Water Resources in American Sāmoa:
Law and Policy Opportunities for Climate Change Adaptation

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Abbreviations Frequently Used in Text

ASEPA	American Sāmoa Environmental Protection Agency
ASPA	American Sāmoa Power Authority
ENSO	El Niño Southern Oscillation
EQA	Environmental Quality Act
EQC	Environmental Quality Commission
NPS	US National Park Service
Pacific RISA	Pacific Regional Integrated Sciences and Assessments
SPCZ	South Pacific Convergence Zone
USEPA	US Environmental Protection Agency
USGS	US Geological Survey

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1. Introduction and Summary of Adaptation Opportunities

This paper is the result of a scoping effort on the status and outlook of climate change adaptation for freshwater resources in American Sāmoa. The goals of this paper are:

- to provide a resource that can be used to quickly brief a variety of stakeholders, lawmakers, regulators, and others on information related to freshwater and climate adaptation in American Sāmoa;
- to summarize existing law, policy, and cultural frameworks that exist to manage freshwater resources, and identify existing adaptive characteristics;
- to integrate themes and comments from stakeholders and experts who were consulted in this scoping effort; and
- to evaluate and compile opportunities to enhance climate change adaptation capacity in American Sāmoa.

The Pacific Regional Integrated Sciences and Assessments (Pacific RISA) program previously prepared a white paper analyzing law and policy issues surrounding water resources and climate adaptation in Hawai‘i.[1] This paper follows the same basic approach: a descriptive introduction to freshwater resources in American Sāmoa, followed by a brief overview of particularly relevant climate trends and projections, and a summary of the existing law and policy framework for freshwater management. We compare and contrast some adaptive features of the Hawai‘i law and policy framework, to identify ways in which American Sāmoa might capture opportunities to enhance adaptive capacity through a combination of policy, climate science, and social science.

We conclude that:

- Basic information on climate trends and projections confirms a need for enhanced climate change adaptive capacity in American Sāmoa.
- The existing law, policy, and management framework is trifurcated, consisting of overlaid US federal environmental laws, territorial regulations and utility management of groundwater, and village-based management of surface water.
- This trifurcation presents both a challenge and an opportunity. At present, the adaptive capacity of this management framework is limited, and fundamental adaptive needs—such as resource monitoring, awareness, and climate research—are pressing. Looking forward, there are opportunities to enhance adaptive capacity in a number of different ways. Nine concepts are presented here:

    i. Support capacity to monitor freshwater resources
    ii. Engage in climate modeling, or foster cooperation with other groups conducting climate research relevant to the Samoan archipelago
    iii. Bottom up—build awareness tools for understanding the impacts of climate change at the local level
    iv. Top down—enhance long-term adaptive capacity via territorial and federal policy

v. Promote climate-conscious water planning and scenario analysis
vi. Convene and support the existing climate change stakeholder network, and introduce adaptive water management as a work topic
vii. Integrate long-term climate adaptation with seasonal drought management
viii. Support enforcement strategies
ix. Identify key industries that can impact adaptive capacity

2. Overview of Freshwater Resources and Climate Change Risks

2.1 Rainfall

Rainfall is abundant in American Sāmoa and varies greatly by season under current climate conditions. At many locations on the main island of Tutuila, rainfall exceeds 100 inches per year. Tutuila's steep topography and the prevailing southeast trade winds result in orographic rainfall in high-elevation locations. At the Pago Pago Airport on the southwest coast of Tutuila, rainfall averages 188 inches per year.[2] In comparison, the much higher elevation former US Geological Survey (USGS) rain gauge in Aasufou Village, at 1,340 feet above sea level, recorded an average of 200 inches per year.[3] At all elevations, the majority of rain is received during the wet season, from October to May.[4] The Southern Hemisphere's most expansive and persistent rain band, the South Pacific Convergence Zone (SPCZ), lies between American Sāmoa and Fiji during these months, typically bringing substantial rainfall.[5] In the dry season (June to September), the SPCZ shifts to the northeast and becomes weak and sometimes inactive.[6] Thus, the movement of the SPCZ contributes to American Sāmoa's seasonally variable rainfall.

Further complicating seasonal differences, rainfall also varies significantly from year to year in American Sāmoa, with amounts in some years totaling approximately half of those in other years. This interannual variability is influenced by the El Niño Southern Oscillation (ENSO). During strong ENSO events, the SPCZ moves east-northeast of the Sāmoa region, and the weather significantly dries. An El Niño event in 1997 and 1998 caused a severe drought in American Sāmoa, for example. On the other hand, weak ENSO events can also bring drier conditions by pulling the SPCZ and monsoon trough west of American Sāmoa.[7] During strong La Niña events, the SPCZ lies southwest of American Sāmoa.[8] Rainfall in American Sāmoa in La Niña years has averaged slightly below normal.[9]

2.2 Groundwater Resources

As on other volcanic high islands in the Pacific, a freshwater aquifer lies beneath the surface of each island in American Sāmoa, floating as a basal lens on the underlying denser salt water. Rainfall that percolates through the ground recharges the islands' groundwater resources. Groundwater stored in the freshwater lens is the source of nearly all public drinking water supplied by the territorial water utility, the American Sāmoa Power Authority (ASPA). A large freshwater lens underlies the Tāfuna-Leone Plain on Tutuila. Smaller freshwater lens aquifers are present on the islands of Aunuʻu, Ofu-Olosega, and Taʻū.[10] A brackish transition zone occurs at the boundary between the freshwater and salt water layers. The salt water underneath the freshwater lens limits groundwater pumping on Pacific Islands. If too much groundwater is pumped at a particular location, or if a well is drilled too deep in an area where the lens is thin, salt water may be drawn into a well, affecting the well's water quality. A number of wells on Tutuila occasionally or frequently have experienced high chloride levels, especially at thin points in the freshwater lens.[11]

The volcanic geology and topography of the island of Tutuila also form other types of aquifers containing "high-level groundwater" impounded in rock above sea level. The permeability of the specific lava flows and the presence of dikes and other material of low or no permeability are factors controlling the volume of groundwater stored in these higher-elevation aquifers. In American Sāmoa, high-level reservoirs are generally small and supply the base flow of streams.[12]

The most productive wells in American Sāmoa are located on the island of Tutuila in the Tāfuna-Leone Plain, an extensive area in the southwest that is relatively flat compared to the rugged mountains that comprise much of the island. The Tāfuna-Leone Plain also contains most of Tutuila's industry and population, which is particularly concentrated around the Pago Pago Airport area.[13]

The groundwater production potential of the Tāfuna-Leone Plain is much higher than that of most of the other wells on the island, mainly owing to the Plain's unique geology and hydrologic features. The mountains of Tutuila and most of the island's area were formed during the Pliocene and Pleistocene by hot-spot shield volcanoes.[14] However, the Tāfuna-Leone Plain is the product of younger (Holocene) volcanism, including thin pāhoehoe lava flows and ash, cinder, and breccia deposits that overlie an ancient barrier reef.[15] These lava flows of the Tāfuna-Leone Plain are predominantly porous and generally highly permeable.[16] While the older volcanics of Tutuila are characterized by steep water table gradients and inland water levels that are hundreds of feet above sea level, the Tāfuna-Leone Plain has a gently inclined water table gradient and a large capacity for storing groundwater.[17] Elsewhere on Tutuila, wells are mainly located in small valleys or in narrow, low-lying areas along the coast.

Groundwater production on the Tāfuna-Leone Plain is distributed among four main well fields—Malaeloa, ʻIliʻili, Tāfuna, and Malaeimi—most of which were constructed in the 1970s and 1980s. From 1985 to 2005, total production from all 31 wells in the Tāfuna-Leone Plain averaged 6.1 million gallons per day.[18] A 2005 analysis of areas contributing to well recharge in the Tāfuna-Leone Plain found that groundwater levels showed no long-term increasing or decreasing trends.[19] Since the USGS discontinued its groundwater monitoring program for American Sāmoa in 2008, however, certain groundwater measurements have been discontinued and others have become more limited.

