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Seawalls in Samoa: A Look at Their Environmental, Social and Economic Implications

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SIT Study Abroad

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Abstract:

This study concerns the environmental, economic and social implications of seawalls in Samoa. Information for this study was gathered using a combination of secondary sources and primary sources including interviews, surveys and participant observation. Given the cultural and economic importance of Samoa's coastline and the fact that seawalls, which already occupy much of Samoa's coast, are becoming more abundant, it is important to understand the implications of building them. The researcher found that partially due to climate change and sand mining, Samoa's coastline has become increasingly threatened by erosion and coastal retreat. Seawalls are in many cases the fastest and most effective way to stabilize a particular area of coastline. There are, however, downsides to seawalls such as their common tendency to accelerate erosion on adjacent land. The researcher proposes utilizing "soft stabilization" methods to protect coastlines wherever possible and only using seawalls as a last resort. When seawalls are built, the social implications should be taken into account and the overall costs and benefits should be analyzed, including externalities. Relocation of many coastal communities will also be a necessary long-term solution. Given predictions of a significant rise in sea-level over the course of the next century, it is imperative that Samoa manages and protects its coastline in the most effective way possible.

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To Soi Laititi in the village of Lotofaga.

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Last but not least, the people of Samoa

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Introduction:

One does not need to spend long in Apia, the capital city of The Independent State of Samoa, to notice the strong presence of the seawall. Alongside the main road, spanning from the wharf on one end of the small city to the end of the Mulinu'u peninsula on the other, the seawall is one of the defining physical characteristics of Apia. Outside of Apia as well, traveling along the coastal road that circles around the island of Upolu, one will quickly notice long stretches of seawall occupying much of the coast. Why are all these seawalls here? Who is building them? What are the implications of the seawalls for Samoa? In this study, the researcher examines the presence of seawalls in Samoa and their implications. The paper begins with background information about why seawalls are built, the environmental effects they often have and what some alternatives to seawalls are. Next, information is provided about two specific seawalls in Samoa, the Apia seawall and the Saoluafata seawall. After this is the analysis of the findings and suggestions for future coastal protection in Samoa.

In an island nation such as Samoa, where the vast majority of the population lives near the ocean, the coastline is a very important space. Samoa's coast has great cultural and economic significance for the people who live there. Given the importance of Samoa's coastline, it is imperative that people understand the geologic processes that go on there and the implications of human activity on these processes. The building of seawalls also has social and economic implications, which are essential to understand as well. In light of rising sea-levels and other factors that are thought to contribute to coastal vulnerability in Samoa, coastal protection is becoming an increasingly important issue for Samoa. As of now, seawalls appear to be the most appealing option for Samoans in terms of how best to protect their coasts. Therefore, it is

important to know what the implications of these structures are so that Samoa can make well informed choices in the future concerning coastal protection and adaptation to coastal retreat.

Methodology:

The research for this study was carried primarily between Tuesday, April 26th 2011 and Monday, May 9th 2011. Some of the information included in this paper was gathered before this time period, in the month of March as part of a previous study. Although this study is concerned with seawalls in Samoa in general, a few specific seawalls were studied more closely to be used as examples. The seawall in the Apia harbor and the seawall that was completed in 2005 along the shore of the village of Saoluafata are used as case studies. These seawalls are similar to one another in some ways and different from one another in many ways. Many of the implications and issues concerning seawalls in Samoa can be illuminated through discussion of the Apia wall and the Saoluafata wall.

Information for this paper was gathered from both primary and secondary sources. Primary sources cited in this paper include interviews, in person and by email, as well as surveys and observations. Formal interviews were conducted mostly with people from various environmental organizations that are active in Samoa. Some of the interviewees have been involved with carrying out specific seawall projects. Other interviewees were also very helpful because of their knowledge of other information such as climate change in the Pacific and environmental education in Samoa.

Informal interviews also yielded some very important information for this study. These interviews were mostly with people who live near seawalls in Samoa, concerning their views about specific seawalls. Informal interviews were particularly useful in contributing to the case

study of the seawall in the village of Saoluafata. Observations of these seawalls and some other coastal areas also contributed important information for this study.

Surveys were given out to residents of the village of Saoluafata. These surveys were used to evaluate the current status of the seawall project in Saoluafata and to find out what the villagers think about the project. A total of eleven surveys were filled out in the village. Respondents were chosen at random based on whoever the researcher could find who was willing and able to fill out a survey. The ages of the informants ranged from about nineteen to about sixty-five years old, although most informants were middle aged. Seven of the respondents were women and five were men. Some of the people who filled out surveys lived on the coast, right next to the seawall, while others lived further inland. Although the sample size is relatively small, these surveys reveal some of the common views that Saoluafata villagers have concerning their seawall.

Secondary sources that were used in this study include documents published by organizations involved with funding, carrying out, or assessing seawall projects in Samoa. In addition, secondary sources were used for background information on climate change and the resulting problem of sea-level rise in the Pacific. Secondary sources were used to gather information about the geology of seawalls. Finally, secondary sources were used to gather information about climate change adaptation methods for coastal erosion other than seawalls.

