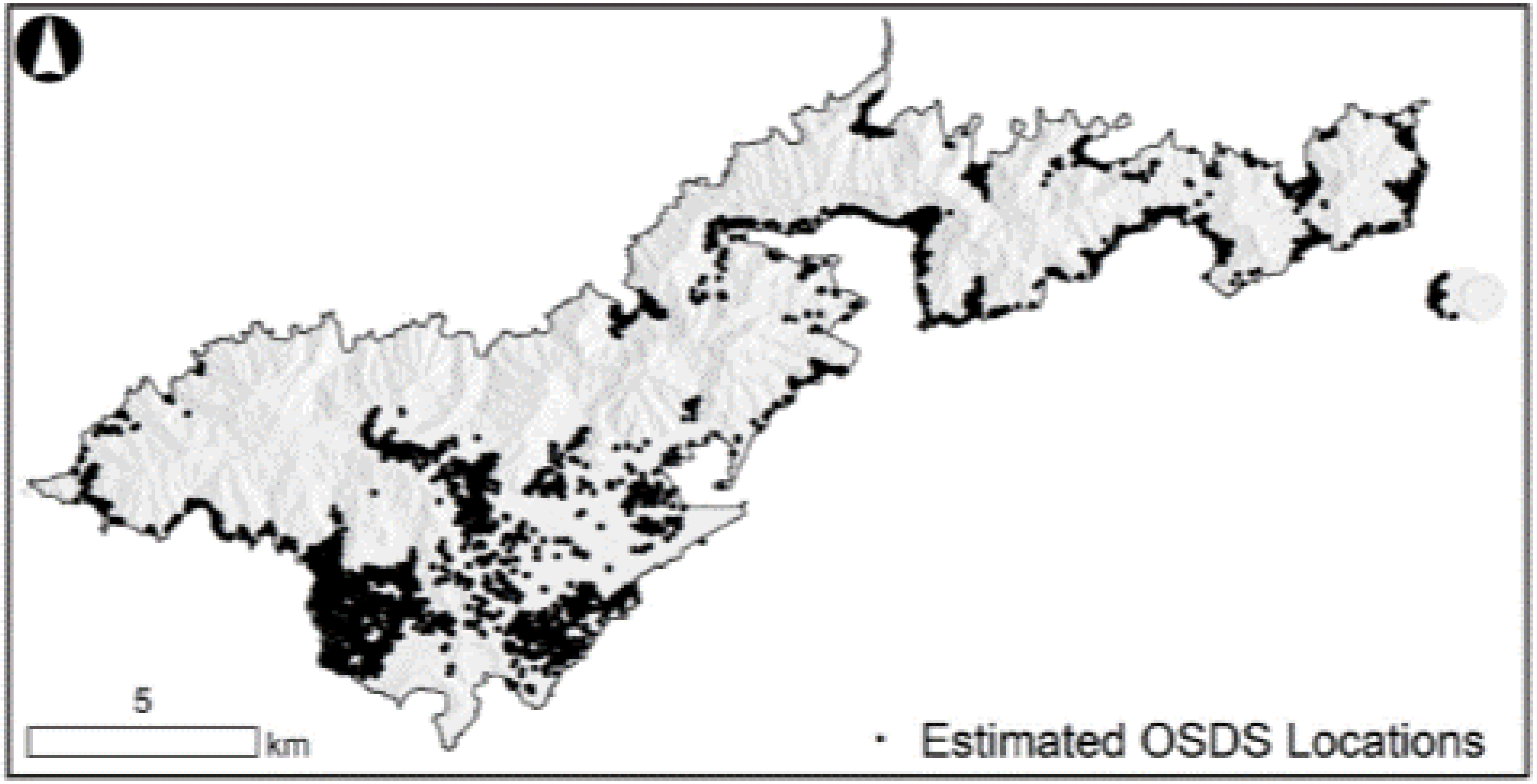


Figure 1-4. Estimated OSDS Locations (Shuler, 2020)

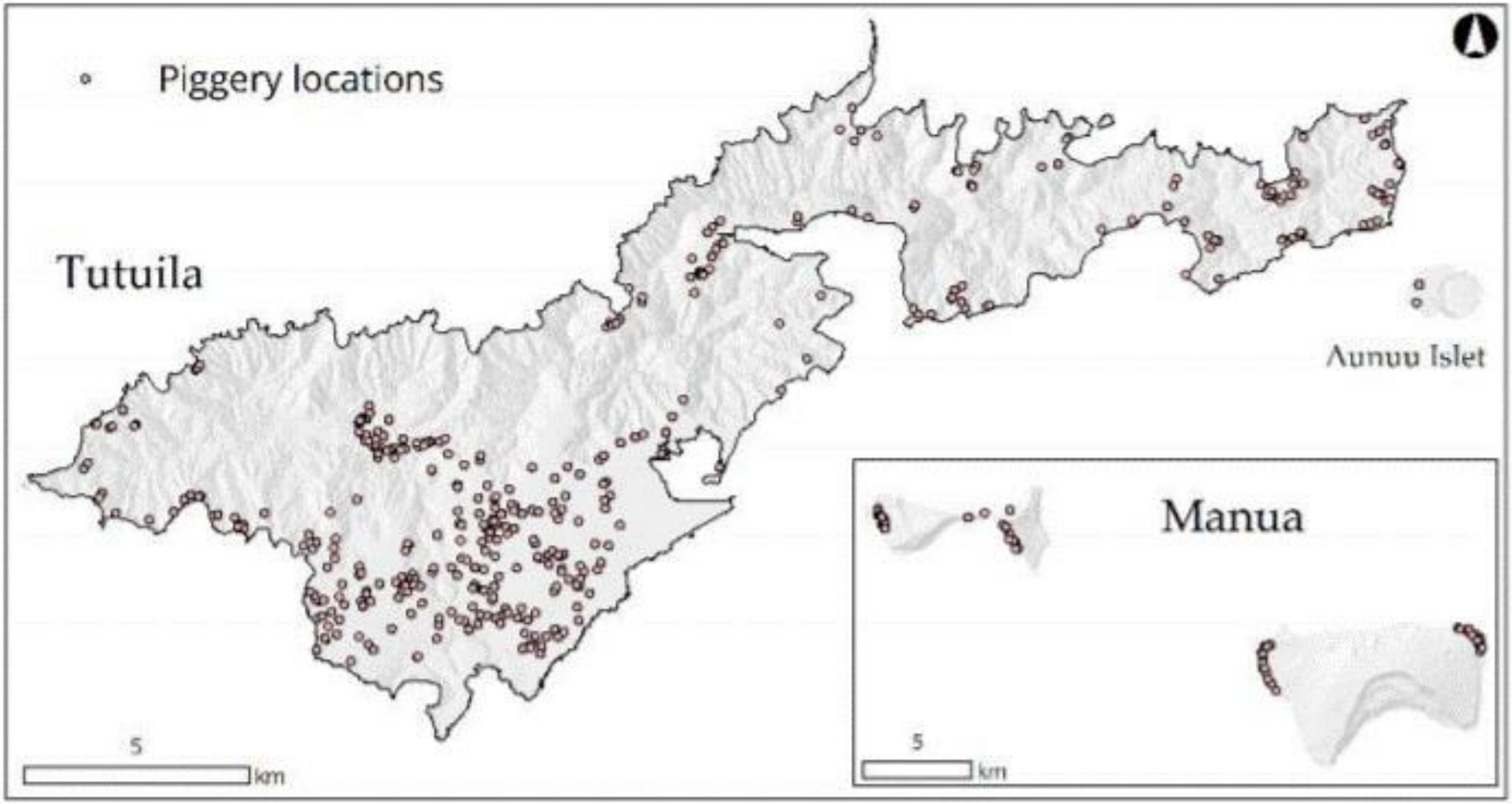


Figure 1-5. Piggery locations (ASPA, 2018)

The American Samoa Power Authority (ASPA) is expanding sewer systems on Tutuila and cesspools will no longer be needed for most human residences. However, there are no plans currently to eliminate the use of cesspools for piggery manure. With EPA support, ASPA has concurrently converted approximately 260 cesspools to septic tanks since 2006 (ASEPA, 2019). OSDS and cesspool systems were found to be unreliable and prone to leaking bacteria, viruses, and other contaminants during heavy rainfall events. The ASEPA is working with local stakeholders to prioritize safe drinking water access for all through the following actions:

- Reduce the percentage of treated water that does not produce revenue from as high as 73% down to 59%.
- Shutdown two contaminated drinking water wells and lift boil water notices for over 6,500 residents.
- More readily spend millions of dollars in EPA funding for critical drinking water and wastewater infrastructure by employing more local contractors and bolstering local economic opportunities.
- Conduct a Groundwater Exploration Plan to identify and prioritize safe sources of drinking water and help increase the island's resilience to sea level rise and drought.
- Assess contamination at a brownfield site (the former Rainmaker Hotel) to allow for redevelopment and support economic recovery. https://cfpub.epa.gov/bf_factsheets/gfs/index.cfm?xpg_id=11752&display_type=HTML

Solid waste, i.e., improperly disposed of trash, is another source of pollution in open coastal waters and embayment. Pago Pago harbor is the most industrialized embayment in the Territory, with over a century of development subsequent to the creation of the Territory under the United States. As well as the sources of water quality impairments mentioned above for embayments in general, Pago Pago Harbor is affected by pollution from marina and port traffic, a small shipyard, and in the outer harbor effluent from the tuna canneries and sewage treatment plant. All point sources have National Pollutant Discharge Elimination System (NPDES) permits. Due to the segregation and transportation of cannery waste beyond the inner harbor, better treatment of sewage, and more effective monitoring and prosecution by the Coast Guard of commercial vessels that pollute the harbor, the water quality in the inner harbor has greatly improved in the last three decades. (ASEPA, 2020).

