CLIMATE CHANGE TOOLKIT FOR HAWAI'I'S COASTAL COMMUNITIES

Pilot Project

June 2024

Prepared for:
State of Hawai'i
Hawai'i Technology Development Corporation

By:
Oceanit Research Foundation

Mantokuji Bay, Maui was the focus of this pilot

EXECUTIVE SUMMARY

This Toolkit combines science and technology, team collaboration, and community building skillsets.

Sea Level is rising globally and locally, and sea level rise rates are expected to accelerate. This will add pressure to already eroding beaches and coasts throughout Hawai'i. To address this multifaceted community-wide issue the concept for a Climate Change Toolkit was developed. This Toolkit combines science and technology, team collaboration and community building skillsets. This approach was piloted in collaboration with the Pā'ia Mantokuji Soto Mission.

The **primary** goal of this project is to increase public awareness of coastal erosion caused by climate change and sea level rise. To accomplish this goal, a team of mentors worked with student interns to empower them with the knowledge and tools to understand climate change, sea level rise and its impacts on our coastal communities. The students were provided training necessary for critical thinking and analysis, communication and team collaboration, data gathering and problem solving with the use of technology to consider possible adaptation pathways. The intention is for these students to become "ambassadors" and create awareness on the effects of climate change on Hawai'i's coastline and their communities.

A **second** goal is to develop a toolkit that will help students and their community understand how climate change and sea level rise are affecting our coastlines. To accomplish this goal, the students were provided the opportunity to learn technical skills through hands-on experiences and active engagement with mentorship guidance and support. The skillset includes biological assessment, water quality sampling, beach sand evaluation, topographic mapping, ocean current measurements and real-time coastal monitoring. The student interns used the gathered data to develop a better understanding and new insight of the dynamics in Mantokuji Bay.

The Toolkit framework applied to the pilot project at Mantokuji Bay can be used to study and create a community discussion on sea level rise and the coastal erosion threats for any of Hawai'i's unique coastal communities.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

On behalf of the Oceanit Research Foundation Board members we thank the leaders of the Pā'ia Mantokuji Soto Mission (Mantokuji), the University of Hawai'i Maui College, the student interns and their mentors from Oceanit for their participation on this Project.

We also thank the Hawai'i Technology Development Corporation for its support and the Hawai'i State Legislature for providing the grant to conduct this project.

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TOC

INTRODUCTION

ORF is dedicated to developing programs through curriculum, community outreach, and promoting STEM programs to students of all ages.

The Oceanit Research Foundation (ORF) is a non-profit entity dedicated to developing programs through innovative curriculum, community outreach and promoting Science / Technology / Engineering / Math (STEM) programs to students of all ages.

Through the State of Hawai'i 2023 Grant in Aid Program, Oceanit Research Foundation (ORF) developed a pilot Project "Climate Change Toolkit for Hawai'i's Coastal Communities" designed to promote awareness, understanding and community discussion of the long-term impact of climate change and sea level rise.

The foundation of this Toolkit project was built on years of work conducted by Oceanit Laboratories, Inc. (OLI) on projects with our coastal communities. OLI's approach combines their experience and expertise in ocean engineering with unique tools including design thinking, advanced computer programming, artificial intelligence and other technologies.

This approach is critical in understanding the complex issue of climate change and sea level rise and for developing effective strategies for our island communities to adapt to coastal erosion.

ORF collaborated and partnered with OLI to develop the Toolkit and the Pā'ia Mantokuji Soto Mission temple on this Project. ORF also collaborated with the University of Hawai'i Maui College.

MANTOKUJI CLIMATE TOOLKIT REPORT

Important Information

Video Report Available

A video report is available online by **clicking this link**

The Video Report can also be accessed by scanning the QR Code above

Supplemental

This written report provides supplemental materials

PROJECT GOALS

- ✓ To increase public awareness of coastal erosion caused by climate change and sea level rise;
- ✓ To develop a toolkit that will help students and the community understand how climate change and sea level rise are affecting our coastlines.

WHY A TOOLKIT?

Climate change and sea level rise are accelerating causing coastal erosion that will impact our buildings, roadways and critical infrastructure that serve our communities - including underground electricity, gas, water, sewerage and communication services.

With the understanding that there is no one-size-fits-all solution to coastal erosion, the toolkit is intended to increase awareness of the effects of climate change and sea level rise, and study approaches and strategies to address the conditions and needs of unique regions in the State of Hawai'i.

This pilot Project was designed to empower student interns with the knowledge and tools to understand climate change, sea level rise, and its impacts on our coastal communities.

OLI developed the Toolkit to provide the students the opportunity to learn by doing through hands-on experiences and active engagement with mentorship guidance and support.

Working with the mentors, the students were provided training necessary for critical thinking and analysis, communication and collaboration, data gathering, team building and problem solving with the use of technology and monitoring to help chart adaptation pathways.

This Toolkit can be used on any coastline in developing effective erosion control measures that can be adapted to regional conditions and needs.

TOC

WHY THIS PROJECT IS IMPORTANT

Our response to coastal erosion adaptation strategies and management are critical for our communities to address and prepare for coastal erosion.