One of the most significant constraints to this study was time. Since the research topic was refined part way into the allotted time for the project, the researcher was only able to spend two and a half weeks on this study. Since much of the research for this study came from interviews, the researcher had to schedule many interviews on very short notice, but fortunately, most interviewees were very accommodating given these time constraints. Information about the

building of the Apia seawall was very hard to come by because it was built almost twenty years ago, before many of the interviewees began working in coastal protection. Had this study been carried out over a longer period of time, the researcher could have conducted interviews with more people and given out more surveys.

The language barrier was another obstacle. The researcher speaks very little Samoan. Fortunately, all of the interviewees from the various environmental organizations spoke fluent English so the researcher was able to communicate easily with them. Some of the residents of Saoluafata, however, spoke little or no English, which made giving out surveys and conducting informal interviews challenging. The surveys given out in Saoluafata were bilingual, but in some cases, the translations of questions or of answers might have caused confusion or misinterpretation by the respondents and the researcher.

Some of the residents of Saoluafata appeared to have a hard time reading and writing, which could have skewed their answers to the survey questions. Some of the answers written on the surveys reflect that the informants might have been confused about exactly what the question was asking. Some of the surveys were filled out as a group effort, which could also have skewed the results.

As with any study, the researcher's biases must be acknowledged. The researcher is not a resident of Samoa, so due to cultural differences, the researcher might interpret his findings differently than a Samoan would. In western cultures, environmental issues such as climate change are often viewed from a scientific perspective. Many Samoan are not necessarily aware of the science behind climate change, but they do witness first hand in their day-to-day lives its effects. Biases of interviewees may have also had an effect on the research. Someone who has been involved with a seawall project may be somewhat biased in their evaluation of that project.

Despite these constraints, the researcher did find a lot of useful, relevant information about seawalls in Samoa and their implications.

Acronyms:
CMADPIC: Capacity Building to enable Development of Adaptation Measures in Pacific Island Countries
CIDA: Canadian International Development Agency
EPA: Environmental Protection Agency
MNRE: Ministry of Natural Resources and Environment
PACC: Pacific Adaptation to Climate Change Project
SPREP: Secretariat of the Pacific Regional Environmental Programme
Samoan Words:
Matai: Chief
Fale: house

Threatened Coastlines:

Throughout the earth's history, coastlines all around the world have constantly been changing. Climatic changes have caused the global sea-level to rise and fall numerous times. Movement of tectonic plates and other geologic processes that occur in the earth's crust cause continents to move and new islands to rise out of the sea. The repeated pounding of waves on shorelines and forces of hurricanes and cyclones erode land, shaping coastlines. All of these processes are natural and have been occurring for as long as the oceans are old. Although much of the time, changes in coastlines happen on geologic timescales, over the course of thousands or millions of years, coastlines can change within human timescales as well. A tsunami can erode away a large area of land overnight. Humans all over the world who have built their homes, villages and cities next to the ocean have been faced with the unfortunate truth that coastlines are not as stable or permanent as we might like them to be. Building seawalls is one way that humans have attempted to cope with this dilemma. Seawalls are built to protect specific areas of land that are vulnerable to the sea and that are in some way important to humans.

The island nation of Samoa is one place where the ocean threatens land. It is no surprise then that seawalls line much of the coast. It is unknown exactly how many seawalls currently exist in Samoa, but the number of seawalls certainly appears to be increasing. Within the last decade at least four new seawalls have been constructed along the roughly 35 kilometer stretch of coast between Apia and the village of Lufilufi.[1] Although it is unknown how many seawalls have been built historically in Samoa, there is documentation of a sudden increase in the number of seawalls in the nearby island nation of Fiji. Prior to 1960, there were very few seawalls in Fiji. Since the 1960s, however, the number of seawalls has rapidly increased.[2] It is fair to assume that the apparent increasing number of seawalls in Pacific Island countries could reflect an increasing demand for seawalls by way of an increase in erosion and coastal retreat, and an increasing tendency to share lessons learned across the region. The idea that coastal erosion is increasing in Samoa matches both the predictions of scientists and the observations of Samoans who live along the coast.

Many factors could contribute to an increase in coastal retreat. As stated above, coastal retreat and erosion are natural processes, but there is reason to believe that anthropogenic activity, meaning human activity, could be a major factor in the increase of erosion and coastal retreat currently occurring in Samoa. The theory of anthropogenic global warming (also known as climate change) is widely accepted in the scientific community. In short, the theory states that the increase in greenhouse gas concentrations in the atmosphere due to anthropogenic activity is causing the average global atmospheric temperature to rise. The impacts of global warming will vary greatly all over the world. Some areas are expected to get warmer, some colder, some drier, and some more humid. Due to the complexity of the global climate system, it is impossible to

[1] (Fa'asisila, 3 May. 2011)
[2] (Mimura, 1999)

know exactly what impacts of global warming will be in any given region. It is widely believed, however, that "Pacific Islands are in one of the most vulnerable regions in the world."[3] Although there are many ways in which Samoa is vulnerable to climate change, this paper will only deal with two ways: sea-level rise and the intensification of storms. These two climate change impacts are relevant to this study because they threaten the coasts of Samoa, the areas that seawalls are built to protect.