2.3 Surface Water Resources

High-level aquifers discharge water in springs and seeps, and supply the base flow for American Sāmoa's streams. Historically, the island of Tutuila has over 160 perennial streams, which, in general, flow from the mountains toward the ocean.[20] Many streams contain diversion structures or collection basins, or are otherwise modified.[21] Whereas the majority of public water in ASPA-operated systems is groundwater from the Tāfuna-Leone Plain, village water systems rely heavily on surface water sources. In outlying villages, beyond the reach of ASPA systems, surface water or water catchment is the primary source of water for drinking and domestic use. Even in locations where ASPA water infrastructure does exist, village surface water or catchment systems may be used as alternative or supplemental sources.

In addition to serving as an important water source for villages, streams provide habitat for many fish, plants, and aquatic invertebrates. A 1981 inventory of streams on Tutuila found that although the island's streams are small, they support a high diversity of aquatic fish and invertebrates, including *tuna* (freshwater eels), *apofu* and *mao'o* (goby fishes), *sesele* or *inato* (mountain bass), *ulavai* (prawns), *mosimosi* (shrimp), and *sisivai* (freshwater limpets).[22] Stream animals are harvested for both subsistence and recreation. Many of these stream species depend on reaching the ocean to spend their early life in the nearshore plankton communities, later migrating back up the stream to grow to maturity. Thus, adequate streamflow is critical to support the diversity of indigenous freshwater species.[23] Stream water quality can also affect nearshore marine ecosystems, including nearshore fish populations, which may be important for subsistence and local economies.[24]

2.4 Water Quality Challenges and Trends

In conversations with American Sāmoa water resource managers, scientists, and government agency staff, water quality was repeatedly identified as the primary concern related to water resources, in scenarios both with and without climate change impacts.

Data published by the American Sāmoa Environmental Protection Agency (ASEPA) and ASPA have indicated that recent levels of contamination of both surface water and groundwater resources make certain uses of water, such as drinking, swimming/bathing, and fishing, unsafe in some locations. Furthermore, water quality assessments suggest that the quality of surface water has deteriorated over the last 10 years in numerous watersheds.[25] However, consistent, publicly available water quality data appear to be lacking, making it: (i) difficult to identify historical trends, and (ii) difficult to anticipate possible future water quality problems associated with climate variability and change. There is an apparent need for expanded water quality monitoring and further assessment of potential alternative sources of clean drinking water.

2.4.1 Surface Water Quality

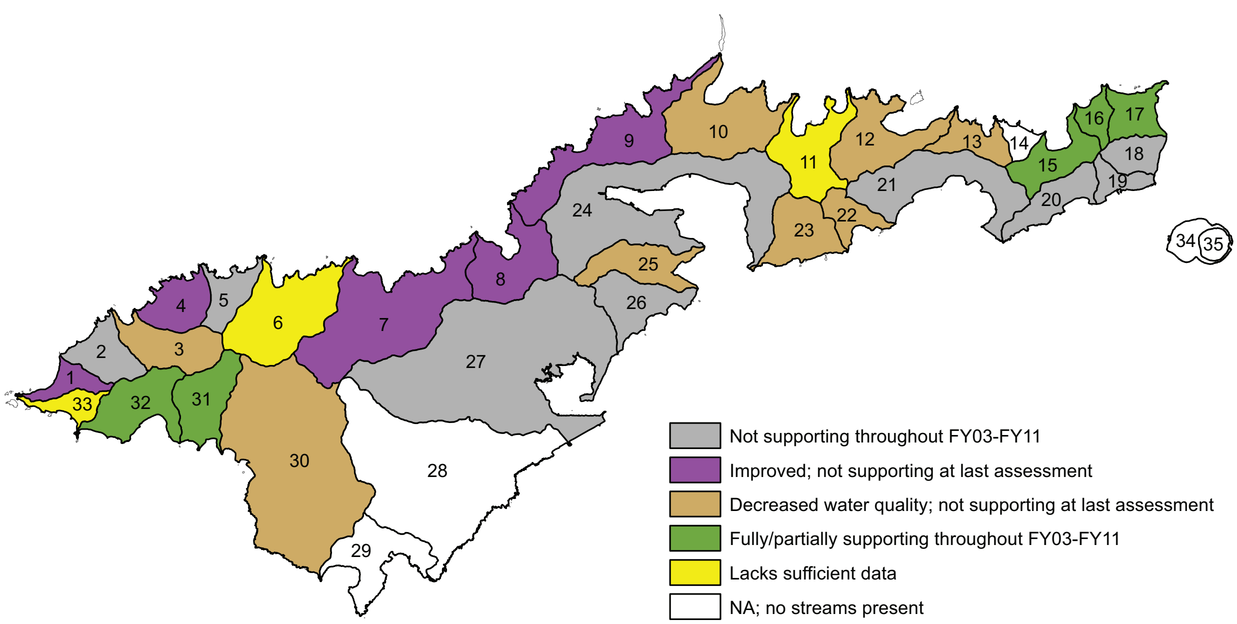
In American Sāmoa, limited data on surface water quality were collected prior to the year 2000. A baseline survey of water quality was completed in 1979, following the 1973 establishment of the American Sāmoa Water Quality Standards.[26] Following the baseline assessment, ASEPA established a long-term water quality monitoring program in the Pago Pago Harbor beginning in 1984 and continuing through 1998. ASEPA targeted the Pago Pago Harbor for a periodic sampling program to satisfy federal permit and monitoring requirements associated with two tuna cannery operations in the harbor.[27] A 1991 assessment of five streams in the Pago Pago Harbor Basin indicated that total nitrogen exceeded American Sāmoa Water Quality Standards at all sampling locations, and elevated phosphorous levels were recorded at the Fagatogo watershed monitoring stations.[28] Sampling was conducted multiple times over more than five years, so the results suggest that streams in the densely populated and industrial Pago Pago Harbor Basin suffered from chronic water quality concerns.[29] Other miscellaneous and intermittent data are available for Vaipito and Utumoa Streams in 1970, indicating the presence of significant concentrations of coliform bacteria.

In 2001, ASEPA expanded its sampling regimes for both drinking water and beaches, and initiated a stream sampling program as part of the new territory-wide Watershed Protection Plan. The implementation of ASEPA's Stream Water Quality Monitoring Plan has increased the amount of data available for surface water quality in the territory; yet, the short data collection period limits the data's usefulness in identifying long-term water quality trends. Under ASEPA's probabilistic approach for choosing streams to monitor, a small population of streams is selected at random from the overall population and sampled for one year. After that period, a new population of streams is selected at random for monitoring. The intent of the Stream Water Quality Monitoring Plan is to provide a robust assessment of stream water quality in American Sāmoa after about three to four years of data collection.[30] It appears, though, that more sampling points were assessed in some years than in others; still, several streams have been assessed multiple times from 2002 to 2014.