1. Sea Level is rising globally and locally, and sea level rise rates are expected to increase.

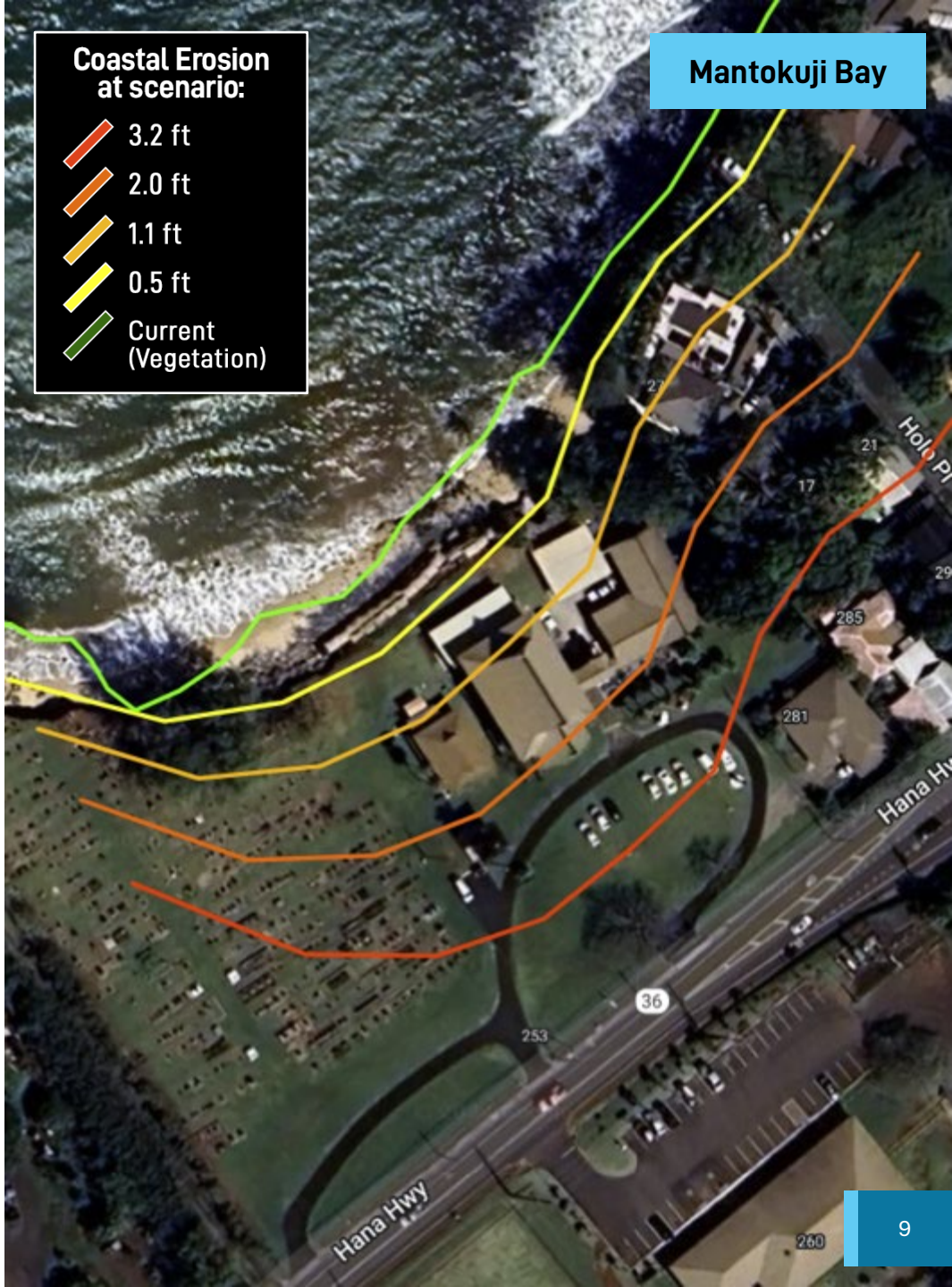
   Source: https://www.epa.gov/arc-x/climate-adaptation-and-sea-level-rise

2. There is scientific consensus for 1 foot of global sea level rise by the year 2050, and 3 feet or more by the year 2100.

   Source: https://www.epa.gov/arc-x/climate-adaptation-and-sea-level-rise

3. Increases in sea level will result in increases to local erosion rates and will add pressure to already eroding beaches and coasts throughout Hawai'i.

   Source: Hawai'i Climate Change Mitigation and Adaptation Commission. 2021. State of Hawai'i Sea Level Rise Viewer. Version 1.12. Prepared by the Pacific Islands Ocean Observing System (PacIOOS) for the University of Hawai'i Sea Grant College Program and the State of Hawai'i Department of Land and Natural Resources. https://www.pacioos.Hawai'i.edu/shoreline/slr-Hawai'i/



WHY MANTOKUJI WAS SELECTED FOR THIS PILOT PROJECT

1) This coastline represents the erosion threat of one of Maui's historic landmarks, the Pā'ia Mantokuji Soto Mission temple, which is listed on the Hawai'i State Register of Historic Places.

2) Mantokuji Bay lies within the 3.2 feet coastal erosion zone identified by the "Hawai'i Climate Change Mitigation and Adaptation Commission."

3) The erosion claimed about 1 acre of Mantokuji land over the years. According to a study by the Coastal Geology Group, School of Ocean and Earth Science Technology, at the University of Hawai'i, the Mantokuji Bay shoreline is moving inland at an average rate of about 1.6 feet per year.

4) The erosion caused the loss of many gravesites in the cemetery which contained human remains (iwi) to the ocean. Many headstones were also washed onto the beach and into the ocean.