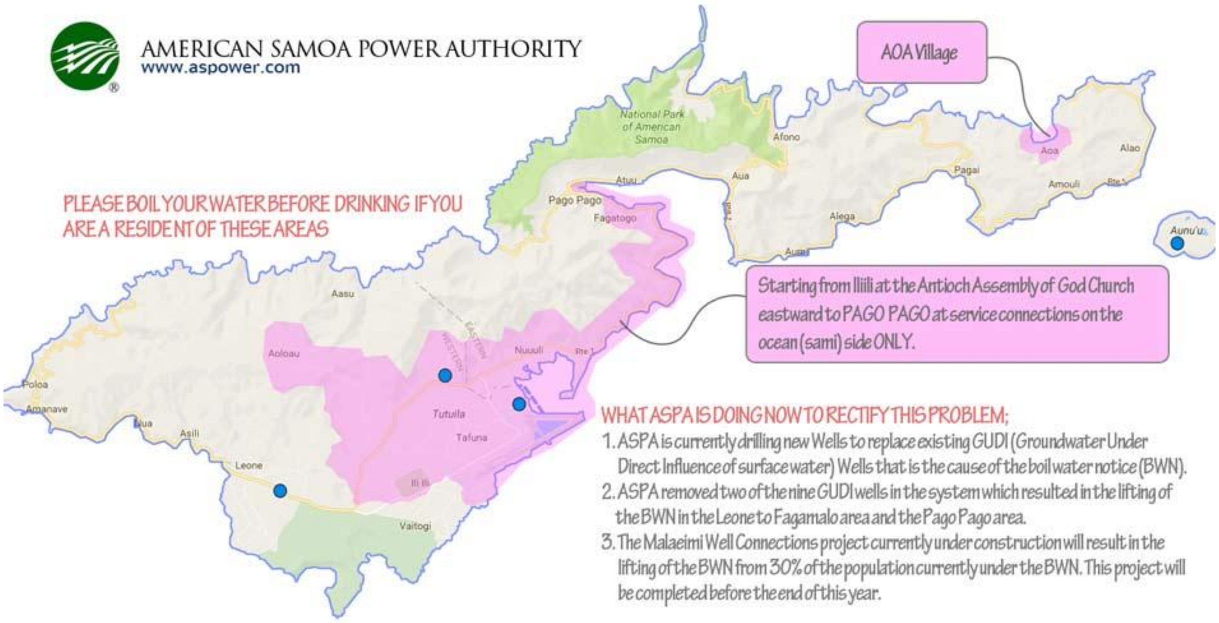


Figure 1-6. ASPA Boil Water Updates (accessed 12 Dec 21)

2 Groundwater Pollution

The Tafuna-Leone plain is the site of the majority of American Samoa's residential and business development, **Error! Reference source not found.**. It also contains most of the wells that pump groundwater for distribution. The volcanic stratum of Tutuila is highly permeable and does not have a great capacity to filter, there is a constant risk of groundwater contamination by rainwater that captures and transports pollutants into the aquifer. The greatest threats to groundwater quality in American Samoa are pesticide residues, sediment loading from land-based sources of pollution (quarry's, development), pollution from automobiles, and pathogen and nutrient pollution from poorly constructed human and pig waste disposal systems.

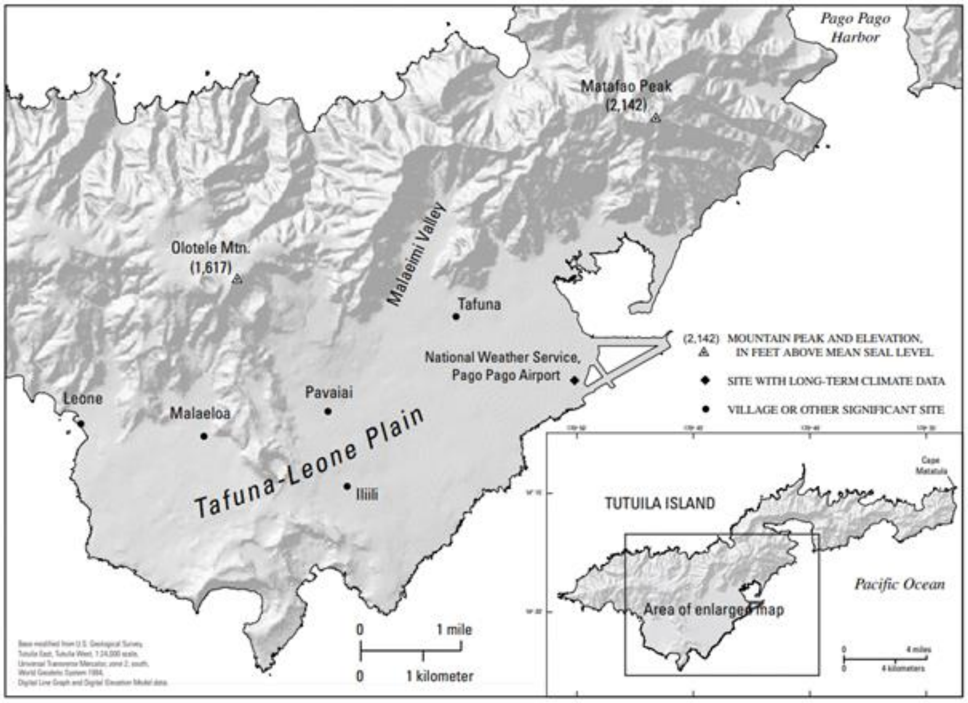


Figure 2-1. Tafuna-Leone Plain and Surrounding Areas (USGS 2007)

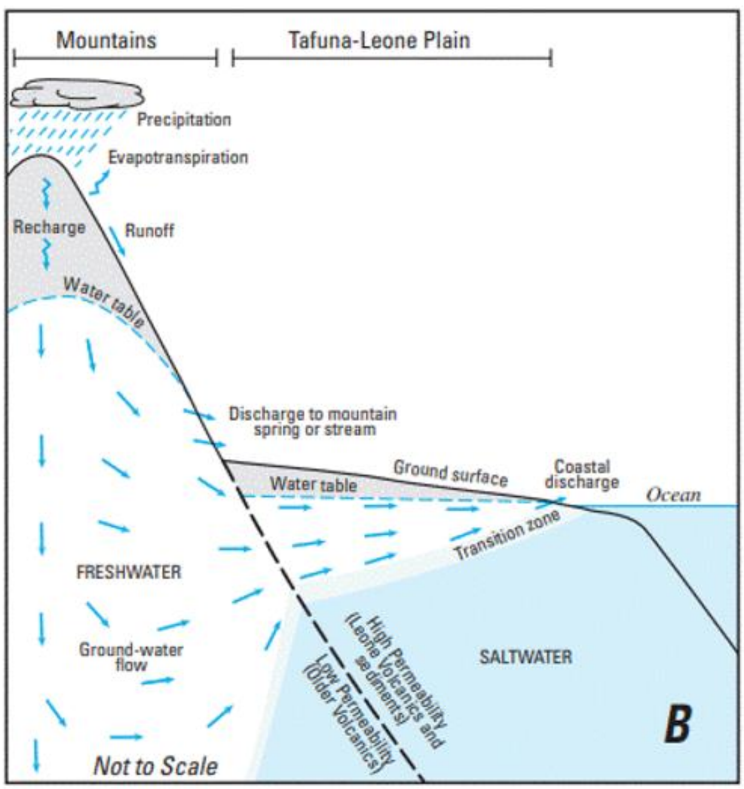


Figure 2-2. Cross-Section of Tafuna-Leone Plain Mountains and Aquifer (not to scale, USGS 2007)

3 Saltwater Intrusion

American Samoa's groundwater resources depend on rainfall. On Tutuila, where most of the territory's population resides, groundwater is stored in a freshwater lens in the aquifer (Figure 2-2) and is the source for nearly all public drinking water supplied by ASPA. To minimize upconing, the rise of saltwater into freshwater, wells should not be deeper than one-third of the thickness of the freshwater lens. In the Tafuna-Leone Plain area, the lens is believed to be approximately 120 feet thick and wells drilled in a lens of this thickness should be no deeper than 40 feet. The rate of extraction from the aquifer is significant because higher rates are much more likely to cause upconing. At the same time, dikes and layers of the older volcanic soils can trap freshwater at significant depths below sea level. Figure 3-1 shows drivers and stressors of saltwater intrusion.