As of 2003 the global sea-level had already been rising at a rate of 1-2 mm/yr.[4] Global warming is expected to increase this rate of sea level-rise by causing ice caps to melt and by causing thermal expansion in the oceans. Computer models have predicted that the rate of sea-level rise will increase to about 4 mm/yr.[5] The United States EPA says that a 1.2-2.2 meter sea-level rise by 2100 is a possibility.[6] Samoans who live along the coast are already noticing the sea-level rising and threatening their land.

In addition to accelerating sea-level rise, climate change is expected to cause an intensification of cyclones and tropical storms.[7] When a cyclone is forming, the warmer the ocean water, the more energy the storm builds. Average air temperatures at the earth's surface in the South Pacific region are predicted to increase between .6 and 3.5ºC by the year 2100.[8] A rise in air temperatures will lead to a rise in surface temperatures of the water, thus leading to more intense storms. Samoa has experienced the terrible destructive forces of cyclones Ofa and Val in the 1990s. Cyclones are undoubtedly one of the biggest threats to Samoa's coastline and global warming is thought to be amplifying this threat.

[3] (Hay, et al., 2003)
[4] (Hay, et al., 2003)
[5] (Hay, et al., 2003)
[6] (Pilkey & Wright III, 1988)
[7] (Hay, et al., 2003)
[8] (Hay, et al., 2003)

Anthropogenic activities have also affected the Samoan coastline in much more direct ways. One way is by sand mining. Sand is extracted from beaches or dredged from offshore and used to make concrete. Sand mining takes place in Samoa on a large scale, with companies using machinery to extract sand in large quantities, and also on a small scale with families extracting sand with shovels.[9] The removal of sand can be very detrimental to the stability of Samoa's coasts. It is obvious how removing sand from a beach affects the coast in that location. Not quite as obvious, however, is the effect that dredging offshore can have on the coast. The topography of the seafloor affects the strength of waves and the movement of ocean currents that in turn affect the coastline. Under water sandbars can be very important protectors of the shoreline. Examples of sand mining leading to erosion will be discussed later in this paper.

Although there is strong evidence that climate change and sand mining are having significant effects on Samoa's coastline, they cannot be blamed for all of the erosion that takes place there. Many factors affect a coastline including natural processes. Each coastal environment is unique. Whatever the reasons are, Samoa's shores are clearly vulnerable to erosion and inundation and this problem must be addressed or severe damage to coastal communities will occur.

Seawalls as a Response to Threatened Coastlines:

Seawalls have been and continue to be one of the major ways that Samoans choose to protect their coasts. As previously mentioned, many seawalls have already been built, and it doesn't look like people are going to stop building them any time soon. SPREP (Secretariat of the Pacific Regional Environmental Programme) is about to commence new coastal protection projects in three Samoan villages, which will likely include building seawalls, given the

[9] (Carter, 1989)

popularity of this option among the general public.[10] The appeal of building a seawall is obvious. They are generally very effective protectors of the land where they are built. A seawall is a straight forward solution to coastal erosion and its effectiveness is visually obvious.

There are, however, downsides to seawalls. Seawalls are thought to be particularly detrimental to beaches, which are an important resource for Samoa for both sand mining and tourism. Seawalls can create standing waves, intensifying erosion in front of them. They often disrupt the natural process known as "long-shore transport" in which sand is carried horizontally along shorelines, replenishing eroded areas. This effect, according to Espen Ronneberg of SPREP "also has seasonal variation, depending on the ENSO effect at the time, and could result in greater or lesser erosion during a particular 6-month period, with a return to the opposite for the next 6-month period."[11] As a result, areas surrounding seawalls often suffer more coastal retreat as a result of the seawall. According to the U.S. Army Corps of Engineers, if a seawall is built on a receding shoreline, "the recession will continue and may be accelerated on adjacent shores. Any tendency towards loss of beach material in front of such a structure may well be intensified."[12] There have been many cases in which seawalls spread all along a shoreline because they keep accelerating erosion next to them. The most famous example is in the state of New Jersey where a hundred miles of coastline is now covered by seawalls. The process of seawall spreading has now taken on the name "New Jersyification."[13] Although seawalls are generally very effective at protecting the land behind them from slow systematic erosion, there have been cases when dislodged boulders of failing seawalls actually end up creating more damage in extreme storm events. Boulders from seawalls have been found over a hundred meters

[10] (Ronneberg, 26 April. 2011)
[11] (Ronneberg, 12 May. 2011)
[12] (Pilkey & Wright III, 1988)
[13] (Pilkey & Wright III, 1988)

inland after tsunamis and cyclones (See Appendix A).[14] Although many seawalls have been known to have these negative effects, some seawalls have not caused these problems because each coastal environment is unique.[15]