5) The ocean erosion engulfed the Mantokuji's historic crematory and crumbled it, leaving bricks onto the beach.

6) It is a community gathering place where many activities are held on the grounds of the temple, such as the observance of Obon.

7) This coastline provides valuable habitat for turtles, ocean plants, and small animals.

8) The beach sand on the Mantokuji Temple property was mined for over a decade by Maui County for its capital projects.

- 1 -
TOOLKIT FRAMEWORK

Toolkit Framework

Scientific and Technical Tools

- ✓ Data collection techniques
- ✓ Use of technology in measuring and analyzing data
  - Biology
  - Water Quality
  - Sand
  - Topography
  - Ocean Current
  - Monitoring

Team Collaboration Tools

- ✓ The discipline of scientific study
- ✓ Research resources and methods
- ✓ Cooperative teamwork

Community Building Tools

- ✓ Create awareness of Mantokuji Temple's history, cultural contributions and the erosion threat
- ✓ Share experiences via online resources
- ✓ Help communities learn about how the Toolkit can help to protect and preserve our coastline
- ✓ Develop potential solutions/responses to coastal erosion threats
- ✓ Encourage support

- 2 -
MANTOKUJI BACKGROUND

Pā'ia Mantokuji Soto Mission

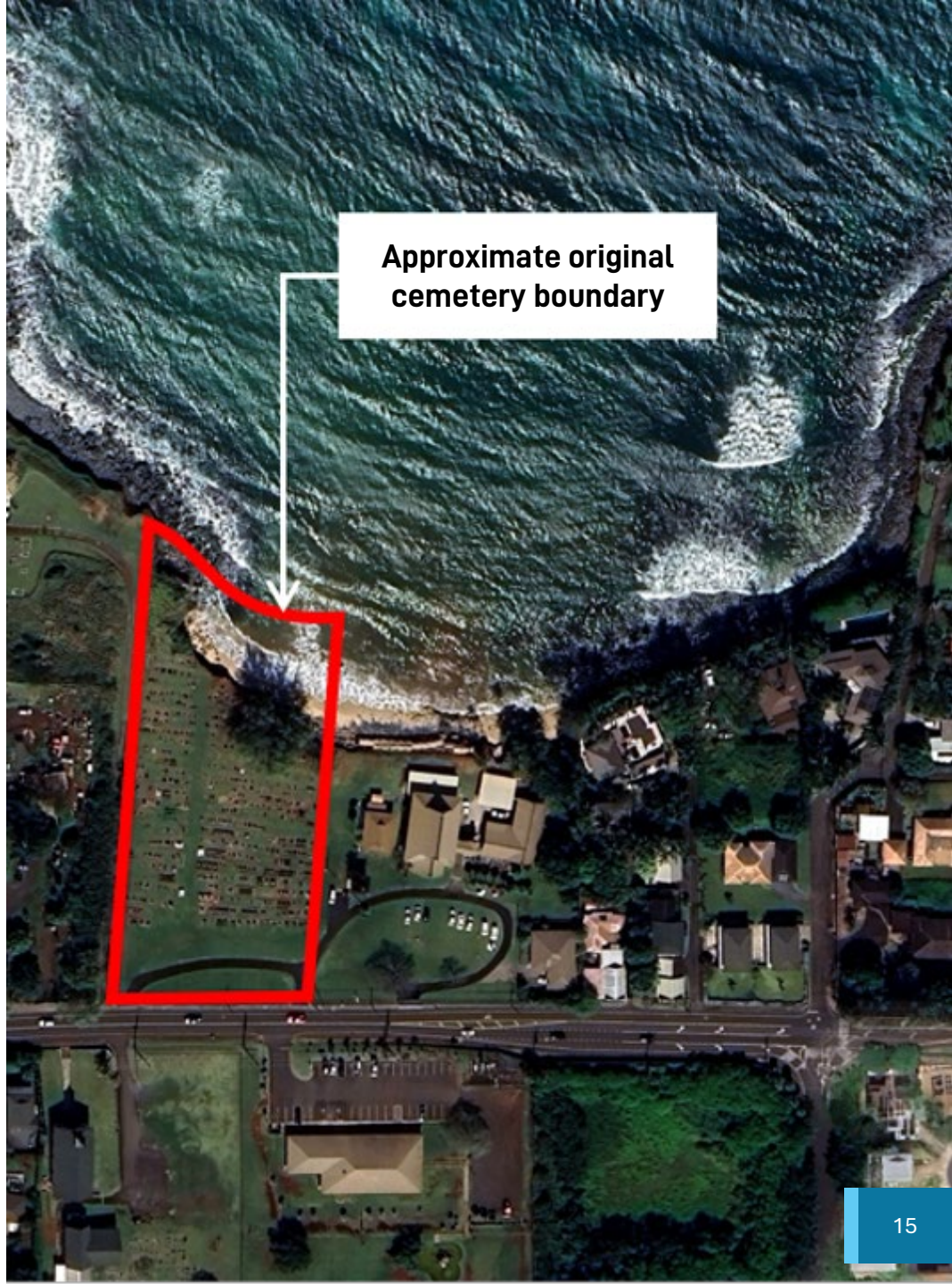
- 4.2-acre property
- July 1921: Temple was built at Pā'ia and dedicated in service to the community (103 years at this site).
- The Mantokuji property includes temple and downstairs social hall, bell tower, War Memorial Monument, minister's residence, and related buildings and structures.
- The property includes a cemetery, columbarium and once had a crematory, but it was lost to ocean erosion.
- The cemetery has also lost many grave sites which contained iwi (human remains) and headstones to ocean erosion.