The ASEPA sampling regime for 2002 to 2014 confirms that poor surface water quality is an ongoing issue in American Sāmoa, particularly on Tutuila:

- Of the 41 watersheds in American Sāmoa, 28 were recently classified as impaired, meaning that their streams or shorelines, or both, do not safely support certain designated uses (such as habitat for aquatic life, swimming, or fish consumption).
- Stream water quality declined in at least eight watersheds over the period from Funding Year 2003 to Funding Year 2011, and streams in those watersheds were down-classified from "fully supporting" or "partially supporting" of certain uses to "not supporting," as shown in Figure 1.
- Deteriorating water quality in these watersheds impacted aquatic life in streams.
- At least seven shorelines experienced a decrease in water quality during the same period. In particular, numerous beaches that had previously supported swimming were later classified as "not supporting" of this designated use.[31]

Figure 1. Map of Tutuila watersheds showing trends in water quality classifications for streams between Funding Year 2003 and Funding Year 2011.[32]



2.4.2 Groundwater Quality

The 2014 ASEPA Integrated Water Quality Monitoring and Assessment Report identified the following priority sources of groundwater contamination in American Sāmoa:

- animal feedlots
- fertilizer applications
- pesticide applications
- underground storage tanks
- landfills
- septic tanks
- pipelines and sewer lines
- salt water intrusion
- urban runoff
- small-scale manufacturing and repair shops

Pathogens (bacteria, viruses, and protozoa) from poorly constructed septic systems, cesspools, and leaky sewer pipes, as well as from piggeries, are possibly the most widespread and chronic form of contamination. Additionally, salt water intrusion into wells has been a persistent problem affecting water quality and usability for decades.[33]

ASPA monitors the drinking water that it distributes, most of which is basal groundwater. ASPA's Annual Drinking Water Report for 2011 disclosed that seven of the eleven public water systems across all islands were in violation, for at least part of the year, for pathogen indicators (total coliform), or for disinfectants and their byproducts, or both. This includes their central system, which encompasses the Pago Pago Harbor area and the Tāfuna-Leone Plain, where a large portion of Tutuila's population and most of its commercial activity are centered. In ʻAoa Village and parts of the central system, a boil water advisory has been continuously in effect since 2009.

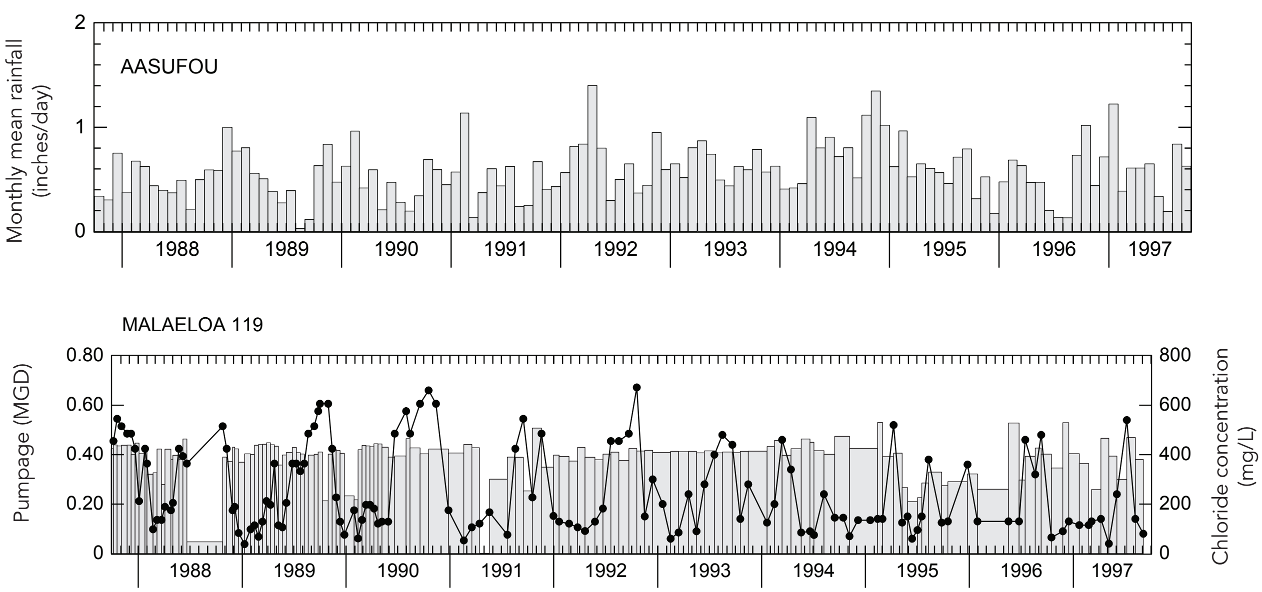
Groundwater underlying the Tāfuna-Leone Plain has been classified by the USGS as Groundwater Under the Direct Influence of Surface Water, denoting that it receives direct surface water recharge. During heavy rain events, the water levels, bacteria concentrations, and turbidity of groundwater in the Tāfuna-Leone Plain can abruptly increase, sometimes rendering well water unsafe to drink for a period of time during and after the storm. In recent years, ASPA has shut down certain wells during storms, as a precautionary measure, because it has consistently observed dangerous levels of pathogens or other pollutants in those wells after rain events.

A second persistent groundwater issue in American Sāmoa is the high salinity levels in some wells, particularly in certain regions. While salinity poses different health risks than pathogens, it may deter many people from using the public water supply, it diminishes the efficacy of water for domestic uses, and it can impact agriculture. Thus, high chloride levels are a concern for ASPA. The US Environmental Protection Agency (USEPA) does not set mandatory limits on chloride concentrations in drinking water; however, the federal agency has issued a Secondary Drinking Water Regulation for chloride concentrations of 250 mg/L. Some ASPA wells constantly or frequently exceed chloride concentrations of 1,000 mg/L.[34] For comparison, the Honolulu Board of Water Supply prefers to distribute water containing less than 160 mg/L.[35]

Nearly all villages in Eastern Tutuila and on the small island of ʻAunuʻu are affected by high chloride levels in the groundwater. Wells serving the villages of Fagaʻitua, Alofau, Ālao, Tula, and ʻAunuʻu have historically risen to over 1000 mg/L at various times, usually as a result of the combined factors of high pumping rates and periods of low rainfall, and chloride concentrations in some of these wells have exceeded 2,000 mg/L. ASPA has attempted to reduce chloride concentrations at various times by shutting down certain wells for several months to several years and even backfilling some wells in Eastern Tutuila.[36]

A number of wells on the Tāfuna-Leone Plain appear to be susceptible to high salinity. This can be illustrated, for example, by a comparison of fluctuating chloride levels in a Malaeloa well with rainfall data from the nearby Aasufou rain gauge over the period from 1988 to 1997 (Figure 2).[37] Qualitatively, salinity appears to increase during drier periods.[38]

Figure 2. Monthly mean rainfall (in inches per day) at the Aasufou rain gauge (top), compared with pumping rates and chloride concentrations in one well in the Malaeloa well field on the Tāfuna-Leone Plain.



From Izuka, 1999.

2.5 Population and Freshwater Demand

The population of American Sāmoa rose sharply in the second half of the twentieth century, more than doubling from about 20,000 in 1960 to about 47,000 in 1990.[39] Aware of the rapidly growing population and its potential strain on resources, in the early 2000s the government of American Sāmoa sought international involvement and funding to confront potential future crises associated with continued high rates of population growth. A 2010 ASEPA water quality report indicated that "the pressure that the growing population in American Samoa is exerting on natural resources and the local environment" was a "main concern."[40] This concern was also expressed by at least one stakeholder interviewed for this project. The 2010 US Census, however, revealed that American Sāmoa's population growth had reversed over the last decade, and population had dropped by a few thousand individuals since 2000.[41]

3. Climate Trends, Projections, and Impacts on American Sāmoa's Water Resources

The above overview of water resource issues illustrates that although American Sāmoa enjoys relatively abundant resources, a number of factors contribute to present and potential future risks to those resources. Developing and maintaining sustainable water sources is an obvious priority for government, business, and water users at the village level.

Potential impacts of climate change on water resources further sharpen the need to protect and carefully manage water resources. The 2012 Pacific Islands Regional Climate Assessment Report presents the current state of scientific knowledge of climate change indicators and impacts across the Pacific Islands and outlines multiple concerns for human and natural communities in the region as a whole.[42] The following survey of climate observations and projections is not intended to duplicate that report. Rather, this information is provided to set the stage for examining the capacity of the existing law and policy framework to adapt.

In American Sāmoa, the impacts of climate change on some aspects of water resources have been documented for over 50 years, or longer in some datasets. Where specific data are not available for American Sāmoa, records from Sāmoa, located just 50 miles to the west, can be referenced for information on how climate change is affecting the region.