Seawalls are a form of "hard stabilization." Also in this category are groins, which are walls that stick out to sea, perpendicular to the shoreline rather than parallel.[16] Groins have many of the same negative effects as seawalls. There are other options for protecting shorelines. These "soft stabilization" options include things like "coastal management planning, beach replenishment, dune creation and restoration, ecosystem (e.g. mangroves) restoration and enhancement, and coastal tree planting."[17] Another form of "soft stabilization" that is accessible to Samoan people is coral gardening. A shallow coral reef circles much of the country's shoreline, particularly around the island of Upolu, the most populated island and the location of the capital city, Apia.[18] These forms of shoreline protection do not have the negative effects of seawalls such as of causing more erosion around them and depleting beaches. There are, however, different drawbacks to "soft" options. As much as the coral reef or a mangrove forest does limit the strength of waves that reach the shore, it cannot necessarily hold back the powerful waves of a cyclone or protect the shore from storm surge the way a seawall can. In addition, "soft stabilization" often takes much longer to become effective than do seawalls. It takes decades for trees to grow to full size, whereas a seawall can be erected in under a year. "Soft stabilization" efforts are being made in Samoa, sometimes on their own and sometimes in addition seawall construction. Now that the basics of why Samoa's coasts need protection and

[14] (Ronneberg, 26 April. 2011)
[15] (Pilkey & Wright III, 1988)
[16] (Pilkey & Wright III, 1988)
[17] (Hay, et al., 2003)
[18] (Rasmussen, 5 May. 2011)

what options Samoa has to protect them have been presented, a detailed description of two specific Samoan seawalls will be provided.

Case Study Seawalls:

The Apia Seawall:

The Apia seawall is roughly 4.5 kilometers long. It is what is called a "rubble mound seawall," which consists of a mound of boulders. The boulders that make up the wall are generally .3 m to 1 m in diameter. The mound is constructed at a slope of roughly 30º-40º. Supporting the mound of boulders from behind is a cement cap. This cement structure runs parallel to the main road through Apia and is generally between .5 m and 1 m above the footpath. The top of the seawall is generally between 2.5 and 4 m above high tide sea-level.[19] On the eastern end of the seawall, it meets the Apia wharf. On the western end, the wall rounds the end of the Mulinu'u Peninsula and then tapers off. Some groins, roughly 10 meters long protrude out from the Mulinu'u side of the wall. There are some staircases and ramps spread out along the seawall that provide people with access to the ocean. (See Appendix B).

Building a wall the size of the one in the Apia harbor is no small undertaking. The project, which was funded by Japan, cost millions of dollars.[20] The construction of this wall took place between 1990 and 1994. The construction of the wall was one of Japan's many efforts to help Apia recover after Cyclone Ofa.

Cyclone Ofa hit the northern side of Samoa, where Apia is located, in February 1990, causing seven deaths and millions of dollars of damage, according to some estimates.[21] Although some of the damage was caused by extreme winds and rainfall, the worst problems for Apia came from the sea. The combination of huge waves and the storm surge that lasted 2-3 days

[19] (Solomon, 1994)
[20] (Solomon, 1994)
[21] (Rearic, 1990)

caused serious damage in the harbor and in the city.[22] One resident of Vailele, a village near Apia, reported that the streets of Apia were flooded from the storm surge. The storm, she reported, also destroyed the Apia harbor to the point that ships could not land there for weeks after the storm.[23]

Although the wall was built as a direct result of Cyclone Ofa, Apia's coastline was in need of some protection from erosion even before the storm, particularly along the Mulinu'u Peninsula. There had actually been a previous seawall built there, but that wall had failed sometime before 1980.[24] The Mulinu'u Peninsula has been undergoing changes due to erosion since at least 1954.[25] Even before Cyclone Ofa, erosion was a serious problem and was threatening to wash away burial grounds located in the Mulinu'u Peninsula.[26] One of the major catalysts for the erosion in this location is thought to be dredging for sand that had been taking place right off the coast. An estimated 420,000 cubic meters of sand were removed from this area over the course of 15 years of sand mining. About 12 m of land was eroded away from the Mulinu'u peninsula during this time period.[27] When this dredging decreased in the 1980s, so too did erosion.[28]

As of 2011 the Apia seawall appears to be fully intact and still functioning. The Mulinu'u Peninsula, which had previously been constantly changing due to erosion, appears to be stable for the time being. Some of the reclaimed land on this peninsula, land that was once ocean, is now home to government buildings, the fish market and a major bus parking lot. Without the seawall, this infrastructure could not exist, or would at least be extremely vulnerable to erosion.

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[22] (Rearic, 1990)
[23] (Fa'asisila, 3 May. 2011)
[24] (Carter, 1989)
[25] (Solomon, 1994)
[26] (Carter, 1989)
[27] (Solomon, 1994)
[28] (Solomon, 1994)

The wall, which was not yet completed at the time, was put to the test when Cyclone Val struck in December of 1991.[29] Although the strength of Val was comparable to that of Ofa, Apia's harbor fared better in the second storm, presumably because of the seawall.[30] After Cyclone Val, ships were able to land in the Apia harbor within a matter of days, a large improvement over the way things played out after Cyclone Ofa.[31] In terms of protecting Apia and the Mulinu'u Peninsula from the sea, the Apia seawall appears to be doing its job. According to Moira Faletutulu, PACC (Pacific Adaptation to Climate Change Project) Coordinator at MNRE (Ministry of Natural Resources and Environment), "the Apia seawall is well designed and it's serving its purpose well."[32]