Severe Coastal Erosion

The property, including the cemetery, has been severely diminished due to coastal erosion.

- Lost about 1 acre as erosion of the soil escarpment (bluff or cliff) along the shoreline has been ongoing for decades
- Loss of wildlife habitat
- Sea turtles, a protected/endangered species, are losing their beach
- Degraded reef
- Declining water quality
- Loss of cultural and historic resources
- Loss of iwi
- Estimated 25% of iwi buried in the cemetery may have fallen in the ocean

Beach sand was mined by Maui's government for use in public infrastructure including roads, buildings, etc. since the 1930s.



- 3 -
TOOLKIT DATA

Biology Tools

- **Purpose:**

  To understand the living organisms that exist in the nearshore coastal area and identify protected species or habitat.

- **Goal:**

  Adapt to the climate change hazards while avoiding significant impacts to Mantokuji's biological resources.

- **Methods:**

  Biological surveys were conducted to identify plants and animals along the beach and shoreline. A microscope was used to search for animals in sand samples.

Honu (Green sea turtle)

Limu palahalaha (sea lettuce)

Beach Naupaka

Biology Results

- **Animals:** Green sea turtles were frequently observed resting on the beach. Crab, 'opihi (limpets), and pipipi (Nerite snails) were common in the intertidal zone. No birds or bats were observed. No organisms were found within the sand. In the water, presence of coral was recorded but appears uncommon with low coral coverage.

- **Plants:** No protected plants were found along the shoreline. Non-native grasses and small plants were dominant behind the shoreline. A few trees (Ironwood, Heliotrope, Seagrape, Portia, Hau) remain along the shoreline.

- **Algae:** Sea lettuce was common on the rocks in the intertidal zone. Several species of algae were found within the bay.


'Opihi (Limpets)


Honu (Green sea turtle)


Looking west along shoreline


Looking east along shoreline

TOC

Water Quality Results

Collecting Water Samples

Underwater visibility (hand in background typical of this location)

Purpose:

To understand the quality of the ocean water in the nearshore coastal area.

Goal:

Adapt to the climate change hazards while avoiding significant impacts to the ocean water quality.

Methods:

Samples were collected in nearshore waters at Mantokuji Bay and the two adjacent bays. A multiparameter probe was used to measure temperature, salinity, pH, turbidity, and dissolved oxygen onsite. Water samples were also analyzed for nutrient content in the laboratory.

Results:

The water in Mantokuji Bay is highly turbid in areas and appears to be receiving significant nutrient input from groundwater inflows.