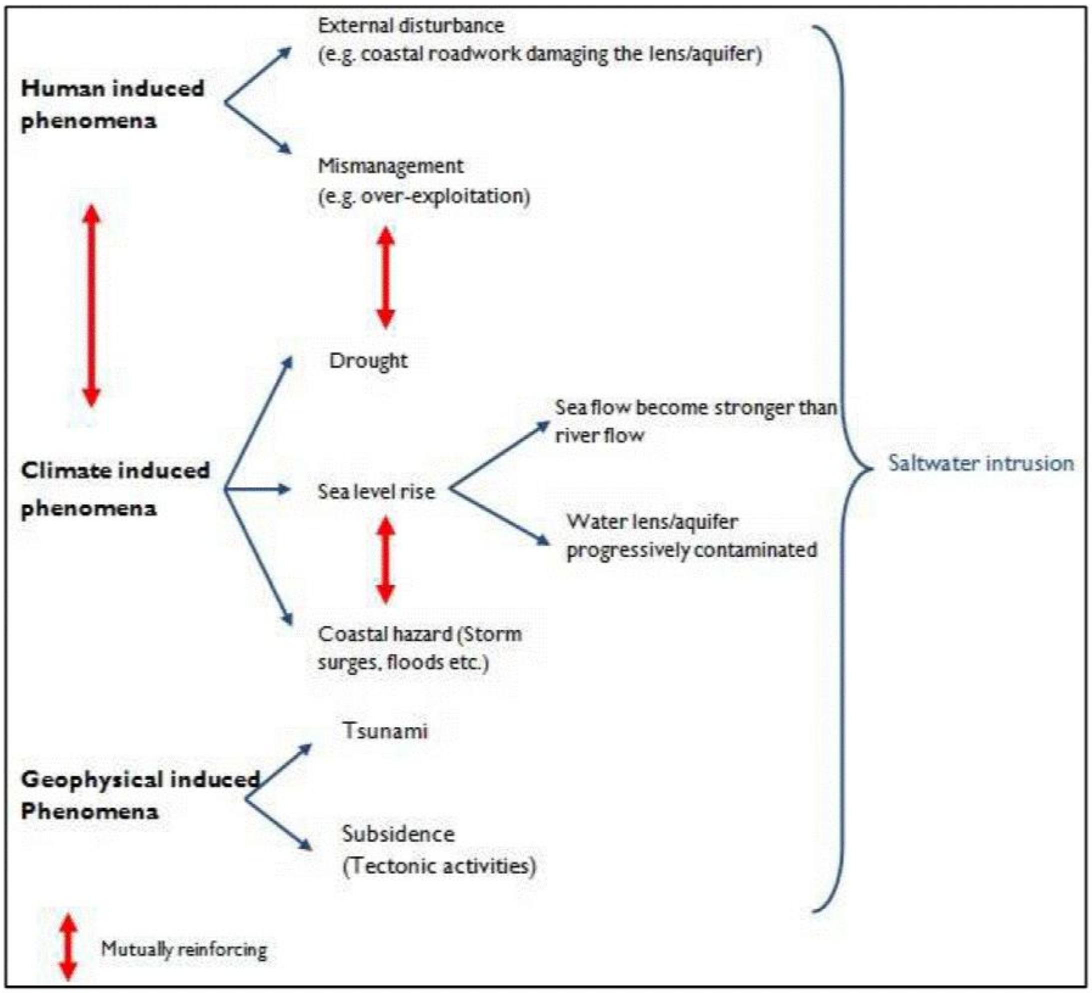


Figure 3-1. Drivers and Stressors of Saltwater Intrusion

4 Water Supply and Management

In American Samoa, municipal water production and delivery services are provided by ASPA, the island's water and power utility. Groundwater provides 99% of the island's public-supply water, and this water is sourced from wells with pumping capacities that range between 15 and 400 gallons per minute (GPM). Currently there are 44 active municipal wells on Tutuila, one active well on Aunu'u, three active wells on Tau, and two active wells on Ofu-Olosega. Once extracted, groundwater is pumped into water delivery systems, which on Tutuila consist of about 600 km (375 miles) of pipeline, 19 booster stations, 800-900 valves, and 41 water storage tanks, Figure 4-1.The main water system is interconnected across Tutuila's south shore and there are eight disconnected satellite systems with their own wells that serve some of the communities on the north shore of the island, or on separate islands such as Ofu, Olosega, and Tau. The water delivery lines are divided into about 240 km (150 miles) of main lines which range in size from 24 inches to 2 inches in diameter (with the majority of lines in the 4 to 8-inch range) and are composed primarily of PVC pipe with some older asbestos-concrete pipes. There are also about 360 km (225 miles) of service lines which are primarily 1-inch poly PE (Polyethylene) lines running between the main lines and customer meters (Shuler, 2018).

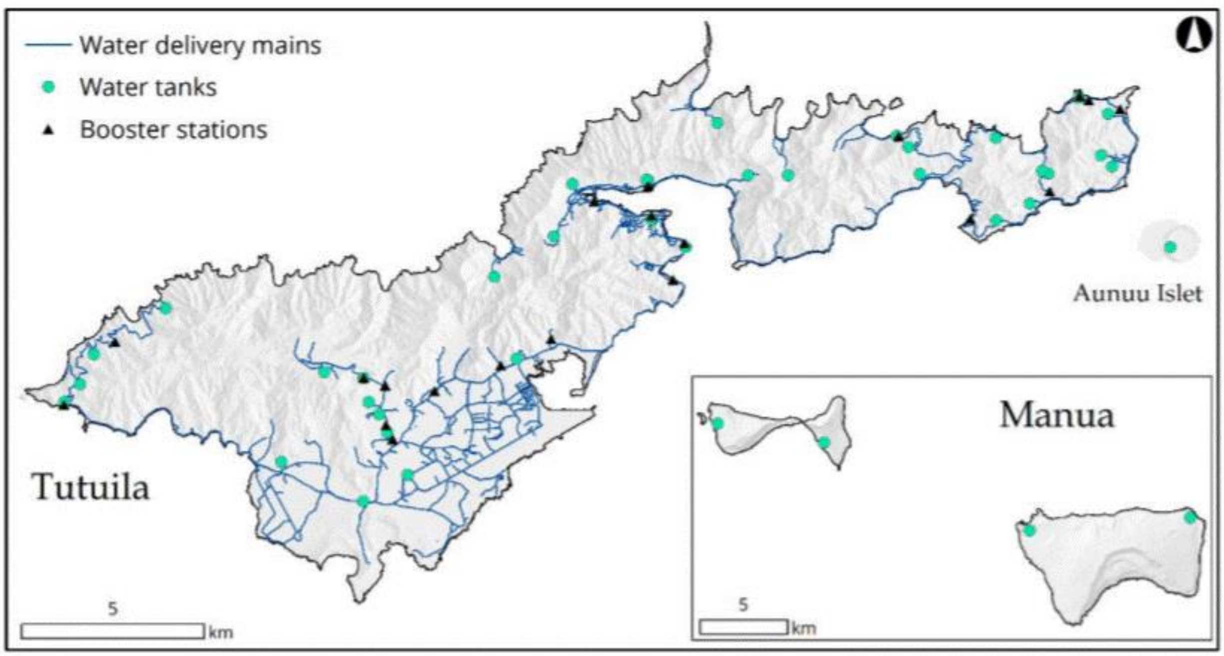


Figure 4-1. ASPA Municipal Water Supply (Shuler, 2018)

American Samoa averages 382 cm of rainfall per year (Shuler 2021). The USGS rainfall has indicated that if American Samoa receives steady rainfall, at least 16 million gallons of water seeps into the freshwater zone per day. In 1998, water usage per day averaged about 8 million gallons, with 2 million gallons utilized by the local canneries, 2 million gallons for residential use, 1 million gallons to other businesses, and 1 million lost through leaks. (AS HMP 2020).

Most of the water supply system in American Samoa was built in the early 20th century by the US Navy with additional construction of asbestos-cement pipes in the 1960's. The system is composed of approximately 150 miles of water mains and 150 miles of service laterals from the mains to structures. Currently there is no centralized wastewater infrastructure for many villages in American Samoa. Efforts at workable on-site wastewater management in these villages are impeded by population density, topography, soils characteristics, and complex land tenure among residents.

ASPA is upgrading their system to iPerl smart meters in an effort to start using advanced metering infrastructure which will further advance the ability to quickly detect system leakages and repair damaged infrastructure. Rough order estimates for the replacement of approximately 50 miles of the asbestos-cement and HTPE pipes with PVC pipes is in the range of $200 million.

5 Benthic Communities

The ASEPA and UoG monitor benthic species and water quality around Tutuila. Data collection focused on seagrass species, macroalgae, corals, other macroinvertebrates, and sand including dead coral and rubble. Data sets from 2010 and 2015 are described below. The following habitat categories were used:

- 1 – hard-bottom flat with coral, crustose coralline and turf algae
- 2 – hard-bottom flat with sparse coral, turf and macroalgae
- 3 – hard-bottom flat with sparse coral, other invertebrates, turf and macroalgae
- 4 – soft bottom with sand
- 5 – soft bottom with sparse massive corals

Surveys cited the impacts of watershed drainage directly impact water quality especially in the nearshore. Figure 5-1 displays results of the two surveys. Distance from shore, exposure to wave energy and presence of soft/hard bottom reefs were the dominant factors predicting habitat type. Due to strong waves during the 2015 surveys it was inappropriate to draw any specific site variation conclusions.

The following is an excerpt from publication: Coral cover comprised between zero to 35% of the benthic substrate, being highest and most diverse with hard-bottom reef types and high exposure to wave action. Where hard-bottom reef types but low wave exposure existed, a less diverse but equally high coverage of corals was noted. *Pocillopora* and *Pavona* corals were most prevalent in lower energy environments with hard-bottom substrate. Closer to shore along the wave exposed coasts the dominance of hard-bottom substrates diminished, but intermixed corals and coral framework with turf and macroalgae still prevailed. Eventually sand became the dominant benthic substrate for sites with low wave energy that were close to shore, often associated with a larger reef flat between the shoreline and fore reefs that restricted coral growth completely due to intertidal extreme temperatures and exposure. The only notable difference between the 2010 and 2015 assessments was the dominance of sand habitat during 2015. This was attributed to rougher weather during the 2015 assessment compared with 2010 which forced surveys closer to shore and increased the proportional contribution of sand to the overall benthic substrate coverage, Figure 5-1 and Figure 5-2.