3.1 Rising Air Temperatures

The Samoan archipelago is getting warmer. Air temperature data collected from 1950 to 2009 in Apia, Sāmoa, show a pronounced upward trend in average annual and seasonal air temperatures. Maximum air temperatures are increasing at a higher rate in the wet season than in the dry season.[43] Higher temperatures could lead to increased water demand by users and may increase water loss via evaporation and evapotranspiration. Currently in American Sāmoa, evapotranspiration has the potential to remove 23 to 61 percent of the water brought by rainfall.[44] Although cloud cover and solar radiation appear to be the largest factors affecting the amount of evapotranspiration in a particular location in American Sāmoa, air temperature is an important secondary factor controlling water loss.[45]

3.2 Rising Sea Level

Sea level in American Sāmoa has risen at a rate of approximately 0.8 inches per decade over the last 50 years.[46] Globally, the rate of sea-level rise since the early 1990s is twice the estimated rate for the twentieth century as a whole.[47]

In American Sāmoa, rising sea level may impact the transition zone between fresh and salt water, and may increase seawater intrusion into coastal aquifers and wells.

3.3 Variable Rainfall

Rainfall amounts vary considerably from year to year in American Sāmoa and are strongly influenced by ENSO events and corresponding shifts in the position of the SPCZ rain band. This means that the region is at a much higher risk for drought or heavy rainfall in certain climate phases than in others. If global climate change yields systematic changes in ENSO frequency or amplitude, it appears that such changes may impact annual rainfall variability and the frequency or intensity of weather extremes for American Sāmoa.

Although other components of climate are shifting, no long-term change in rainfall has been documented in the Samoan archipelago over the last century. Rainfall data from Apia, Sāmoa, show no statistically significant trend over the period from 1950 to 2009.[48]

Along with rainfall, stream flow is an indicator of the capacity and replenishment of island water resources. Unfortunately, recent stream flow data for American Sāmoa are limited and existing data are aged. Since the 1950s, 11 continuous-record gauging stations maintained by the USGS had collected stream flow data on the island of Tutuila. Additionally, a 1996 analysis used stream flow data from 75 low-flow, partial-record stations and 4 sites where intermittent stream flow measurements were taken 8 or more times.[49] The USGS ended these monitoring operations in American Sāmoa in 2008, and stream flow gauges were discontinued on Tutuila. Only one of the existing long-term records contains more than 35 years of continuous data for a stream that was unaffected by artificial diversions or other human activities. An analysis of data from this gauge did not reveal a significant trend in total stream flow, base flow (the groundwater component of stream flow), or the number of extreme low-flow or high-flow days. Although the lack of a trend in stream flow is consistent with the lack of a consistent trend in rainfall data, it is unclear whether this finding indicates no trend across American Sāmoa or whether it is an artifact of the lack of sufficiently long stream flow records.

3.4 Climate Projections

Although downscaled statistical projections of climate change at the individual island level are presently not available for American Sāmoa, in 2010 and 2011, the Australian government used an assemblage of up to 18 climate models to simulate future climate conditions in a broad geographic region encompassing the Samoan islands.

The Australian government's climate models were selected to simulate future trends based on their ability to reproduce important features of the current climate.[50] Those accurate climate models were then forced with three different scenarios of possible future greenhouse gas emissions to produce a picture of how the local climate might respond. Their projections represent a range of potential climate change scenarios across the Samoan islands. Several results of the model projections have significant implications for future rainfall and water availability:

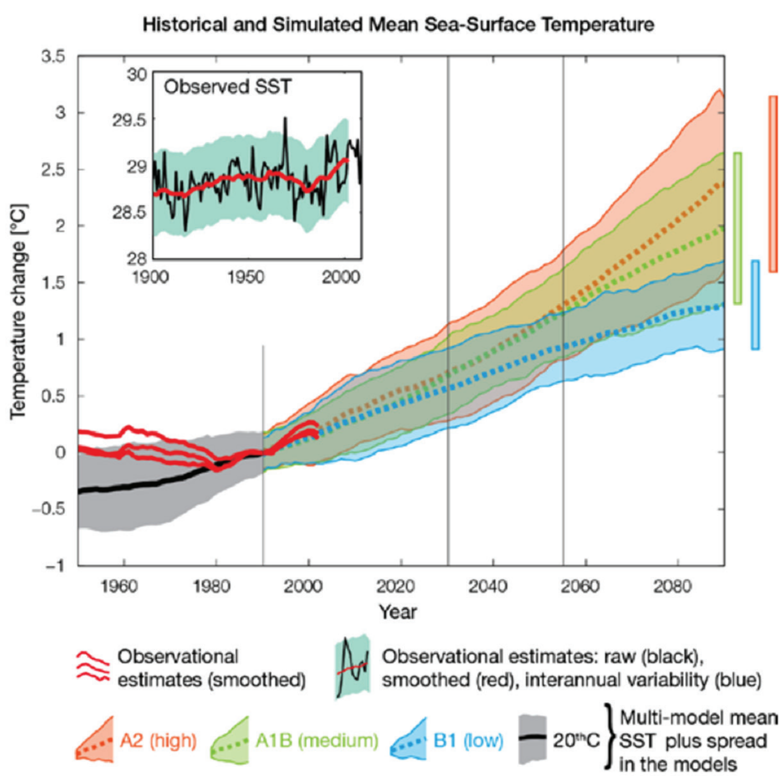
3.4.1 The Intensity and Frequency of Days of Extreme Rainfall Are Projected to Increase

Both the number of days of extreme rainfall per year and the amount of rain falling during those extreme events are projected to increase over the twenty-first century.[51] There is high confidence in this projection, meaning that all climate models agree on this trend in the frequency and intensity of extreme rainfall. Furthermore, this trend is consistent with the projected intensification of the SPCZ, as well as the physical observation that the atmosphere can hold more water as the climate warms.[52]

3.4.2 Wet Season and Total Annual Rainfall Are Projected to Increase

The majority of models agree that both wet season rainfall and total annual rainfall will increase by 2090. However, there is more disagreement among models for mid-century wet season rainfall.[53] One main reason for the inconsistency among model results is that two conflicting mechanisms govern conditions of the SPCZ and rainfall in the equatorial South Pacific. On one hand, rising tropical temperatures lead to more water vapor in the atmosphere, and this abundance of moisture tends to bring about heavier rainfall in regions of converging winds, such as the SPCZ (i.e., "wet gets wetter"). On the other hand, climate change model simulations suggest that the equatorial Pacific will warm faster than the SPCZ region. Thus, under the moderate warming that is possible through the mid-twenty-first century, uneven warming may pull the rain band away from its normal position, potentially causing drying during the summer months. However, models predict that in the late twenty-first century, "wet gets wetter" is most likely to win out, and wet season rainfall will likely increase.[54] Despite the uncertainties about the degree of warming and rainfall changes in the next 30 to 70 years, there appears to be general agreement among the models that rainfall in the Sāmoa region is not likely to change much by 2030 and that annual rainfall is likely to increase by 2090.

Figure 3. Historical and projected sea-surface temperature. From Australian Bureau of Meteorology Samoa Country Report.[55]



3.4.3 Temperatures Are Projected to Increase

"Over the course of the 21st century . . . [s]urface air temperature and sea-surface temperature are projected to increase (very high confidence)."[56] Models project an increase, ranging from 1 to 2.5 degrees Celsius, in average air temperature by 2090 (low confidence), depending on the amount of future greenhouse gas emissions (Figure 3).