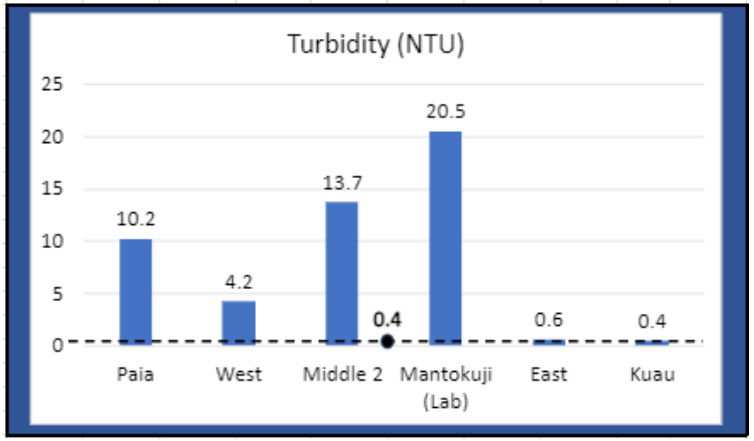
Color of water in turbid areas

Multiparameter Probe

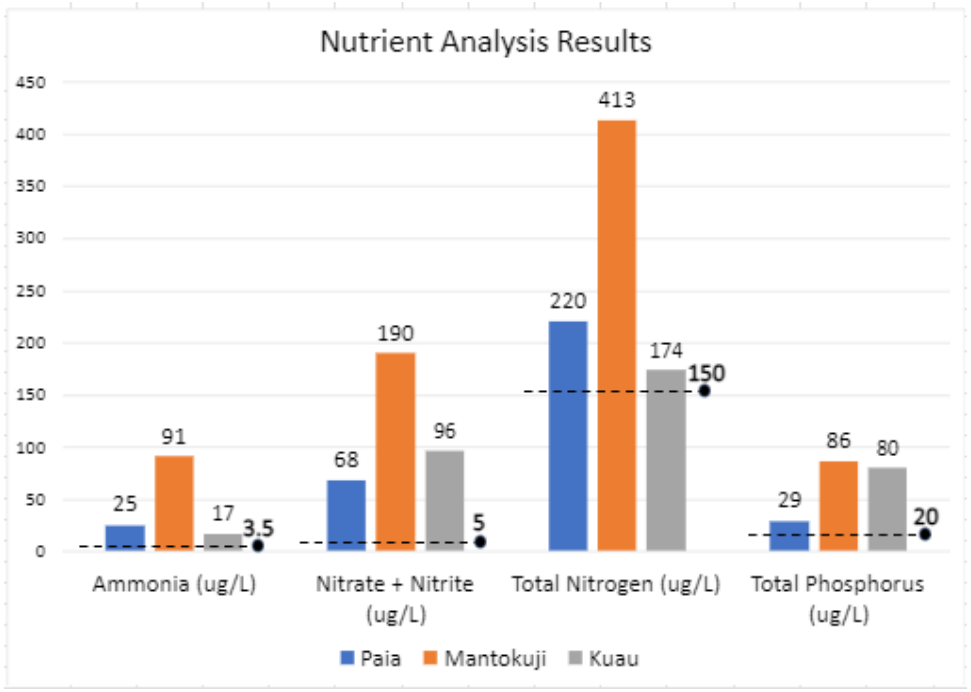
Water Quality Data

Field Day 1

Six shoreline sites tested on Field Day 1. Three of the sites (yellow labels) also analyzed for nutrient content in the laboratory.



	Paia	West	Middle 2	Mantokuji	East	Kuau
Turbidity (NTU)	10.2	4.2	13.7	20.5	0.6	0.4
Salinity (ppt)	32.8	32.7	32.3	32.1	32.8	32.6
pH	8.26	112	98.6	8.22	8.31	8.29
Dissolved Oxygen (%)	105.9	30	30	92.1	77.1	175.2
Total Suspended Solids (mg/L)	11.4			19.1		3.2
Ammonia (ppm)	25			91		17
Nitrate + Nitrite (ppm)	68			190		96
Total Nitrogen (ppm)	220			413		174
Total Phosphorus (ppm)	29			86		80



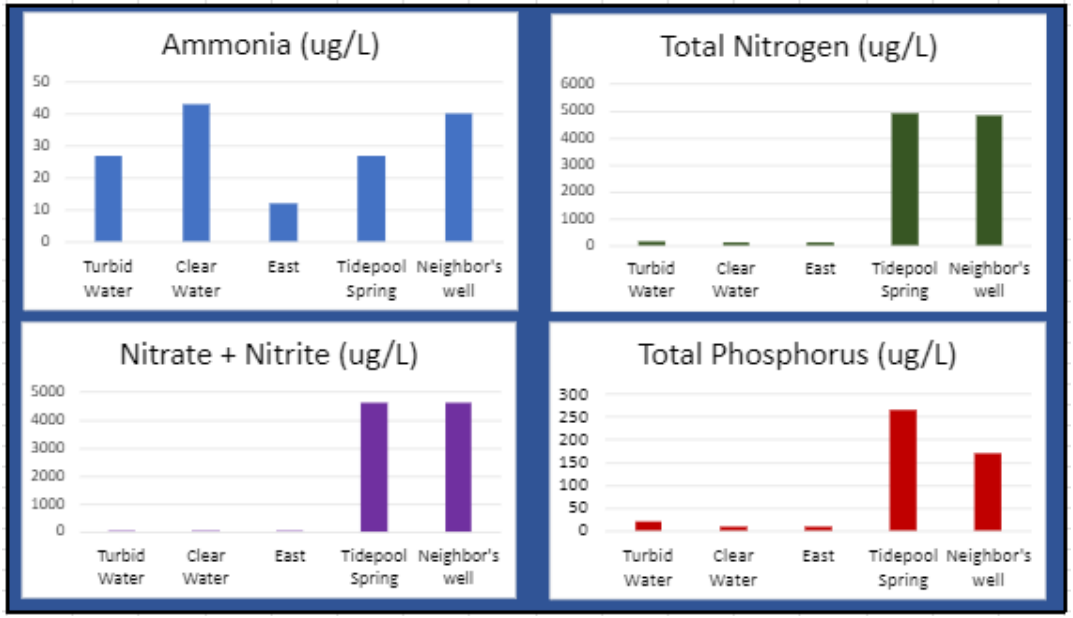
Horizontal dotted lines represent SOH "dry" water quality standards for embayments

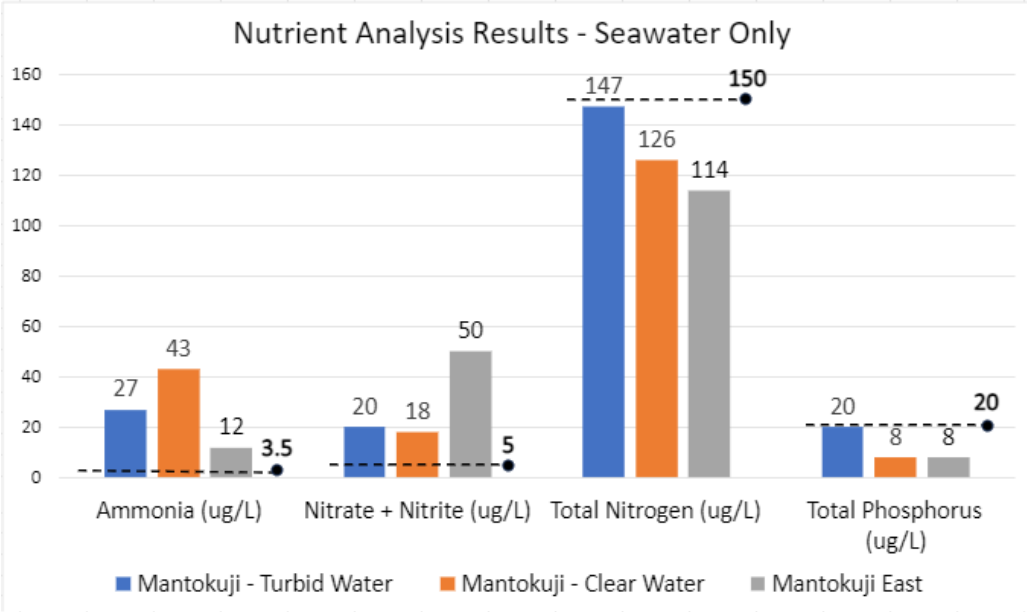
Water Quality Data

Field Day 2

Five sites tested in the laboratory for nutrients. Purple labels represent fresh/groundwater sites, while yellow represents seawater.