During both timeframes, hard-bottom habitats had the most notable abundances of sea urchins (mainly *Echinothrix*), starfish (mainly *Linckia*), and sea cucumbers (mainly *Actinopyga*, *Holothuria*, and *Stichopus*). Although abundance patterns between habitats remained similar across the two years, there was a notable decline in the overall densities in 2015, Figure 5-3.

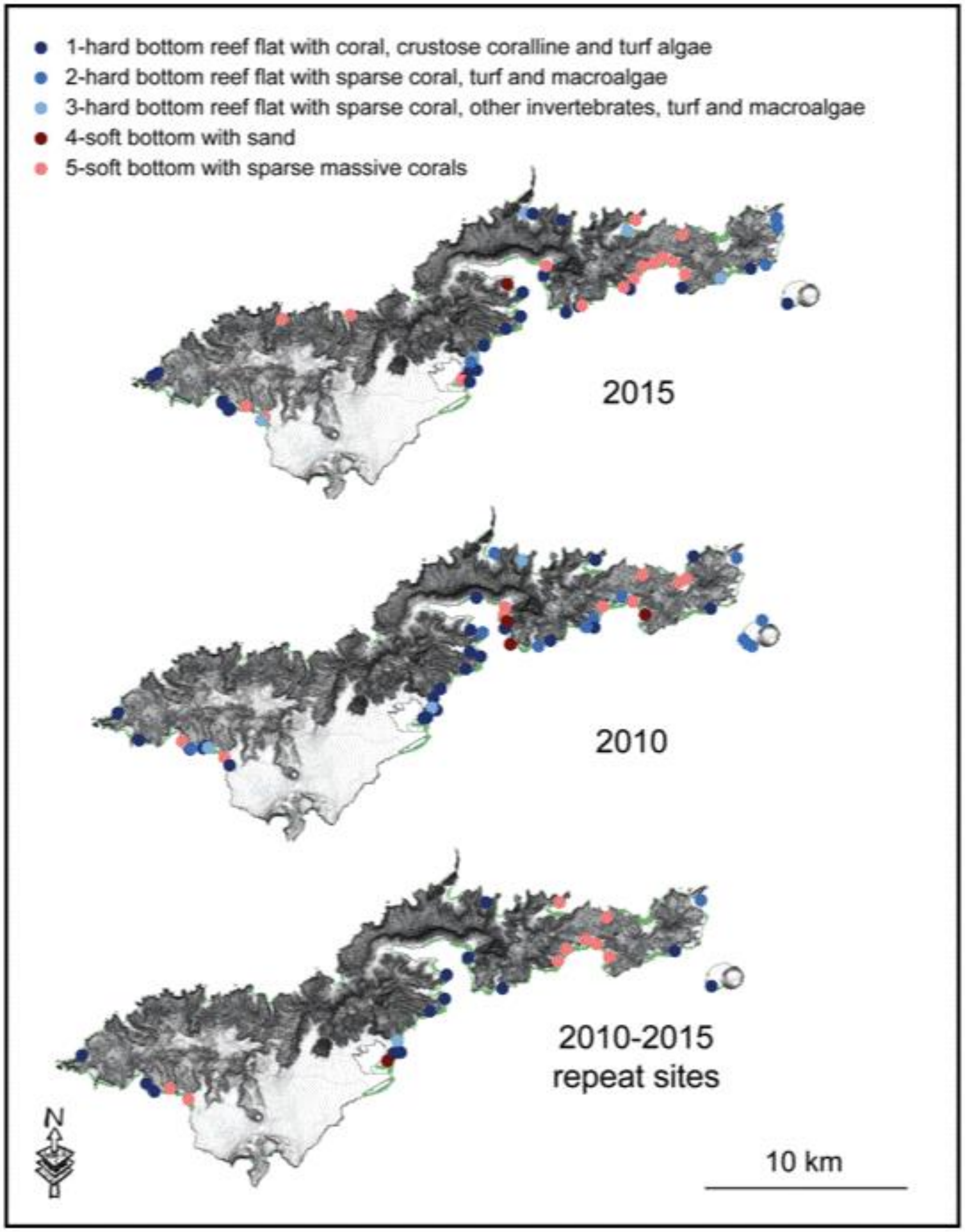


Figure 5-1. Benthic Surveys (Houketal 2015)

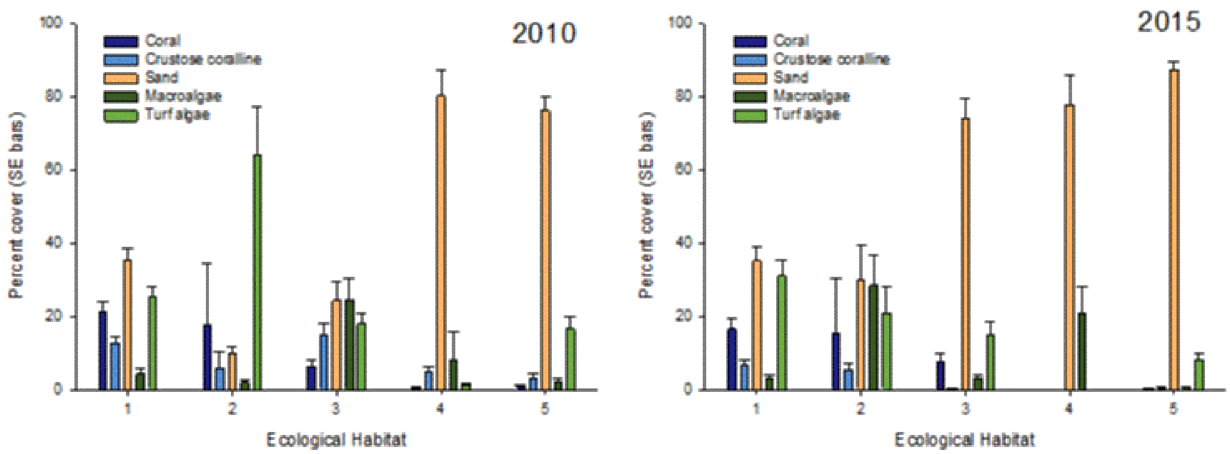


Figure 5-2. Benthic Substrate Types (Houketal 2015)

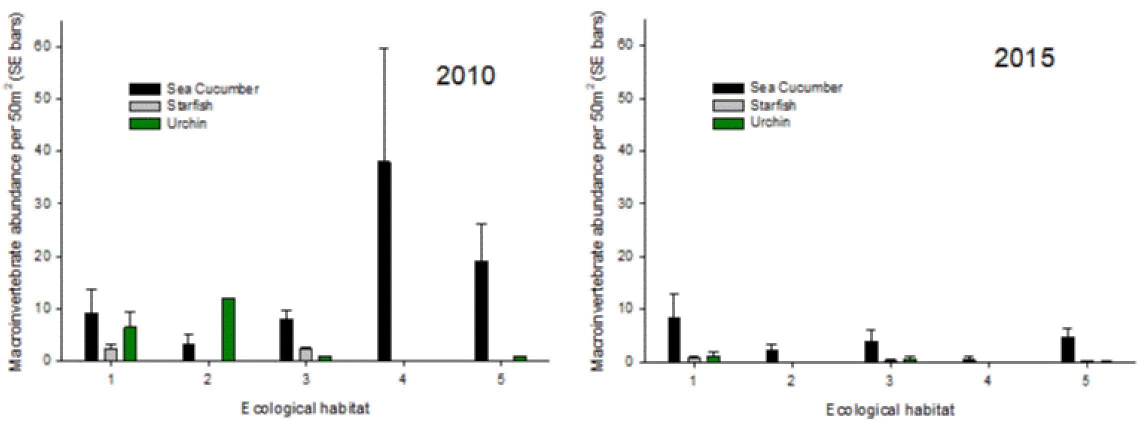


Figure 5-3. Macroinvertebrate Surveys

Prior to comparing the condition of benthic substrate assemblages across the reef flats, soft and hard-bottom habitats were separated to account for inherent natural variability. This stratification facilitated the development of gradients in reef flat substrate condition that best indicate the potential influence of watersheds and land-based pollution (Houk et al. 2005; Houk et al. 2010). The results did not provide evidence for consistent, geographic partitioning of reef-flat integrity scores. Rather, hard-bottom reefs with lowest condition were: 1) closest to stream discharge points, 2) associated with the large and/or populated watersheds, and 3) associated with relative lower wave exposure (i.e., not subjected to high southeast exposure). For example, there were a cluster of sites surveyed between Nua Seetaga and Leone watersheds (1015, 1094, 1106, 1004, and 1092), with highest condition found for sites farther away from discharge points and subjected to higher southeast exposure. While some exception to these general findings existed for some reef flats in Nu'uuli where a recent bleaching event impacted some of the corals, the patterns were robust across hard-bottom habitats. However, this pattern was not found for soft-bottom habitats. Direct linkage between water quality and benthic communities is apparent. To read the entire article see Benthic Assessment of American Samoa's Reef Flats: Integrative findings from 2010 and 2015.

6 Marine Protected Areas

Marine Protected Areas (MPA) in American Samoa are intended to maintain, restore, or improve marine biodiversity and ecosystem function, improve socioeconomic conditions by increasing fisheries production, and foster ecological resilience from human stressors and climate change impacts. American Samoa has a goal to protect 20% of its coral reef areas. MPAs are a primary marine conservation strategy. MPAs are implemented using diverse governance approaches involving a range of institutions operating at different scales and including federal, territorial, and local village entities. This innovative approach to management takes advantage of the territory's traditional marine tenure system while drawing on resources available from the US federal government. Since 2000, total MPA coverage in American Samoa has expanded to encompass approximately 25% of coral reef area in the territory, with nearly 7% of reefs in no-take reserves. Once a MPA is designated management policies, communication, and enforcement must be in place for a successful outcome. Often community-based enforcement is more effective than governmental enforcement.