The Apia seawall, however, is not simply a protector of the city's coastline, but has also taken on social functions and cultural meanings. The cement cap that runs behind the mound of boulders makes the coastline an accessible place to walk, jog or sit. Particularly in the morning and the late afternoon, it is common to see people going for a walk or a job on the seawall. The wall is also commonly used by tourists as a place to walk or sit and enjoy the sites of the harbor and downtown Apia. The seawall is also a place where couples can be found sitting together, talking. On a Thursday afternoon, walking along the Mulinu'u side of the seawall, the researcher witnessed four separate couples sitting on the seawall. It is possible that couples sit on the seawall because it is a place where they can find some relative privacy compared to the communal living situation they likely have at home. It is not common to see people swimming off of the seawall, but it does happen from time to time. During the daytime, the Apia seawall is generally a safe and peaceful place.

[29] (Gill, 1994)
[30] (Fa'asisila, 3 May. 2011)
[31] (Fa'asisila, 3 May. 2011)
[32] (Faletutulu, 6 May. 2011)

When the sun goes down, however, the social functions and meanings of the seawall transform. It is a commonly known fact in Apia that the seawall can be unsafe at night. The seawall is a place where there is a lot of crime, especially the area right in front of Apia's night clubs. When the night clubs close many drunken people who do not want the end their night just yet chose to loiter on and around the seawall. Physical fights sometimes break out on or near the seawall at night. One informant told me that one of his friends had once drunkenly passed out on the seawall and woken up to people trying to steal his wallet from his pockets.[33] The seawall has also been known to be used as a place to have sex and do drugs. Although the Apia seawall is very important to discuss because of its social significance and the fact that it protects Samoa's only city, it is not necessarily representative of Samoan seawalls in general because most of Samoa's coastline is occupied by villages, not cities. The next section of this paper is a description of the seawall that now exists in the village of Saoluafata.

The Saoluafata Seawall:

Saoluafata is a village roughly 30 kilometers east of Apia- a half-hour bus ride along the coast. The wall is a little over 2 kilometers long. Like the wall in Apia, the Saoluafata wall is a "mound seawall" that is constructed of boulders piled on top of one another to form a diagonally sloped barrier. The pile of boulders sits on a bed of sand, a meter or so of which is exposed at low tide. The top of the wall is about 1.5 meters above the sand. Unlike the Apia seawall, there is no cement cap behind the boulders supporting them. At the top of the wall there is a neat row of plants lining the edge of the land. Directly behind the plants there are yards and homes of Saoluafata villagers. Like the Apia seawall, there are a few locations along the Saoluafata wall where there are stairs, providing access to the water. There is a small stream coming from the

[33] (Anonymous Interviewee A, March. 2011)

wetland that runs into the ocean in the middle of Saoluafata. At this location, the seawall curves in and lines the shores of the stream for about 5 meters. (See Appendix C).

On the main road running through Saoluafata, there is an old, beaten up sign for "Saoluafata beach fales." Although the sign remains, the beach resort no longer exists. Before Saoluafata's beaches were eroded away these beach *fale* were a major source of income for some families in Saoluafata. According to one resident of Saoluafata, there were always tourists staying in the beach *fale*, every single day. Now that source of income is gone.

The seawall project in Saoluafata was one of nine CBDAMPIC (Capacity Building to enable Development Measures in Pacific Island Countries) pilot projects carried out in the South Pacific islands between January 2002 and March 2005.[34] All nine of these pilot projects were funded by Canada's CIDA (Canadian International Development Agency) and executed by SPREP.[35] The projects were carried out in four Pacific countries- The Cook Islands, Fiji, Vanuatu, and Samoa. The goal of these CBDAMPIC pilot projects was to help build capacity for Pacific Island communities to adapt to threats of climate change. According to the economic assessment of the CBDAMPIT pilots, which was produced by the International Global Change Institute at the University of Waikato in New Zealand, "Without exception, pilots were extremely successful: there was a high degree of community participation and in-kind contributions, both problems and solutions were linked to climate change and all communities felt a big improvement in day-to-day life."[36]

Anne Rasmussen, who is now the Principal Climate Change Officer/ Project Manager at MNRE and was the Assistant Coordinator of the Saoluafata CBDAMPIT project, says that the

[34] (Kouwenhoven & Cheatham, 2006)
[35] (Kouwenhoven & Cheatham, 2006)
[36] (Kouwenhoven & Cheatham, 2006)

project was "very well researched" and a "big success."[37] As of 2006, the last time the project was monitored, it was still benefitting the village and surrounding villages were not complaining of any negative effects. According to Rasmussen, one of the most notable reasons for the project's success was the fact that it was carried out in a bottom-up manner. She says that "villagers made all of the decisions," and anecdotal evidence was used to identify the problems. *Matai*, women, youth, untitled men and religious leaders were all consulted with before the project was carried out. While villagers were heavily involved in planning and decision making, the wall was actually built by private contractors. Another reason why the project has been successful is that much more was done than simply building a seawall. There was an educational component to the project in which villagers were taught about coral gardening and the importance of protecting their reef. There was revegetation of the coast and the wetland. The village water tank was upgraded. Even the seawall was "not an everyday seawall," according to Rasmussen.[38] Prior to building the seawall, experts studied the coastal environment and the effects the wall might have on aquatic life.[39]

No formal assessments of the Saoluafata adaptation project have been carried out since the International Global Change Institute's economic report in 2006.[40] As part of this study, a survey was handed out to residents of Saoluafata to determine the current status of the project (See Appendix D).