	Turbid Water	Clear Water	East	Tidepool Spring	Neighbor's well
Ammonia (ppm)	27	43	12	27	40
Nitrate + Nitrite (ppm)	20	18	50	4630	4620
Total Nitrogen (ppm)	147	126	114	4900	4820
Total Phosphorus (ppm)	20	8	8	263	170





Horizontal dotted lines represent SOH "dry" water quality standards for embayments

Sand Tools

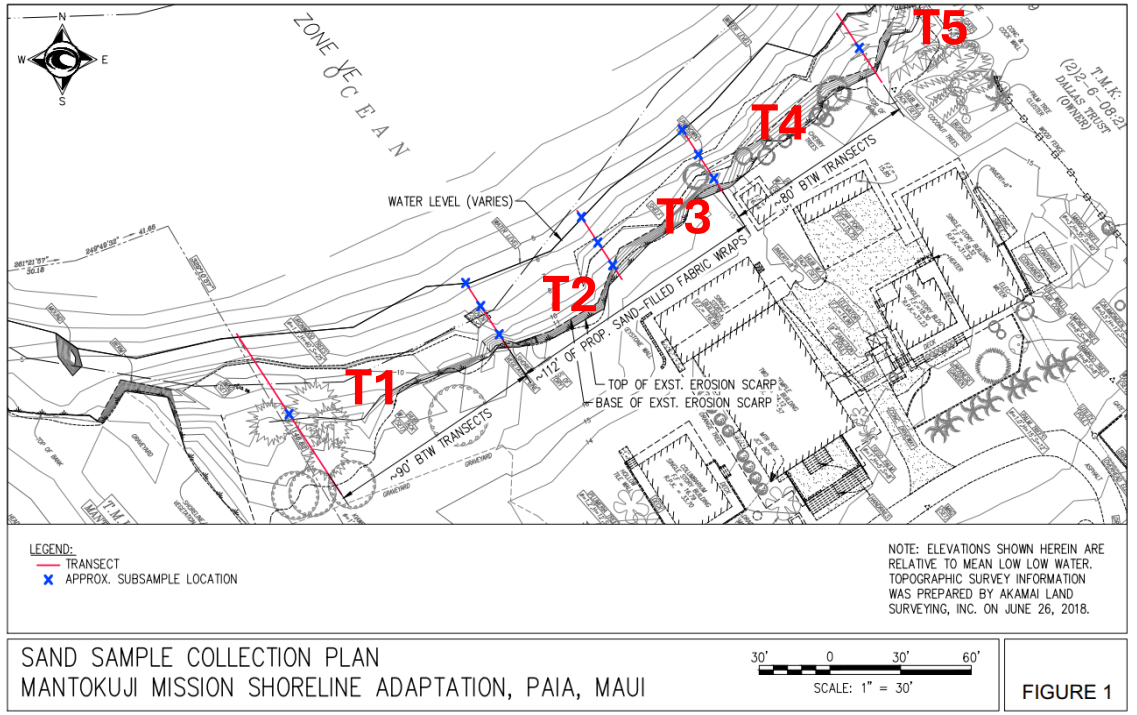
- **Purpose:**

  To understand the characteristics of the sand that compose Mantokuji's beach.

- **Goal:**

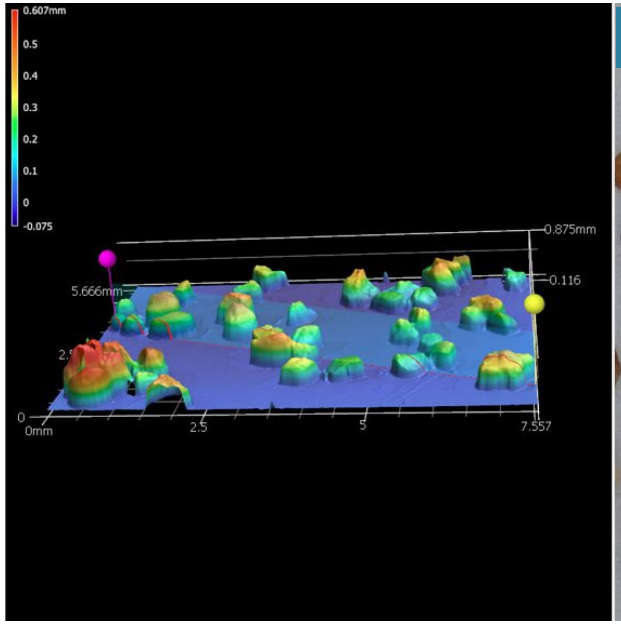
  Adapt to the climate change hazards while avoiding significant changes to the beach sand that could impact the sites' biology, resistance to erosion, and recreation.