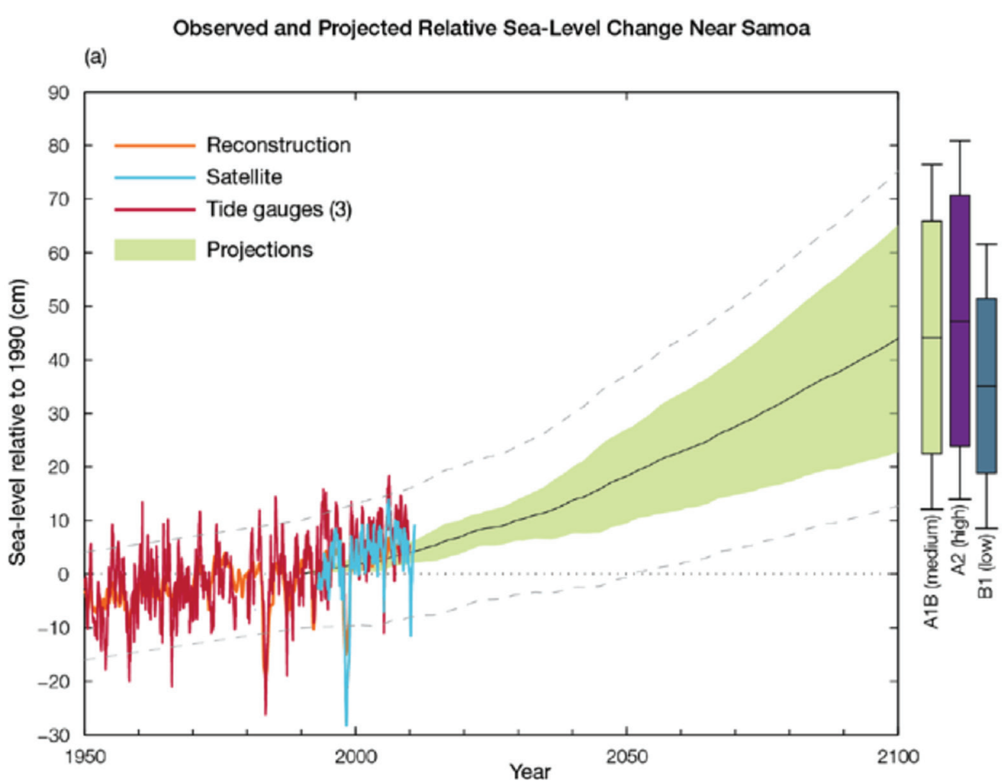
3.4.4 Days of Extreme Heat Are Projected to Increase

"The intensity and frequency of days of extreme heat are projected to increase over the course of the 21st century."[57] There is "very high confidence" in this projection because it is physically consistent with increasing atmospheric concentrations of greenhouse gases.[58] Under current climate conditions, the Sāmoa region experiences significant year-to-year variability in air and sea-surface temperatures, strongly influenced by ENSO. Scientists expect that ENSO will continue to be a source of variability in the region, and temperature extremes will increasingly be magnified by the overall increase in average temperatures.

3.4.5 Sea Level Is Projected to Rise

Average sea level is projected to continue to rise over the course of the twenty-first century, with high confidence (Figure 4). Year-to-year variability in sea level is expected to continue to result in lower and higher periods of regional sea level.[59]

Figure 4. Historical and projected sea-level change. From Australian Bureau of Meteorology Samoa Country Report.[60]



Scientists continue to investigate other potential threats from climate change, including, for example: (i) changes in the trade wind regime, which is a key to the orographic effect and American Sāmoa's abundant rainfall;[61] and (ii) potential changes in drought frequency and dry season rainfall, which have proven difficult to model accurately for American Sāmoa to date.[62]

4. Adaptive Capacity under American Sāmoa's Current Law and Policy Landscape for Managing Freshwater Resources

The current problems with groundwater contamination associated with heavy rainfall illustrate one mechanism for climate variability to impact freshwater resources in American Sāmoa. Climate change impacts, such as the outlook for more frequent extreme rainfall events, a wetter rainy season, rising temperatures, rising sea level, and uncertainty about the potential for ENSO-driven seasonal drought, can amplify the water management challenges posed by climate variability.

The ability of the water management framework to address these challenges is the system's "adaptive capacity."

4.1 Characteristics of Adaptive Capacity from *Water Resources and Climate Change Adaptation in Hawai'i: Adaptive Tools in the Current Law and Policy Framework*

In Pacific RISA's analysis of climate adaptation for Hawai'i water resources (the "Hawai'i Water Study"), climate adaptation (strategies to enhance resilience to climate change impacts) was distinguished from climate mitigation (attempting to avoid some climate change impacts).

Four core characteristics were identified to define the adaptive capacity of the state of Hawai'i's law and policy framework:

(1) *Forward-looking*. There is general agreement that climate change adaptation requires management techniques that are forward-looking, with a focus on long-range planning, and a preference for crisis avoidance over crisis mitigation. A number of water utilities across the country have similarly recognized that:

> Traditionally, water resource planning has used recorded weather and hydrology to represent future supply conditions. . . . It was assumed that the hydrologic determinates of future water resources—temperature, precipitation, streamflow, groundwater, evaporation, and other weather depend[e]nt factors—would be the same as they had been in the past. While there may have been large variations in observed weather, it was assumed that weather statistics would stay the same and variability would not increase in the future. This core planning assumption is often referred to as *climate stationarity*.[63]

Climate change disrupts that assumption. Management techniques that rely too heavily on historical constraints to inform decision making will lack the capacity to address "no-analog" climate change scenarios.[64]

(2) *Flexible*. Predictions of future climate conditions inherently involve some degree of uncertainty. Thus, adaptive management must acknowledge a lack of complete understanding of the resource being managed. Nonetheless, decisions must be made now.[65] Adaptation requires that once an uncertainty is resolved, for example by the introduction of new scientific data, prior decisions can be revisited. The management scheme must be flexible to allow for such revision.

(3) *Integrated*. Climate change implicates systemic threats that cut across existing physical boundaries and political divisions. Thus, adaptive management favors integrated solutions and policies over piecemeal ones.[66]

(4) *Iterative*. The uncertainty, variability, and potentially devastating effects of climate change require vigilant awareness of changing conditions. Thus, adaptation starts with ongoing monitoring, reporting, and evaluation of the resource being managed, as well as of climate trends and effects. Then, this information is incorporated into management decisions, in an ongoing feedback cycle.[67]

This paper applies the same four-part rubric to the law and policy framework currently in place in American Sāmoa.

4.2 Adaptive Capacity under Existing Territorial Law and Policy

Hawai'i's adaptive capacity was found to be largely a function of (i) adaptation-relevant mandates found in the state's constitution, and (ii) the resulting comprehensive regulatory structure established in the Hawai'i Water Code. American Sāmoa's legal and regulatory structure is fundamentally different, consisting of less adaptive federal regulation mapped onto less comprehensive territorial law and policy.

4.2.1 Territorial Executive Order on Climate Change

One source of climate policy in the law and policy framework for American Sāmoa is a 2007 Executive Order on Climate Change (Executive Order).[68] While the Executive Order presents a worthy policy statement, it is not focused on freshwater and it does not address climate change adaptation.

Threats to freshwater are not among the five identified "significant and undeniable repercussions to [American Sāmoa's] land and . . . way of life" imposed by climate change:

i. A loss of landmass and shoreline from an increase in sea level
ii. An increase in food cost and dependence upon off-island food sources because of projected decreases in local agricultural production due to the increase in temperature, loss of land mass, and higher rate of pest infestation
iii. Potential need for the relocation of our population and the resulting loss of spiritual connection to the land our families have occupied for centuries

iv. Coral reef loss due to increases in water temperature and depth
v. An increase in mortality and economic losses from an increase in the number and strength of tropical storms and lack of reef protection

Moreover, the strategies outlined in the Executive Order are solely focused on mitigation, such as improving the fuel economy of government-owned vehicles and reducing electricity consumption via efficient lighting and appliances, rather than adaptation.

However, the Executive Order acknowledges that it was intended merely as an "initial step by American Sāmoa." This suggests that subsequent executive action could be used to establish climate policy that fosters adaptation.