The first question on the survey asked the residents why they think the seawall was built and what the problems were before the wall existed. All of the answers referred to the ocean threatening the land, or important things on the land. Eight of the eleven respondents mentioned

[37] (Rasmussen, 29 April. 2011)
[38] (Rasmussen, 29 April. 2011)
[39] (Rasmussen, 29 April. 2011)
[40] (Kouwenhoven & Cheatham, 2006)

waves as a major problem for the village. The waves were reported to be strong and getting too close to homes. Six of the respondents said the seawall was built to protect the land. They reported that the main problem before the wall was that land was being washed away, particularly their beach. Three of the respondents said that the reason for building the seawall was to protect houses. One respondent reported that waves were coming into some homes and other homes had been washed away.

The second question on the survey asked the residents why they think the problems they reported were occurring. Some of the respondents appear to have misunderstood the question because they simply restated problems that were occurring rather giving reasons for the problems. Four respondents said that the problems were occurring because there was no seawall or other protection. Four respondents reported that the problems were occurring because the sea-level was rising. One respondent said that over time the waves were getting rougher. One respondent said that the reason for the problems was that sand was being taken away by companies for business purposes.

The third question on the survey asked the residents whether or not the seawall had solved the problems identified. All eleven respondents checked "yes."

The fourth question on the survey asked the residents how else they could have dealt with their problems had the seawall not been built. Two of the respondents did not write in an answer for this question, which can be interpreted to mean that they did not understand the question or that they did not know an answer to the question. One respondent wrote, "I have no idea." Two respondents said that the people of the village would have worked together and moved stones to build a seawall on their own. Five respondents said that there were no other options to deal with the problem other than moving away from the shore.

The fifth question on the survey asked the residents whether or not any of the old problems have come back or new problems arisen, and if so, what problems? One responded checked both "yes" and "no" and did not provide a reason. Seven respondents reported that no old problems have come back or new problems arisen. Of the three respondents that did report that there are problems, one did not specify what the problems are, and the other two reported that the rocks of the seawall are sinking or falling down.

The sixth question on the survey asked the residents whether or not the people of Saoluafata helped with the seawall project, and if so, how they helped. All eleven respondents reported that people of Saoluafata did help with the project. Four respondents reported that the village helped with actually building the wall. Four respondents said that villagers helped with planning the project. Some respondents wrote in other ways that the village helped with the project, including providing food for the workers and providing the rocks from which the wall is made.

The final question on the survey asked the residents whether or not they think their seawall has or could affect other nearby villages, and if so, how? One respondent did not answer the question. Seven respondents said "no," the seawall had not and could not have an effect on other villages. Of the three that said their seawall could affect other villages, none of them gave a clear answer as to how exactly the seawall could affect other villages but one respondent did refer to poor design.[41]

Based on reports from the people of Saoluafata, people who were involved with carrying out and assessing the project, and the researcher's observations, the condition of Saoluafata's coastline appears to be much better now than it was before the construction of the seawall. Waves are no longer crashing in peoples' homes. According to one man who lives right behind

[41] (Saoluafata Seawall Survey, 2011)

the seawall, sand is returning in front of the seawall, making it suitable for swimming again. Most importantly, the land appears to be stabilized for the time being.

Analysis:

It is clear that Samoa's coast is a very important location for cultural and economic reasons. It is also clear that Samoa's coast is a very vulnerable location due to sea-level rise, sand mining and whatever other processes might be contributing to the coastal retreat. Certainly coastal retreat, to the extent that it can, should be dealt at the source of the problems. Sand mining must be controlled and regulated so as not to cause damage to the shoreline. Climate change mitigation is extremely important for Samoa's coasts, but considering how little Samoa contributes to total anthropogenic greenhouse gas emissions compared to larger, more developed nations, it has very little power to mitigate climate change. Samoa is going to need to figure out how to adapt to many of the impacts of climate change, including the increase of coastal erosion. The central questions remain what role should seawalls play in protecting Samoa's coasts? In what ways are seawalls a good option for Samoa and in what ways are they not? What other options do the people of Samoa have? How should seawall projects be carried out to be the most cost-effective and beneficial to Samoan people?