American Samoa has jurisdiction over waters up to three nautical miles offshore. However, the waters adjacent to coastal villages are typically considered to be under local village jurisdiction, and the territorial government rarely interferes with the traditional management and livelihoods associated with village reefs. Villages traditionally hold tenure over adjacent waters and reefs and enforce many restrictions on access to and use of coastal resources. Such restrictions include designating individuals to regulate village fishing, the delineation of areas where fishing is not permitted for a period in order to preserve reef fish for special occasions, and the naming of species that only village chiefs are allowed to consume. Traditional village tenure is still, for the most part, recognized today and extends to prohibitions against fishing by nonresidents without prior permission, temporary restrictions on fishing certain species, and some annual and even short daily periods where entering the sea is forbidden. While tradition limits some marine resource use, resources also face additional and more recent pressures from residents relying on nearshore waters for fishing and other uses, accumulating impacts of land-based development, pollution, and vulnerability to climate change. Enforcement of traditional rules limiting marine resource extraction and degradation is also challenged by the loss of traditional authority in many villages, greater demand for natural resources and their commercialization, and advances in technology that allow for more efficient resource extraction and the ability to enter and exit village waters unnoticed via motorized vessels (Raynal, et al. 2016).

MPAs in American Samoa range from a privately managed marine area (Alega Bay) to federally managed areas such as those covered by the National Park of American Samoa, the National Marine Sanctuary in American Samoa, and the Rose Atoll Marine National Monument. In addition to these different levels of management, the levels of protection also vary greatly from completely no-take (e.g., Fagamalo No-Take Area), to areas that allow subsistence fishing (e.g., marine portion of the National Park) and areas allowing different levels of take, depending on the decision of the village.

American Samoa recognizes the cultural, economic, and ecological importance of protecting their marine resources and has several local efforts underway to meet this goal. The Coastal Reef Advisory Group (CRAG) is a collaboration of seven local agencies; the Department of Marine and Wildlife Resources (DMWR), the Department of Commerce (DOC)'s Coastal Zone Management Program (AS-CMP), the National Marine Sanctuary of American Samoa (NMSAS), the American Samoa Environmental Protection Agency (EPA), the American Samoa Community College (ASCC), the National Park of American Samoa (NPSA), and the US Fish and Wildlife Service's (FWS) Rose Atoll National Wildlife Refuge and Marine National Monument. CRAG coordinates the coral reef management efforts through education and outreach, identifying stressors, research and monitoring, and developing management strategies to build and sustain the resilience of coral reef ecosystems. Management strategies are both territory-wide and village-based (CRAG 2020).

Current management actions need to further protect, conserve, enhance, and increase coral reef fish stocks in American Samoa, particularly larger and more vulnerable species. Current management practices are failing to adequately protect fish stocks and need to be revitalized and improved to secure food resources for the future of American Samoa. Renewed management effort is especially important given the compounding impacts of global warming, ocean acidification, introduced species, and diseases. Of primary concern are the protection of large fish through catch, size, and/or gear limits, establishment of additional permanent no-take marine protected areas, climate change mitigation, management of invasive species, and reduction in coastal runoff and pollution (CRAG 2020).

The National Marine Sanctuary of American Samoa is one of the federally designated underwater areas protected by NOAA's Office of National Marine Sanctuaries. Of all the areas in the National Marine Sanctuary System, the American Samoa sanctuary is the most remote and is thought to support the greatest diversity of marine life, with close to 3,000 known marine species recorded. The sanctuary comprises six protected areas, covering 13,581 square miles of nearshore coral reef and offshore open ocean waters across the Samoan Archipelago. The Archipelago is comprised of five volcanic islands and two coral atolls, Rose Atoll and Swains Island, Figure 6-1. These protected areas provide habitat for migratory seabirds, shorebirds, sea turtles, marine fish, coral reefs and other invertebrates and aquatic flora and fauna. (Rose Atoll NWR Comprehensive Conservation Plan, 2014)

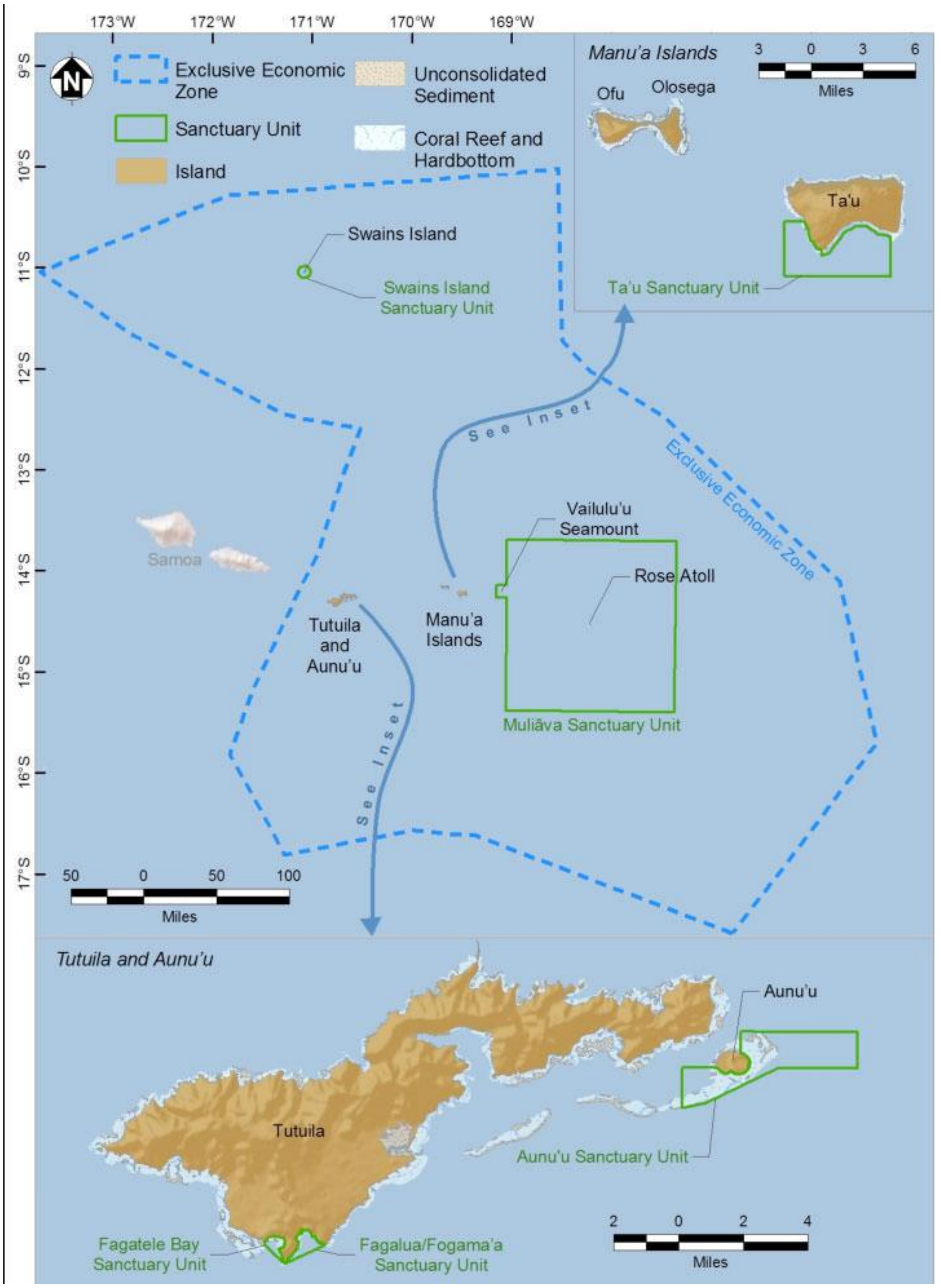


Figure 6-1. National Marine Sanctuary of American Samoa (NOAA)

The National Coral Reef Monitoring Program (NCRMP) collects data at fixed sites yearly to monitor trends in over time. According to the NOAA Coral Reef Conservation Program (CRCP) American Samoan reefs are considered "GOOD" (2018 CORIS). Good is derived from monitoring of five indicator categories:

1. Coral Reef Cover
2. Coral Populations
3. Herbivory
4. Mortality
5. Diversity

Six sub-regions used to evaluate condition of four categories—corals & algae, fish, climate, and human connections. Figure 6-2 below describes the scoring methodology.