Although executive orders are often not self-implementing, they nonetheless provide valuable guidance and inform the establishment and implementation of other policy initiatives. They also can establish necessary long-term policy commitments that may be a precursor to funding and other implementation tools. Thus, an executive order squarely addressing the need for freshwater climate adaptation could be a valuable near-term opportunity to enhance the adaptive capacity of American Sāmoa's law and policy framework.

4.2.2 Environmental Quality Act

Another source of policy relevant to adaptive capacity is American Sāmoa's Environmental Quality Act (EQA), adopted in 1972.[69] Unlike the 2007 Executive Order, the EQA includes a specific focus on freshwater:

(a) It is the public policy of this Territory and the purpose of this chapter to achieve and maintain such levels of air and **water quality** as will protect human health and safety, and to the greatest degree practicable, prevent injury to plant and animal life and property, foster the comfort and convenience of the people, promote the economic and social development of this territory and facilitate the enjoyment of the natural attractions of this Territory.

(b) To these ends it is the purpose of this chapter to provide for a **coordinated** Territory-wide program of air and water pollution prevention, abatement, and control; and to provide a framework within which all values may be balanced in the public interest. [70]

Much like the Hawai'i Water Code's establishment of the Water Commission with broad jurisdiction to coordinate a statewide water regulatory scheme, the EQA similarly aims for territory-wide coordination of efforts to protect water resources for the public interest, via an Environmental Quality Commission (EQC). This broad jurisdiction can promote an *integrated* approach, lending some adaptive capacity. The EQA also appears to allow for a *flexible* approach by the EQC, conferring fairly broad powers to implement the EQA's policy goals.

However, there is little in the EQA that appears to mandate other adaptive characteristics. For example, the EQA requires the EQC to meet only four times per year,[71] limiting the extent to which the council itself could implement a regularly *iterative* regulatory scheme. And there is relatively little focus on *forward-looking* planning.[72] The EQC is expressly charged with protecting water quality, but there is no reference to protecting the quantity of water supply. These two issues are interconnected, as the phrase "water supply" should more accurately describe a supply of freshwater of a quality sufficient to support its intended use. Moreover, the particular climate trends and projections for American Sāmoa, such as more intense rain events, are a specific threat to water quality.

4.2.3 Water Quality Standards, and Fagatele Bay Climate Action Plan as an Example of Adaptive Capacity Conferred through Regulatory Designation of Special Water Resources

The American Sāmoa Water Quality Standards, revised in 2005, establish EQC policy on protecting water quality:

> (a) It is the policy of the Environmental Quality Commission (EQC) that **existing water uses and the level of water quality necessary to protect existing uses shall be maintained**. Any water quality degradation which would interfere with or become injurious to these existing uses is prohibited. Existing uses are those uses identified in these standards.
>
> . . .
>
> (b) In carrying out its responsibilities under these standards, the EQC and ASEPA will undertake such activities and studies as may be necessary to implement the above polices. These activities and studies may include, but are not limited to: (1) **monitoring** the quality of water and the impacts of pollutant discharges; (2) requiring appropriate levels of treatment and other pollutant control measures through conditions placed on water quality certifications (§24.0209) and other approvals granted by the EQC; and (3) performing inspections and, as necessary, undertaking enforcement actions to assure compliance. [73]

There is a partially *forward-looking* component to protecting water resources into the indefinite future to support "existing uses," and an iterative component to the required ongoing *monitoring*.

However, these components do not establish a clear adaptive mandate as found, for example, in a partially analogous policy statement in Art. XI, § 1 of the Hawai'i Constitution, which expressly protects water resources for "the benefit of present and future generations." Moreover, neither the American Sāmoa Constitution nor other aspects of American Sāmoa law establish a public trust over water resources. As explained in the Hawai'i Water Study, the public trust concept strongly promotes an adaptive mandate.

The Water Quality Standards establish two categories of protection for surface water and groundwater, relevant to water supply. "Class 1 [surface] waters are to remain in as near their natural state as possible with a minimum of pollution from any human activity. Protected uses of these waters are: potable water supplies…."[74] "Class 1G groundwaters are current or potential supplies of potable water and their associated recharge areas and shall be protected as potable water supplies. Unless otherwise identified, Class 1G groundwaters include all groundwater with a naturally occurring salinity of less than 10,000 mg/L."[75] Class 2 designation does not create a mandate to protect potable water supplies.

The primary example of climate change response in American Sāmoa is the climate action plan prepared for the Fagatele Bay National Marine Sanctuary.[76] Notably, the Water Quality Standards specifically designate

Fagatele Bay as a "special embayment" with specific water quality standards to protect against "any reduction in water quality."[77] Specifically enumerated "protected uses" are established for these designated embayments.[78] These parallel designations suggest that designation as Class 1 or Class 1G freshwater resources may also provide an opening for climate change action relevant to those resources. Such special designation is also similar to the designation of "water management areas" under Hawaiʻi law (one of the adaptive tools identified in the Hawaiʻi Water Study), insofar as such designation provides a regulatory framework to implement adaptive capacity as needed to address climate change impacts on water supply.

This general "designation" concept has also been identified by ASEPA as a potential strategy to protect water resources.[79] A 2010 ASEPA report states that:

> The Malaeimi valley in central Tutuila has been determined to be a major recharge area for the Tāfuna-Leone aquifer, which supplies the majority of the drinking water for the Territory. **This valley has been proposed as a Special Management Area, and it is critical that the development in the area is carefully controlled to protect groundwater resources.** Unfortunately, the Governor has not yet adopted the proposal.[80]

4.2.4 Territorial Safe Drinking Water Standards and Tie-In to Federal Law

The ASEPA Safe Drinking Water Act[81] implements the federal Safe Drinking Water Act[82] (collectively, the "Safe Drinking Water Act"), and primary standards are adopted in whole from federal standards. The Safe Drinking Water Act establishes only a mildly adaptive framework. For example, water storage requirements are set forth as follows:

> The minimum storage capacity for a water system shall be equal to the average daily demand during the peak demand month. **Storage capacity may be based on existing consumption** and increased to meet future demand as the water system expands.[83]

Thus, while this standard may be *flexible* enough to increase to meet future water demands, it appears to be wholly focused on current consumption, rather than requiring a *forward-looking* analysis of future supply and demand. Since water storage infrastructure is presumably a long-lived asset, a more climate-adaptive approach would base storage standards on an analysis of future supply and consumption.

Much like the Hawaiʻi Water Code, the Safe Water Drinking Act addresses water supply emergency planning due to contingencies such as "loss of source." [84] But this planning appears to be directed at ad hoc water emergencies that can be addressed "quickly," rather than planning to address longer-term threats to water supply.

ASEPA laboratory fees are calculated annually and are directly tied to the cost of water quality analysis.[85] Other than these fees, it appears that ASEPA, as the primary regulator of water resources in American Sāmoa:

> … is one hundred percent funded by the US EPA Region 9 through [an] EPA Consolidated Environmental Program Grant awarded on a fiscal year budget period. At present, the

> Consolidated Grant consists of the following categorical grant funding: Clean Water Act (CWA), Safe Drinking Water Act (SDWA), Resource Conservation and Recovery Act (RCRA), Clean Air Act (CAA), Federal Fungicide, Insecticide and Rodenticide Act (FFIRA), and the Beach Grant Act.[86]

It does not appear that this annual funding cycle, tied to specific federal laws, provides specific adaptive mandates relevant to American Sāmoa. However, some aspects of this federal tie-in may nonetheless provide a platform for adaptive functions, such as water planning. Perhaps the clearest example is the ASEPA's preparation of an Integrated Water Quality Monitoring and Assessment Report, to satisfy the requirements of sections 303(d), 305(b), and 314 of the federal Clean Water Act. ASEPA's plan for this monitoring and reporting requirement combines monitoring efforts in a variety of contexts:

- ASEPA Nearshore Marine Water Quality (BEACH) Monitoring Plan
- ASEPA Stream Water Quality Monitoring Plan
- American Sāmoa Environmental Monitoring and Assessment Program
- ASEPA Coral Reef Monitoring Plan
- Water Quality Monitoring Strategy for Pago Pago Harbor, American Sāmoa
- ASEPA Tier II Fish Toxicity Study
- Sediment Toxicity Study for Pago Pago Harbor, American Sāmoa
- American Sāmoa Coastal Nonpoint Source Monitoring Strategy
- ASPA Drinking Water/Groundwater Systems Water Quality Monitoring Plan
- National Park of American Sāmoa Water Quality Monitoring Plan

While these are focused primarily on water quality, and do not require a particularly robust long-term planning mandate, the ASEPA plan establishes a two-year reporting cycle, which lends itself to an *iterative* approach to water monitoring. And by combining monitoring efforts across a range of contexts, the plan lends itself to an *integrated* approach.