The erosive effects that seawalls often have on the land in front and around them are well known. Although more research would be needed to determine definitively whether or not any of the seawalls that have recently been constructed in the area between Apia and Lufilufi were built as a result of adjacent seawalls, there is a strong likelihood that this is the case. The new seawall which is in front of the tourist destination, Piula Cave Pools, was constructed starting in 2010.[42] Given its location, a few hundred meters from Saoluafata, and the timing of its construction, it is

[42] (Anonymous Interviewee C, 4 May. 2011)

a reasonable possibility that this wall needed to be built as a result of deflected erosion from the Saoluafata wall. When taking into account the externalities of building a seawall, one of which being the possibility that it will damage adjacent shorelines, building a seawall is not necessarily such an economically sound decision. Money spent on one seawall may benefit one village, but the environmental degradation that may occur in the neighboring village could offset that gain. According to Moira Faletutulu, PACC coordinator at MNRE, "erosion does happen around seawall areas but only for poorly designed ones."[43] But even if seawalls are well-designed, their costs may still outweigh the benefits, or in many cases, the costs may simply be too much for a village to afford. The Saoluafata seawall cost WST$156,196.[44] This is far too expensive for most villages to build on their own without government or foreign aid. A well designed seawall, says Ronneberg, "with sloping and anchored stones is also more expensive than the privately built seawalls around the island, but as the USGS survey after the tsunami showed, these can contribute to massive inland damages as well."[45]

Samoa is definitely going to need to utilize "soft stabilization" options. Samoa is fortunate to have mangrove forests in some areas and a coral reef surrounding much of its coastline. The importance of these natural assets should not be underestimated. Their preservation is essential to Samoa's efforts to protect its coast. Preservation efforts are already underway. Mangrove protection is taught in schools. Certain areas of coastline around the country are closed off for a few years at a time to allow the coral to regenerate.[46] Preservation of natural protectors should be continued and even increased. Unfortunately, "soft stabilization" options cannot save every village.

[43] (Faletutulu, 6 May. 2011)
[44] (Kouwenhoven & Cheatham, 2006)
[45] (Ronneberg, 12 May. 2011)
[46] (Rasmussen, 5 May. 2011)

The fact that not one of the eleven survey respondents in Saoluafata believed there was any other way the village could have saved its coast is telling of the dire situation they were in. One man in Saoluafata said straightforwardly, "if we didn't have the seawall, our village's land would be destroyed."[47] Processes like coral gardening cannot save homes that already have waves crashing in them. In some cases, a seawall may be the only way to protect an area of land.

But even if future seawalls are designed well and do not cause any extra erosion, are they a long term solution or simply a way of putting off the problem for a while? None of the seawalls currently lining Samoa's coastline could protect the shore from the two meter rise in sea-level that is a projected possibility by 2100.[48] According to researcher, Patrick Dunn, artificial structures, such as seawalls, can only provide short-term protection. The long term solution in most cases, says Dunn, appears to be relocation.[49]

Relocation is easier said than done. For one thing, the coast is very important to Samoan culture and it is the home of most Samoans. In their economic report of the Saoluafata seawall project, Kouwenhoven and Cheatham speak of the importance of the land for the people of Saoluafata saying, "Their land is their heritage and their home; the people of Saoluafata see retaining their land as a priority to them."[50] Coastal land is also a very important resource for Samoa's for tourism industry. Beach *fale* resorts are one of the biggest attractions for tourists who come to Samoa. If beach *fale* resorts are forced to move away from the coast, Samoa's annual revenue from tourism is sure to decrease.

Although scientists agree that a significant sea-level rise is very likely to happen, science is not necessarily one of the first authorities that Samoan people answer to. The fact that none of

[47] (Anonymous Interviewee B, 4 May. 2011)
[48] (Pilkey & Wright III, 1988)
[49] (Nunn, 1989)
[50] (Kouwenhoven & Cheatham, 2006)

the respondents on the survey conducted in Saoluafata mentioned climate change as a reason for their coastal problems reflects the relative insignificance that scientific theories have in their views. Some Samoans are not worried about sea-level rise because they believe that God promised not to flood the earth again.[51] Even for those who do know about and believe the scientific predictions, it is unlikely that they will make the decision to move away from the land that is their home based on a future prediction because Samoans live very much in the present. Unfortunately, it might take a natural disaster to prompt people to relocate, as it did for the village of Salepaga, among others. Anne Rasmussen, who was the Assistant Coordinator of the Saoluafata seawall project hopes that villages will realize that relocation "needs to happen."[52]

But even if a village or a family wishes to relocate further inland, they may not have the money nor the land to do so. Geographic barriers can also make relocation hard. There are areas like in the village of Solosolo, for example, where there is a narrow rim of land along the coast, just big enough for a few homes, with a steep cliff directly behind it. The people who live there cannot simply move back.

One interviewee, a beach *fale* resort owner on Manono Island, and a survivor of the devastating 2009 tsunami did chose to relocate. After all of their property had been destroyed, he and his family rebuilt their *fale* and their beach *fale* resort further inland, on higher ground. He reported, however, that his family and the guests staying at the resort still always seemed to hang around by the water. He and his family are currently in the process of constructing a Samoan *fale* right on the coast. Perhaps this family's way of coping with the threat of the ocean invading their land is a good one. They are keeping their home and their resort safe from the ocean, but not removing themselves and their guests from it altogether. This option is only available to those

[51] (Ronneberg, 26 April. 2011)
[52] (Rasmussen, 5 May. 2011)

who have enough money and land. Although the long-term solution may well be relocation, it is not an easy solution for the reasons stated above. Surely it will take time for the population of Samoa to move inland. In the meantime, there are villages that need protection now, just as Saoluafata did a few years back. Seawalls are in many cases the best way to provide this short-term protection.