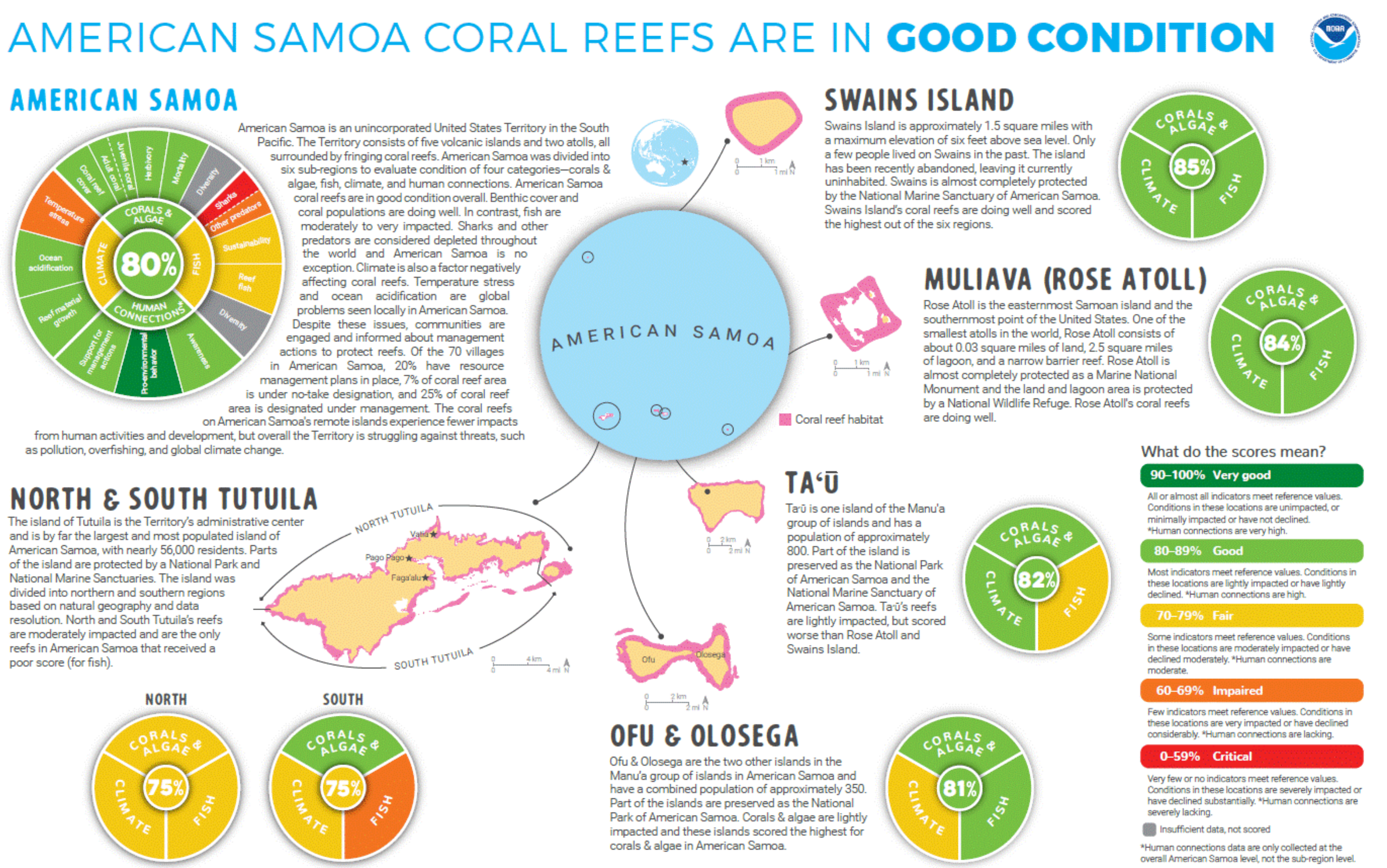


Figure 6-2. American Samoa Coral Status Infographic (NOAA)

Coral reefs are particularly vulnerable to climate change and can be impacted by coral bleaching, ocean acidification, increased storm occurrence and sea level rise. Coral bleaching can occur as the result of prolonged exposure of the corals to increased sea surface temperatures. Bleaching events can lead to coral mortality and have lasting effects on coral ecosystem community structure Figure 6-3. Ocean acidification is also a concern for reef building corals and other organisms with calcium carbonate structures. Increasingly acidic ocean water may diminish an animal's normal ability to build a shell or coral structure and can impact growth rates. Sea level rise brings with it threats of habitat loss, accelerated coastal erosion, and changes in water quality and light penetration. Climate change and ocean acidification are expected to cause coral reef fish to decline by 20% by 2050 (PIRCA 2021). Losses as little as 1 meter in reef height would increase the 100-year floodplain in American Samoa by 2 km^2, placing $70 million dollars of property and economic resources and 1,000 of people at risk(USGS 2019). Scleractinian corals are the primary habitat builders in American Samoa and are already living close to their thermal threshold (Hoegh-Guldberg, 1999). This means that modest changes in temperature affect their ability to survive. The increased occurrence of thermal anomalies expected with climate change is expected to cause widespread coral mortality due to coral bleaching (Glynn, 1993; Brown, 1997), disease (Harvell et al., 1999; Harvell et al., 2002 ; Bruno et al., 2007), and severe storms (Emanuel, 2005; Kleypas et al., 1999), while changes to water chemistry may severely inhibit growth of corals, coralline algae, and reef accretion (Kleypas et al., 1999; Hoegh-Guldberg et al., 2007). Despite these issues, communities are engaged and informed about management actions to protect reefs. The coral reefs on American Samoa's remote islands experience fewer impacts from human activities and development, but overall the Territory is struggling against threats, such as pollution, overfishing, and global climate change.

Coral reefs provide wave attenuation from storm surge acting as natural breakwaters. Annually reefs in American Samoa provide 33 million in averted damages to property and economic activity (USGS 2019). American Samoa’s coral reefs provide over $46.5M in averted damages by protecting 435 buildings from a 10-year flooding event. (PIRCA 2021). Reefs provide direct tourism of approximately $1.07 M/year (PIRCA 2021).

Runoff carrying pollutants (nutrients, pathogens, trash, and sediment) from the land is the greatest threat to the health of reefs and near-shore water quality in American Samoa (ASEPA 2018). Crown-of-thorns starfish (COTS), *Acanthaster planci,* are predators of corals, Figure 6-4. Under normal conditions the COTS are not harmful to the reefs. When nutrients levels spike in near-shore waters creating an overabundance of food sources (phytoplankton, algae) COTS reproduce at above normal rates and can destroy reefs. Unlike typical sea stars that have five to seven arms COTS have up to 21 arms covered in poisonous spines, Figure 6-5. Most sea stars are less than 25 cm while COTS can reach 45 cm, typically sea stars move slowly (some as little as 15 cm/min) COTS can move up to 35 cm/min, eating up to 478 cm^2 /day. Chemical control is employed through divers injecting bile salts, vinegar or sodium bisulfate to kill COTS.

In the late 1970's COTS destroyed 80% of the reefs in American Samoa. Since that time, periodic hurricanes, damage from the 2009 tsunami, the 2011-2014 COTS outbreak, low tide events, and bleaching have slowed the recovery of corals in the territory, although live coral cover has generally increased and is now around 29%, and a majority of indices show the benthic portion of the reefs outside the harbor are in relatively healthy condition (ASCRMP, 2011).

Figure 6-3. Coral Reef bleaching before (Dec. 2014) after (Feb. 2014) photo credit XL Catlin Seaview Survey

Figure 6-4. Crown of thorns starfish feeding on live coral (National Park of American Samoa 2014)