Individual components of the monitoring plan may also be adopted as a platform for climate adaptation. For example, the US National Park Service (NPS) has identified a "need to emphasize climate change adaptation" by (i) incorporating climate change consideration and response in "all levels of the NPS planning framework"; (ii) implementing "adaptation strategies that promote ecosystem resilience and enhance restoration, conservation, and preservation of park natural resources"; (iii) and "including climate-related vulnerability assessments in project approval and funding decisions."[87] Thus, it appears that the National Park of American Sāmoa Water Quality Monitoring Plan could serve as a platform for adaptive planning.

4.2.5 Regulation of Public Water and Wastewater Systems

The American Sāmoa Administrative Code Chapter 12 regulates water and wastewater utility functions for public water systems. These detailed regulations are analogous, in some ways, to Hawai'i Water Commission regulations related to well construction and other infrastructure issues. Chapter 12 also establishes water rates, including a Groundwater Contamination and Protection Charge ($1.95 per thousand gallons)[88] that could potentially serve as a market-based tool to enhance adaptive capacity.

Moreover, it appears that Chapter 12 is a primary source for the integration of land use and water use planning:

> **Whenever applications for any land use activity within the watersheds serving the Utility, whether permitted or not by territorial agencies, are submitted to the Utility for its review, the Utility shall investigate the effects the proposed use may have on water and wastewater resources**. The Utility may recommend disapproval, within thirty (30) days, if it finds for any reason that the proposed activity could affect water resources and may be a detriment to the water resources used or expected to be used for domestic water. If the Utility recommends disapproval, it shall inform the applicant of those facts and reasons upon which the disapproval is based.[89]

5. Conclusions: Nine Opportunities to Enhance Adaptive Capacity in American Sāmoa

This analysis of climate adaptation for freshwater resources in American Sāmoa suggests that the opportunities to support adaptation are related to tools and opportunities previously identified for Hawai‘i, but would be most effective in the near term via fundamental support such as climate-relevant modeling, monitoring, and awareness. In the context of the current legal and regulatory regime, such support is likely to be most effective if directed to ASPA, as the *de facto* entity charged with safeguarding freshwater resources in the face of any climate impacts.

The following adaptation opportunities incorporate and reflect comments, themes, and observations provided by a variety of stakeholders and experts. Those comments and observations generally cover three areas: (i) the cultural and political landscape, (ii) primary areas of climate and freshwater concern, and (iii) immediate information gaps.

5.1 Climate-Conscious Monitoring of Freshwater Resources

Several stakeholders expressed a need to establish long-term, climate-relevant tools for monitoring water quantity and quality. This may include an effort to improve modeling to inform groundwater pumping by ASPA (where wells are already routinely monitored), along with rainfall and surface water monitoring.

Tailoring existing monitoring efforts to provide a reliable data record may be an appropriate first step to enable the type of iterative water management that climate adaptation demands. If appropriate climate considerations are incorporated, the existing ASEPA water quality monitoring program, with a reported two-year reporting cycle, may be able to serve as a relatively robust platform to record a climate-conscious monitoring regime.

5.2 Climate Modeling

Forward-looking climate modeling, of some sort, is an important building block for climate adaptation, although certain adaptive characteristics (e.g., flexibility) do not require identification of specific climate risks. A similar theme was expressed by American Sāmoa stakeholders and experts, and has also been identified by others working on climate adaptation law and policy in the Pacific:

> One of the key findings from the workshops [held in Fiji and Sāmoa in 2013] was that in order to truly embed climate change adaptation into organizations and communities, it is essential that the risks and liabilities related to climate change have been identified, assessed and managed.[90]

At present, it appears that American Sāmoa climate forecasting must largely be drawn from work conducted in Sāmoa. This method either needs to be validated by appropriate climate experts, or an American Sāmoa-specific downscaling effort is required. At least one stakeholder suggested value in fostering closer ties between Sāmoa-based climate research and American Sāmoa-based research.

5.3 Bottom Up—Awareness and Tools for Understanding the Impacts of Climate Change at the Local Level

Several stakeholders suggested that effective resource management in American Sāmoa must start at the village level, rather than with a top-down policy framework born from federal law or American Sāmoa law. Anecdotally, effective engagement at the village level has utilized very specific visualizations of how stewardship can affect resources for each individual village. This suggests that one path for enhancing adaptive capacity would be the creation of mapping tools to identify climate impacts relevant to each village. The Fagatele Bay climate action plan is routinely lauded as the best climate adaptation work conducted in American Sāmoa to date; following a similar blueprint for other regions may be similarly effective.

5.4 Top Down—Enhancing Adaptive Capacity via Territorial and Federal Policy

A number of stakeholders have suggested that top-down law and policy are likely to face implementation hurdles, and may not spur adaptive capacity in the near term. However, near-term implementation must be balanced against systemic change that can match the climate change time horizon. In that vein, there are a number of opportunities to introduce climate adaptation concepts into the American Sāmoa law and policy framework. At the Territorial level, the primary potential vehicles are: (i) an Executive Order establishing climate adaptation priorities; (ii) establishing a public trust over water resources via legislation; and (iii) revising the EQA and/or Water Quality Standards to incorporate adaptive characteristics. Federal policy is likely to be more a matter of implementation. An agency-by-agency (e.g., USEPA, Department of the Interior, NPS) analysis of existing work in American Sāmoa could yield opportunities to promote climate adaptation. For example, the NPS adaptation policy statement could be applied in some fashion to NPS water quality monitoring, which is part of the ASEPA water monitoring program.

Another option would be to examine the degree to which the current Groundwater Contamination and Protection Charge could be increased and used to increase adaptive capacity.

5.5 Climate-Conscious Water Planning and Scenario Planning

In Hawaiʻi, a robust water planning mechanism serves as a platform for key adaptation strategies. It does not appear that water regulation requires ASPA to engage in similar long-term planning, although such efforts may occur organically (when resources allow). Where land use may have a particularly important impact on water resources, such as on the Tāfuna-Leone Plain, the integration of water planning and land use planning may be appropriate. Currently, Chapter 12 of the American Sāmoa Administrative Code (ASAC) empowers ASPA to investigate the effects of each proposed land use activity on actual or expected uses of water resources. This mandate could be transformed into a more robust planning process by requiring a forward-looking and regularly updated analysis of existing, planned, and proposed land use impacts on water resources, alongside an analysis of the impact of projected population changes on water and land use. A planning mandate may be particularly important in the context of expanding groundwater use away from the Tāfuna-Leone Plain and into higher-elevation aquifers. For example, such planning should analyze the potential impact on surface waters, including impacts on surface waters from any potential changes to precipitation and recharge forecasted to accompany climate change.

Scenario analysis, informed by climate models as suggested above, would also enhance the adaptive capacity of this proposed planning process.