When a seawall is going to be constructed, it is important to carry out the project taking environmental, economic and social implications into consideration. The seawall project in Saoluafata is in many ways a prime example of how best to build a seawall. The community-based approach to this project should be emulated in future seawall projects. Not only is their knowledge about their land and the problems that need to be addressed important to developing effective solutions, but local people can also achieve a sense of empowerment by working towards solutions for their village. The holistic approach that CBDAMPIC took in Saoluafata by incorporating education and revegetation of the coastline into its work in addition to constructing the seawall should also be emulated in future seawall projects.

Unfortunately, CBDAMPIC did not consult with or even inform surrounding villages of the seawall project in Saoluafata, due to a lack of financial and technical capacity.[53] Based on the results of the final question on the Saoluafata Seawall Survey, most people in Saoluafata were not aware that their wall could affect other villages. Since seawalls have been known to have effects on adjacent land, all future seawall projects should include an assessment of possible erosion deflection and consultation with surrounding communities.

The social implications of seawalls should also be taken into account during their construction. The accessible cement cap of the Apia seawall makes it more than simply a protector of the coast. By providing a place for people to exercise, the seawall has presumably

[53] (Rasmussen, 29 April. 2011)

benefitted people's health in Apia. This is not to say that cement caps should be part of all seawalls, rather that the social functions that seawalls can serve should be taken into account when designing them. Some seawall projects are more effective than others. All of the available knowledge about seawalls and their implications should be taken into consideration with future seawall projects in Samoa.

Conclusion:

Given the rate at which seawalls have already been appearing on Samoa's coastline and the fact that the global sea-level is rising and storms are expected to get worse, it is not hard to imagine seawalls spreading and covering up more and more of Samoa's pristine coastline. Especially if walls are designed poorly, chain reactions of "New Jersyification" could occur. An island surrounded by walls conjures up images of a castle under siege. The ocean is, in fact, attacking Samoa's coastline slowly, but surely. Being surrounded by walls could also be taken to represent being trapped. This may be a good way to describe Samoa's plight in the face of the global climate change crisis. But even though a small place like Samoa, which is only responsible for a tiny fraction of global anthropogenic greenhouse gas emissions, may have little power to mitigate climate change, the people of Samoa do have the power to adapt to it.

Adaptation will not be easy, but through a combination of "soft stabilization" and "hard stabilization" to protect that coast, and the inevitable long term solution of relocation, Samoa can navigate through the adversity its coasts are predicted to encounter. Seawalls will certainly play an important role in Samoa's future. For villages in dire situations of coastal retreat, seawalls can stabilize the coast for the short-term very quickly and very effectively. But seawalls are only part of the solution. Samoa needs to prioritize the preservation of its natural coastline protectors- mangroves, the coral reef and coastal forests. The threats of coastal retreat and erosion as well as

the importance of "soft" solutions should be emphasized in school curricula so that the upcoming generation will be ready to meet the environmental challenges before them. Finally, people will need to accept that relocation is going to be necessary for many coastal communities in the coming century. Seawalls have improved and even saved many lives in Samoa. But the view that many Samoans have now, that "a seawall will solve all of their problems," needs to change.[54] There are other options available to adapt to coastal retreat. Seawalls should be seen as a last resort

[54] (Rasmussen, 5 May. 2011)

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Saoluafata Seawall Survey. (4 May. 2011)

Appendix A: Image from U.S. Geological Survey

Appendix B: The Apia Seawall

Appendix C: The Saoluafata Seawall

Appendix D: Saoluafata Seawall Survey

O le a le mafuaga na fau ai le taligalu I lo tou nu'u? O a ni fa'a fitauli sa iai a'o le'I fai le taligalu?
Why was the seawall built? What were the problems before the wall?

Aisea na tupu ai na fa'afitauli?
Why were those problems happening?

Sa fofo e le taligalu fa'afitauli sa iaa?
Did the seawall solve the problems?

ioe/*yes* leai/*no*

Ana le fau le taligalu, e fa'apefea ona fofo na fa'afitauli?
If the seawall had not been built, how else could your village deal with those problems?

Sa toe amata nisi fa'afitauli tuai talu ai le taligalu? E iai ni fa'afitauli fou?
Have any of the old problems come back or any new problems arisen?

ioe/*yes* leai/*no*

Afai ioe, o le a fa'afitauli?
If yes, what problems?

Sa fesoasoani tagata a le nu'u i le faiga o le taligalu?

ioe/*yes* leai/*no*

Afai ioe, e fa'apefea?
If yes, how so?

1) Fuafuaga/*Planning* 2) Fausaga/*Building* 3) Isi mea/*Other*:_____

O le a lou silafia, ua afaina isi nu'u latalata i lo tou nu'u ona o le taligalu?
Do you think your seawall has affected or could affect other nearby villages?

ioe/*yes* leai/*no*

Afai ioe, e fa'apefea?
If yes, how so?