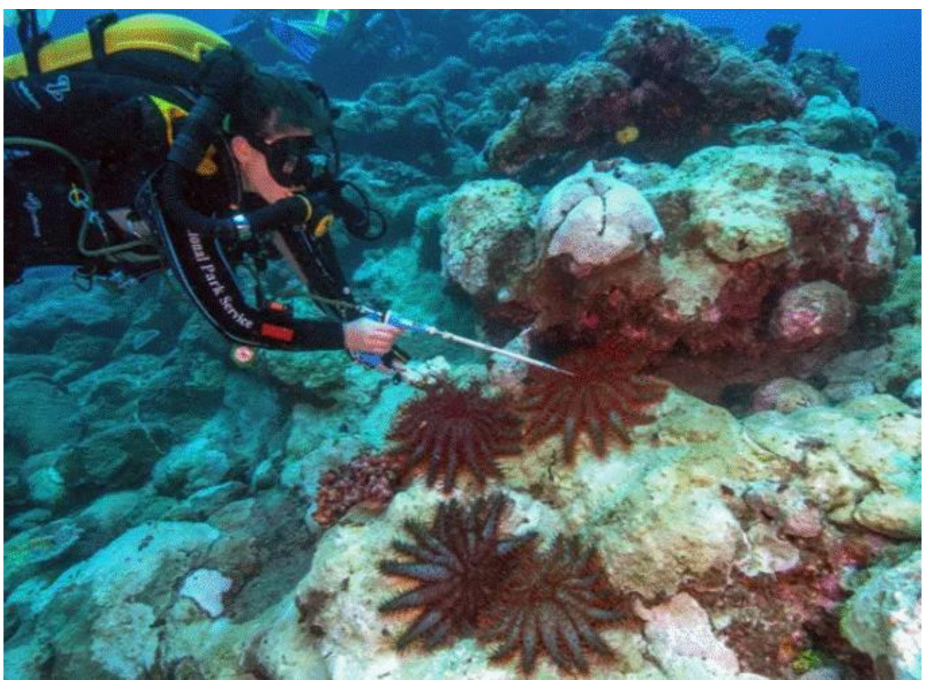
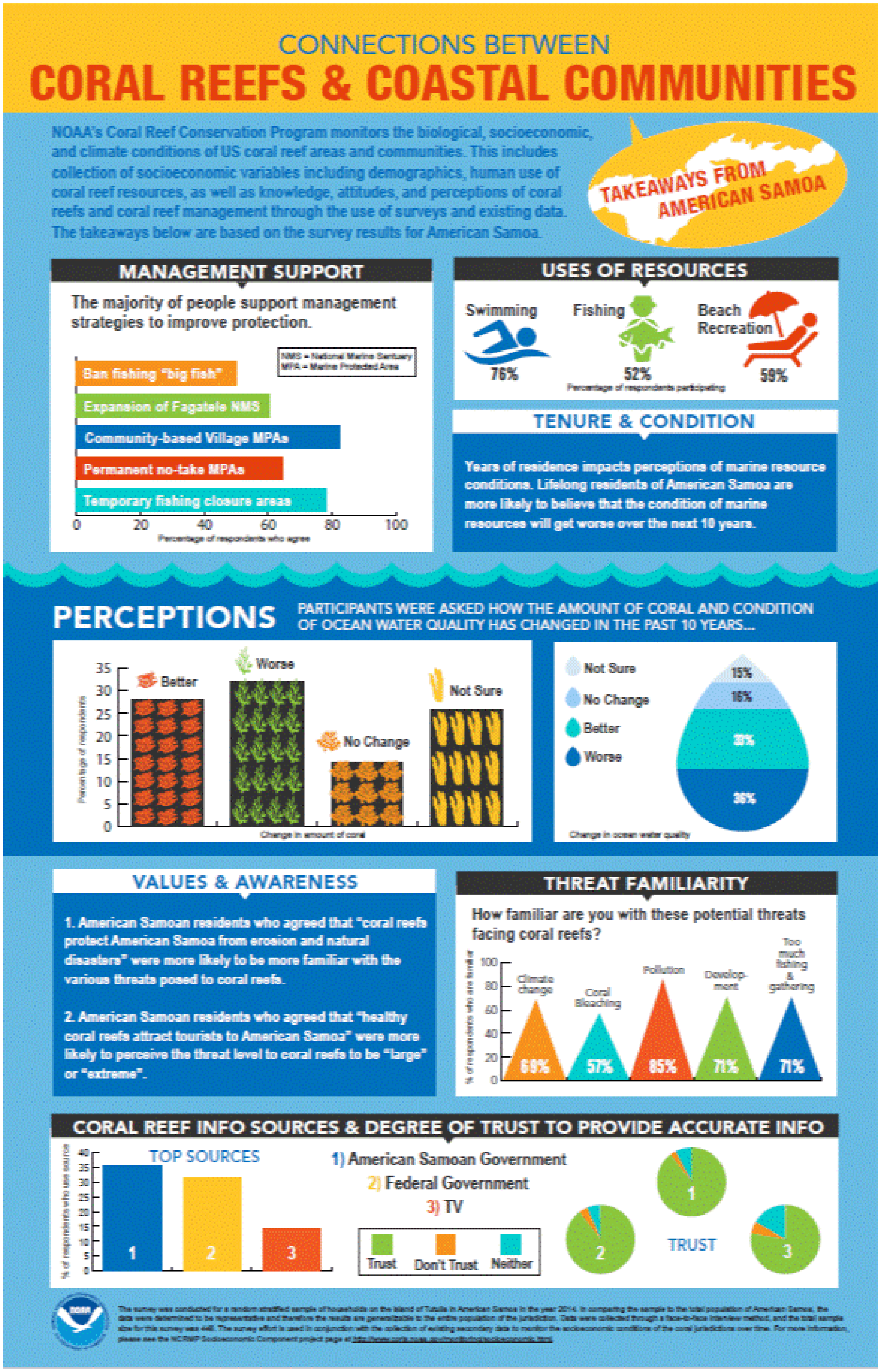


Figure 6-5. Diver at NPSA injecting COTS

Effective management of tropical reef resources depends both on reducing fishing pressure and on maintaining processes that encourage rapid recovery of reef habitat (Grigg, 1994; Bellwood and Hughes, 2001; Friedlander et al., 2003). While fishing is considered to have the most impact on reef habitat and still remains the most significant threat, habitat loss threatens the continued existence of many marine species (Roberts and Hawkins, 1999; Rodwell et al., 2003), including coral reef fish due to their close association with the reef structure (Choat and Bellwood, 1991). Two fisheries in American Samoa currently target coral reef fish: the subsistence fishery and the artisanal (small-scale commercial) fishery. Subsistence fishing includes the multiple ways that Samoans have always caught nearshore fish for food. In modern times, this includes rod and reel, bamboo pole and line, free-diving, throw nets, gillnets, and gleaning (handpicking clams and octopus). Modern fishing gear has replaced most traditional fishing practices in American Samoa; for example, today fish are caught by rod and reel, metal spears propelled by elastic bands, and monofilament gillnets and thrownets. The artisanal fishery that sells reef fish to local stores is a more recent development. It is conducted by teams of night divers who use underwater flashlights and spears to catch sleeping fish. In the mid-1990s, many of these divers switched from freediving to scuba diving, which greatly increased the number of fish they caught. This type of heavy fishing had a significant overfishing impact on reef fish populations, so the use of scuba gear while spear fishing at night was banned in the Territory in 2001. (AS Natural History Guide, 2009)

Land-based sources of pollution including construction, quarry mining, increased solid waste and sewage, and sedimentation, has caused much indirect stress to the coral reefs, (ASEPA 2020). Sedimentation limits coral growth, feeding, photosynthesis, recruitment, and survival. Coastal development and agricultural management degrade habitat by increasing pollution and nutrients to the coral reef systems. These pollutant sources include the proliferation of piggeries, and also the runoff which increases sediment and nutrient loading in areas near highly populated villages. These inputs especially affect reef flats, mangroves, and seagrass beds, which are nursery habitats for the recruitment and juvenile development of some reef fish (Harborne et al., 2006; Dorenbosch et al., 2005; Manson et al., 2005). Coastal development also leads to removal of vegetation, directly reducing ecosystem functions such as sediment and nutrient filtration, aquatic nursery habitat, shoreline stabilization, and storm energy attenuation (potentially exacerbating pollution loads from runoff) (AS CRLAS 2020) .


CONNECTIONS BETWEEN
CORAL REEFS & COASTAL COMMUNITIES
NOAA's Coral Reef Conservation Program monitors the biological, socioeconomic, and climate conditions of US coral reef areas and communities. This includes collection of socioeconomic variables including demographics, human use of coral reef resources, as well as knowledge, attitudes, and perceptions of coral reefs and coral reef management through the use of surveys and existing data. The takeaways below are based on the survey results for American Samoa.
TAKEAWAYS FROM AMERICAN SAMOA
MANAGEMENT SUPPORT
The majority of people support management strategies to improve protection.
NMS = National Marine Sanctuary
MPA = Marine Protected Area
Ban fishing "big fish"
Expansion of Fagatele NMS
Community-based Village MPAs
Permanent no-take MPAs
Temporary fishing closure areas
0
20
40
60
80
100
Percentage of respondents who agree
USES OF RESOURCES
Swimming
76%
Fishing
52%
Beach Recreation
59%
Percentage of respondents participating
TENURE & CONDITION
Years of residence impacts perceptions of marine resource conditions. Lifelong residents of American Samoa are more likely to believe that the condition of marine resources will get worse over the next 10 years.
PERCEPTIONS
PARTICIPANTS WERE ASKED HOW THE AMOUNT OF CORAL AND CONDITION OF OCEAN WATER QUALITY HAS CHANGED IN THE PAST 10 YEARS...
35
30
25
20
15
10
5
0
Percentage of respondents
Better
Worse
No Change
Not Sure
Change in amount of coral
Not Sure
No Change
Better
Worse
15%
16%
33%
36%
Change in ocean water quality
VALUES & AWARENESS
1. American Samoan residents who agreed that "coral reefs protect American Samoa from erosion and natural disasters" were more likely to be more familiar with the various threats posed to coral reefs.
2. American Samoan residents who agreed that "healthy coral reefs attract tourists to American Samoa" were more likely to perceive the threat level to coral reefs to be "large" or "extreme".
THREAT FAMILIARITY
How familiar are you with these potential threats facing coral reefs?
% of respondents who are familiar
100
80
60
40
20
0
Climate change
69%
Coral Bleaching
57%
Pollution
85%
Develop-ment
71%
Too much fishing & gathering
71%
CORAL REEF INFO SOURCES & DEGREE OF TRUST TO PROVIDE ACCURATE INFO
% of respondents who use source
40
35
30
25
20
15
10
5
0
TOP SOURCES
1
2
3
1) American Samoan Government
2) Federal Government
3) TV
Trust
Don't Trust
Neither
1
2
3
TRUST
The survey was conducted for a random stratified sample of households on the island of Tutuila in American Samoa in the year 2014. In comparing the sample to the total population of American Samoa, the data were determined to be representative and therefore the results are generalizable to the entire population of the jurisdiction. Data were collected through a face-to-face interview method, and the total sample size for this survey was 446. The survey effort is used in conjunction with the collection of existing secondary data to monitor the socioeconomic conditions of the coral jurisdictions over time. For more information, please see the NCRMP Socioeconomic Component project page at

7 Management and Research Plans

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8 Terrestrial Habitat

Mangrove forests occur on American Samoa's coastal areas, particularly in sheltered lagoons and protected areas where freshwater enters the ocean at the mouths of streams. The largest mangrove forests are located on the south side of Tutuila Island in the lagoons of Leone and Nu'uuli villages. The mangrove forests of American Samoa are dominated by three species, oriental mangrove (*Bruguiera gymnorrhiza*) is the dominant species, red mangrove (*Rhizophora mangle*) can be found along seaward margins, and the puzzlenut tree (*Xylocarpus moluccensis*) is quite rare. Mangroves serve as prime habitat for numerous fish, crustacean, and mollusk species. Significant portions of mangrove forests have been lost to human land use in American Samoa; only five stands across two islands remain, encompassing roughly 52 hectares. Mangroves may not recover from extensive alteration or mortality; when stands do recover naturally, recovery time ranges from 15-30 years (EcoAdapt, 2016).