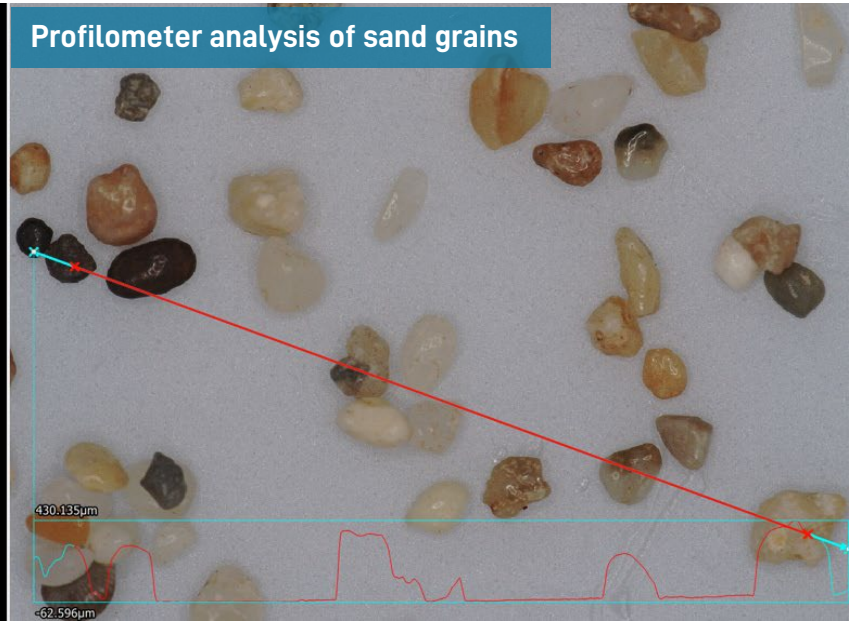
Sand sampling locations

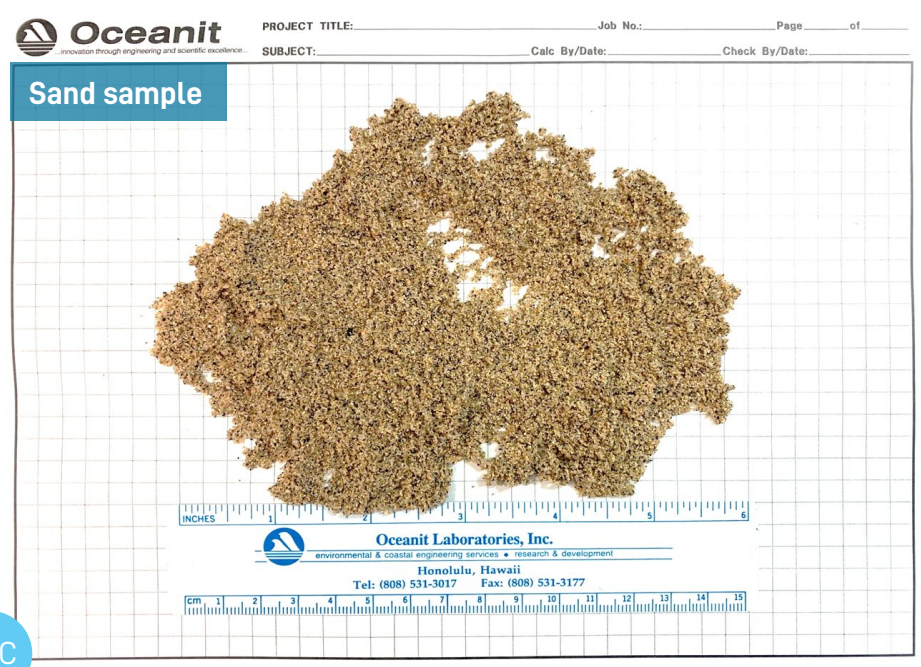


- **Methods:**

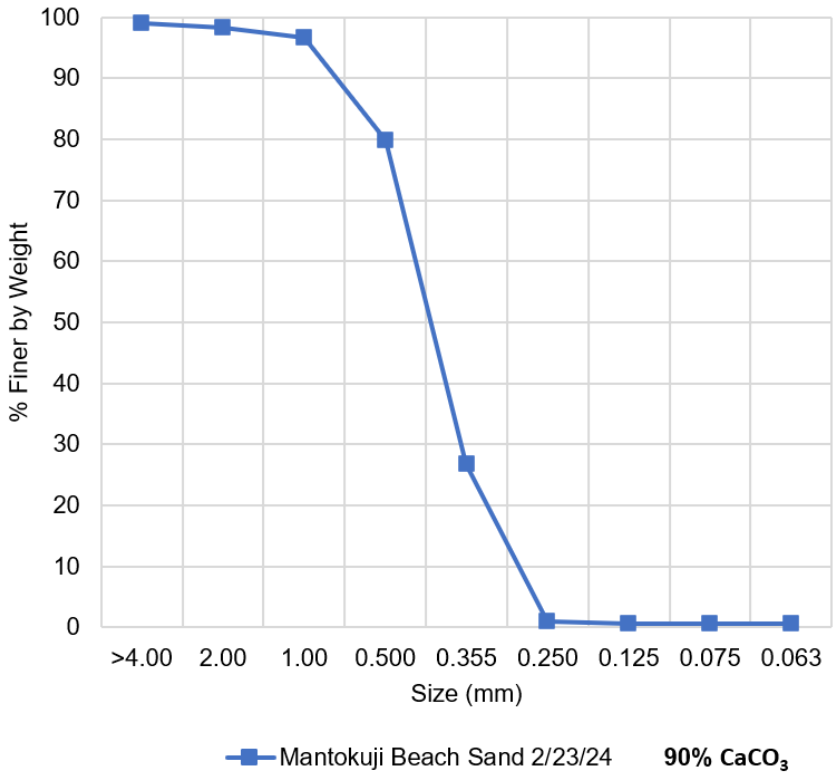
  Samples were collected along the beach profile at five transect locations. A composite sample was prepared, which was analyzed in the laboratory for grain size distribution and carbonate composition. Grain shape and roughness were also assessed with a profilometer and microscope.