5.6 Convening and Supporting the Existing Climate Stakeholder Network

The existing Climate Change Local Action Strategy Working Group can serve as an obvious focal point for identifying effective adaptation strategies. However, we understand that the group has not been focused on water resources, nor on adaptation. Thus, effectively empowering this group is likely a matter of (i) providing resources through the existing working group leadership, (ii) presenting available information on water resources and adaptation strategies, (iii) ensuring that ASPA is represented in the group, and (iv) demonstrating that the group's effort can provide value to American Sāmoa water resource protection.

5.7 Integrating Long-Term Climate Adaptation Capacity with Seasonal Drought Management

Although questions about long-term water supply appear to be secondary to concerns about water quality, shorter-term drought management is important to water managers in American Sāmoa. For example, based on prior droughts correlated with ENSO events, ASPA now routinely anticipates drought conditions prior to the dry season.[91] ASPA's drought management includes strategies such as servicing leaks in the public water system, working to reduce commercial water demand, utilizing non-potable water where appropriate, and implementing a rationing protocol. Similar strategies, implemented in the longer term, can address climate adaptation in much the same way as drought management. Indeed, the fact that 2014 drought management planning was triggered by an ENSO update suggests that seasonal climate forecasting is already linked to ASPA near-term planning. Enhancing climate adaptation is, in part, a matter of extending the time horizon of this link.

5.8 Supporting Enforcement Strategies

ASEPA has frankly acknowledged a need for better enforcement of the environmental law and policy framework in American Sāmoa:

> While local environmental education has made great strides in the last decade, there is still a widespread lack of understanding, acknowledgment, and acceptance of environmental issues that affect the Territory. The need to control litter and pig waste is now somewhat understood. However, the effect of pollution from soil erosion, automobiles and untreated sewage is not recognized as a public health and environmental threat. **There is a lack of political and public will to enforce most environmental regulations. The regulations themselves are quite comprehensive, but are not seen as a priority for enforcement**.[92]

Thus, prior to any attempt to enhance adaptation through policy (e.g., a follow-up to the 2007 Executive Order on climate mitigation) or regulation (e.g., expanding Class 1 or Class 1G-designated waters), enforcement capacity must be addressed.

One potential strategy would be to encourage the use of federal resources for enforcement.

5.9 Identifying Key Industries That Impact Adaptive Capacity

American Sāmoa's tuna canneries are the largest local industry, and this is reflected in the outsized role that the canneries play in water consumption and management. For example, drought management during the 1974 and 1983 droughts required curtailing of cannery operations to conserve water, which impacted the economy. Thus, a renewed focus on water conservation in the cannery industry would likely enhance adaptive capacity, especially in light of plans to expand the industry.[93] With a forward-looking approach, other industries (e.g., tourism, diversified agriculture) that may also take on a larger role in water demand could be identified.[94] Planning for such an industry and demand in advance, in the context of anticipated water issues related to climate change, would contribute to adaptive capacity.

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[64] *See, e.g.*, R. Kundis-Craig, *Stationarity is Dead—Long Live Transformation: Five Principles for Climate Change Adaptation Law*, 34 Harv. Envl. L. Rev. 9, 53-54 (2010).

[65] *See, e.g.*, *id*. ("Adjusting to climate change impacts and feedback loops will require regulatory and management agencies to respond to changing ecological conditions and changing goals on a more or less continuous basis, preferably . . . in response to continuous informational inputs regarding exactly what is occurring.").

[66] *See, e.g.*, Paul Kirshen et al., *Interdependencies of urban climate change impacts and adaptation strategies: a case study of Metropolitan Boston*, 86 Climatic Change 105, 119 (2008); UN-Water, *Climate Change Adaptation: The Pivotal Role of Water* 2 (2010) *available at* http://www.unwater.org/downloads/unw_ccpol_web.pdf ("Climate change is a complex problem that has increased the need for an integrated, multi-sectoral and multidisciplinary response."); Alejandro E. Camacho, *Adapting Governance to Climate Change: Managing Uncertainty Through a Learning Infrastructure*, 59 Emory L.J. 1, 25-29 (2009).

[67] *See, e.g.*, Lara C. Whitely Binder et al., *Preparing for climate change in Washington State*, 102 Climatic Change 351 (2010); Kundis-Craig, *supra* note 59, at 40 ("Principle #1: Monitor and Study Everything All the Time").

[68] Am. Sāmoa Exec. Order 10A-20076, *available at* http://www.epa.as.gov/sites/default/files/documents/climate_change/2007climatechangeeo.pdf

[69] *See* Am. Sāmoa Admin. Code ("ASAC") § 24.0101 et seq.

[70] *Id.* § 24.0102(a) (emphasis added).

[71] *Id.* § 24.0105(b).

[72] Although one of the fifteen enumerated powers of the Commission is to "prepare and develop a comprehensive plan or plans, including administrative rules, for the prevention, abatement and control of pollution in this territory." *Id.* § 24.0106(6).

[73] *Id.* § 24.0201 (emphasis added).

[74] *Id.* § 24.0205(b)(1)(A).

[75] *Id.* § 24.0205(c)(1)(A).

[76] *See* Nat'l Oceanic and Atmospheric Administration, Office Nat'l Marine Sanctuaries, *Climate Impacts to the Nearshore Marine Environment and Coastal Communities: American Samoa and Fagatele Bay National Marine Sanctuary* (2011), *available at* http://sanctuaries.noaa.gov/science/conservation/pdfs/fbnms_climate.pdf.

[77] ASAC § 24.0205(e)(2)(A).

[78] *Id.* at § 24.0205(e)(2)(C)(vii).

[79] ASEPA Water Assessment Report 2010, *supra* note 33.

[80] *Id*. at 8 (emphasis added).

[81] ASAC § 24.0401 et seq.

[82] 42 U.S.C. § 300.

[83] ASAC § 24.0403.3.

[84] *Id.* § 25.0406(1).

[85] *Id.* § 25.0460.1.

[86] *See* http://www.epa.as.gov/about-asepa.

[87] *See* http://www.nps.gov/subjects/climatechange/adaptation.htm.

[88] ASAC § 12.0315.

[89] *Id.* § 12.0329 (emphasis added).

[90] Mark Baker-Jones et al., *Climate Change adaptation guided by the law: A report on the Changing Winds: Climate Change & the Law workshops held in Suva, Fiji and Apia, Samoa, August 2013*, *available at* http://files.dlapiper.com/files/Uploads/Documents/climate-change-adaptation-guided-by-the-law.pdf.

[91] *See, e.g.*, Sāmoa News, *ASPA prepares for possible drought conditions during upcoming dry season* (May 27, 2014), http://www.samoanews.com/content/en/aspa-prepares-possible-drought-conditions-during-upcoming-dry-season.

[92] ASEPA Water Assessment Report 2010, *supra* note 33.

[93] *See, e.g.*, Sāmoa News, *Tri Marine To Open New Facility Early In American Sāmoa* (Feb. 3, 2014), *available at* http://pidp.eastwestcenter.org/pireport/2014/February/02-05-09.htm.

[94] *Cf.* McPhee & Associates et al., *American Samoa's Economic Future and The Cannery Industry* (2008), prep'd for U.S. Dep't Interior, Office of Insular Affairs (on file with author).

Water Resources in American Sāmoa:
Law and Policy Opportunities for Climate Change Adaptation

Freshwater resource managers in American Sāmoa are facing climate change issues. A projected increase in frequency and intensity of extreme rainfall events, rising sea level, and rising air temperature are among these climate-related dynamics. This confirms the need for effective climate change adaptation strategies, particularly with respect to protecting water quality. The existing law, policy, and management framework for American Sāmoa's freshwater resources is somewhat fractured, consisting of overlaid US federal environmental laws and regulations, territorial laws and policies, utility management of groundwater, and village-based management of surface water. This framework presents both challenges and opportunities, but foundational adaptive needs—such as resource monitoring, awareness, and continuing climate research—are pressing. This work identifies nine opportunities to enhance adaptive capacity within American Sāmoa's existing law and policy framework.

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