Lowland and Montane Forest together comprise the "tropical rainforest" that once covered over 90% of Samoa. Montane Scrub and Summit Scrub are unique. Montane scrub comprises the vegetation on the summits and upper slopes and ridges of Tutuila on geologic areas called "trachyte plugs," which have a characteristic chalky soil that appears to cause stunted vegetation. The montane scrub vegetation on these peaks is the only known home of some of American Samoa's rarest native plant species. Montane Scrub looks superficially like Summit Scrub, but is noted only from the summit of Ta'u and is quite different floristically. Its scattered, stunted trees are embedded in a dense matrix comprising shrubs, ferns, and lianas. Epiphytes also abound in this community, sometimes covering the stunted trees. Summit scrub provides prime nesting habitat for the Tahiti petrel (Forest Assessment 2010).

Tree species in this forest type are adapted to rocky lavaflow areas with little soil and low water-holding capacity. The lavaflow rainforest is also one of American Samoa's tallest forests highlighted by its giant banyan (*Ficus* spp.) and tava (*Pometia pinnata*) trees that tower over the plains (Forest Assessment 2010).

Native tropical forests serve several important functions in American Samoa and throughout the tropics. First, they provide protection from soil erosion, which leads to a higher quality of drinking water. Second, they are home to a majority of the world's plant and animal species. Third, they serve as home to animals, such as pigeons and flying foxes, and plants, such as Tahitian chestnut (ifi), that have traditionally been a major part of the local diet. Unfortunately, the forests of American Samoa are seriously threatened. The most dangerous threats, direct or indirect, are the actions of our people. Due to rapid population growth, the existence of communities such as mangroves, wetlands, and some kinds of lowland forest have been nearly eliminated. Non-native plant and animal species also threaten to out-compete and reduce the abundance of some native species (Natural History Guide, 2009 and Forest Assessment 2010) Figure 8-1 displays Vegetation and Land use on Tutuila, Aunu'u and Manu'a.

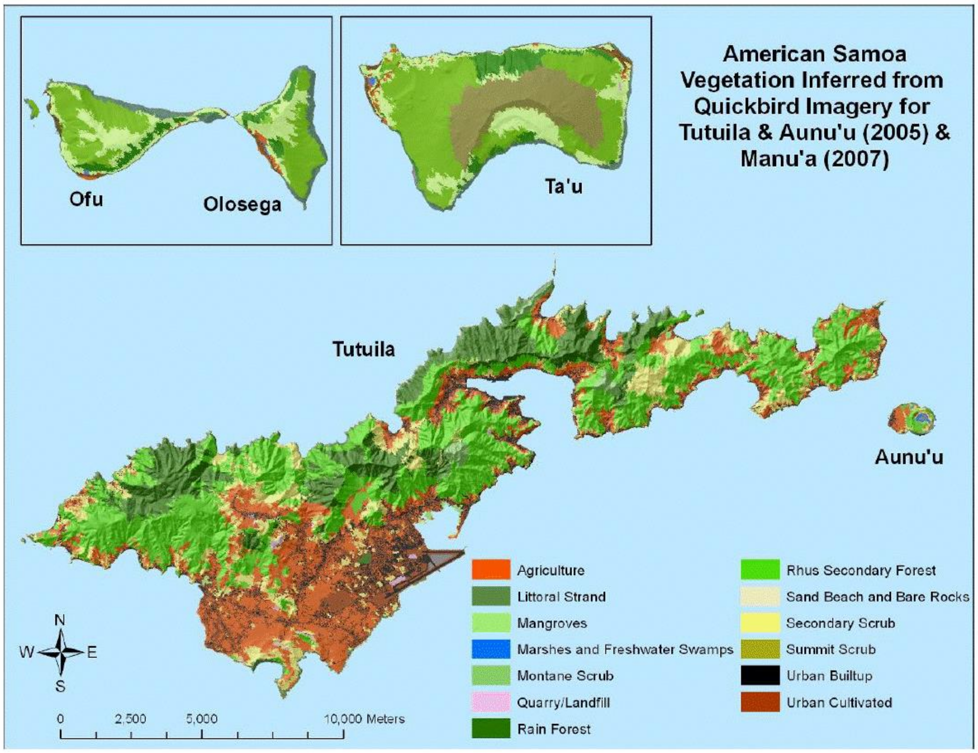

Figure 8-1. Land use and terrestrial habitats in Tutuila and Aunu'u (Forestry Program 2010)

In 2012, the Forest Inventory and Analysis (FIA) Program of the USFS Pacific Northwest Research Station, in collaboration with American Samoa Community College Community and Natural Resources (ASCC-ACNR), conducted an inventory of American Samoa's forests. The FIA Program, under the USDA, is tasked with collecting forest inventory data to examine the forests status and trends throughout the years. The 2012 FIA report also estimated that 81% of the territory's land area was primarily forested, which is a reduction from the 90.1% forested area in the 2001 FIA report. To sustain American Samoa's increasing population and developments, important forest habitats have been cleared and replaced by agriculture and infrastructures. The combination of limited flat lands and high demand for lands suitable for growing crops, building roads, homes, and businesses have significantly increased pressure on the forest. Native species and habitats are heavily impacted by these forest conversions. According to the Wildlife Conservation Strategy plan (2016), the Coconut crab (*Birugs latro*) is being threatened by conversion of rocky coastal plains to housing and other developments.

The mangrove forests of Tutuila and Aunu'u Islands have declined over the past twenty years. Residents clear and fill in mangroves for building homes, businesses, and churches, and for dumping trash. Some of Tutuila's largest mangrove forests are located within heavily populated villages, increasing their vulnerability to encroachment and destructive activities. Many of American Samoa's forests are far from roads and grow on steep and rugged terrain. Of the total land area of 48,767 acres, about two-thirds of the land is difficult to access and unsuitable for agriculture. Although the steep and rugged slopes have protected some forests for a long time, farmers are increasingly encroaching into these areas as a result of suitable flat lands being occupied with urban development and agriculture. The majority of forest clearing on steep slopes is taking place near roads on the southern half of Tutuila Island. Tutuila's main road runs along the entire southern coast providing farmers with easy access to the hillsides. Most of the island's intact forests occur on the northern side where the main road reaches only to a few villages on the far western and eastern ends. These forested landscapes will certainly be threatened if roads are extended into the remote areas of the north. Currently, there are no bylaws or restrictions for clear-cutting in forested areas. The impacts of climate change and economic status have pressured landowners into clearing such areas for agriculture or developments (Forest Assessment 2010).

In the last 30 years, American Samoa has been struck by six major tropical cyclones. More frequent, but less severe tropical storms and near misses from cyclones also bring strong winds, heavy rains, and high surf. Several cyclones have caused devastating impacts to American Samoa's natural resources in the past 10 years. Some of these cyclones includes the following: Cyclone Wilma (2011), Cyclone Evan (2012), Cyclone Amos (2016), and Cyclone Gita (2018). Prior to these were Cyclone Heta (2003), Cyclone Percy (2005), and Cyclone Olaf (2005). These severe weather events can topple trees and defoliate large areas of forest. Landslides often occur on the steep mountain slopes. Subsequent growth of invasive plant species may prevent the natural succession of native trees. Flooding may harm trees, other flora, wildlife, (including endangered or listed species such as the endemic American Samoan land snails, *Eua Zebrina* and *Ostodes strigatus*), especially in the urban forest around low lying villages.

9 Wildfires

According to the American Samoa Community Wildfire Protection Plan (CWPP), produced by the American Samoa Department of Public Safety (2007), saw a total of 98 structure fires and 45 brush/wildfires. Most fires are caused by arson or human activities such as burning rubbish or clearing weeds. A wildland fire risk assessment in 2008 concluded that American Samoa fell into the high-risk range due to the ignitability of the many wood-sided structures, volume of fuels close to these structures, and fire history. The plan's principle recommendations in order of priority were reduction of fuels along roads, empty lots, and common areas; prevention education and outreach; and improvement of community egress and firefighter ingress. The plan does not include any spatial analysis, but recommends measures be taken to reduce fuel loads in the districts of Tualauta, Fofo, and Ituao. These districts were chosen based on their population size and heavy urbanization.

ASCC-ACNR and Department of Public Safety (DPS) have shared responsibilities for educating the public on fire prevention. Fire, although currently not a major threat to most of American Samoa's forests, can potentially be devastating to urban forests. Although American Samoa's climate is wet and humid, with year-round rains, the months of June through September sometimes bring periods of dryness. Instances of fires occur when residents' clear lands and burn piles of debris (e.g., branches, weeds, and trash). Under the EPA regulation for air emissions, agricultural burning, or burning of organic materials such as leaf litter or decaying wood, is allowable. However, the community is encouraged to be mindful of the nearby houses, persons with respiratory or other medical conditions, and to monitor the intensity of the burning. Burning of plastics, tires, and other non-organic materials are prohibited. In some cases, farmers use fire to clear areas of thick grass and for girdling and killing large trees. When such activities overlap with dry conditions, urban forests are at risk of being destroyed. Fire is not a part of the natural disturbance and succession processes in American Samoa's forests (AS Forest Action Plan, 2020).

In remote areas of the island, there are no hydrants, which may increase vulnerability of wildfires caused by brush fires getting out of control. When hydrants cannot be accessed, the fire is fought with water available from the trucks. In addition, buildings are not numbered (unless government owned) which makes locating a fire area particularly difficult. In the past, the island population was small, and everyone knew each other making it easier to identify the location of fires by landmarks. Growth in the previous decades has hindered this method. According to fire officials, response time should be around 3 minutes, but it is much longer (Haz Mit Plan 2015)

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