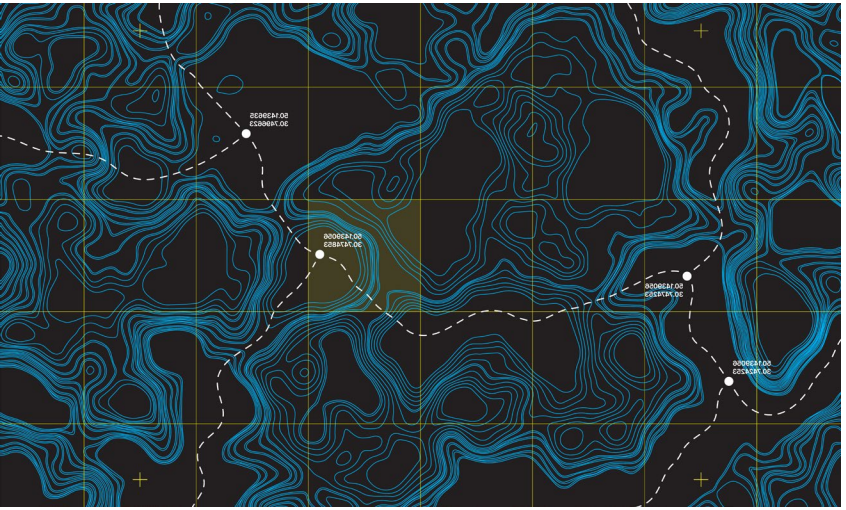


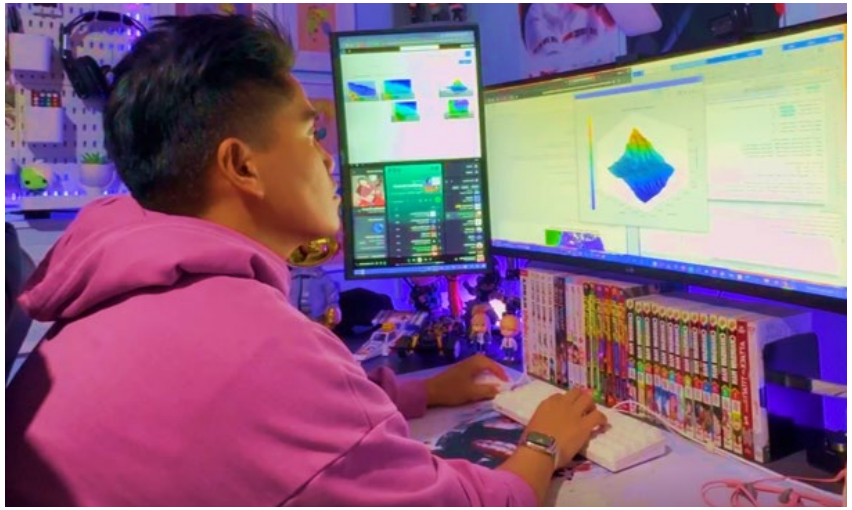
Sand Data

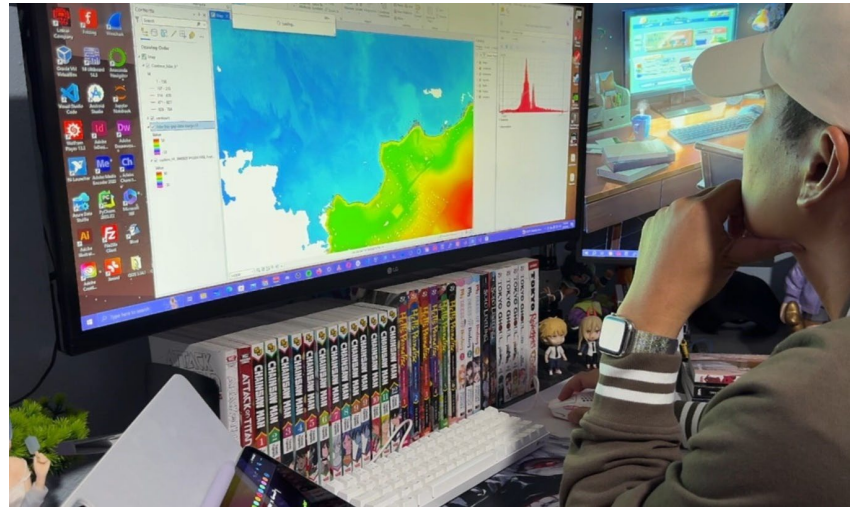


Results:

The beach at Mantokuji Bay is composed mainly of calcium carbonate ($CaCO_3$) grains. Most of the sand grains are 0.25 to 0.50 mm in diameter.







Topography Tools

Purpose:

To understand the shape of the landform at Mantokuji, both above and below the ocean.

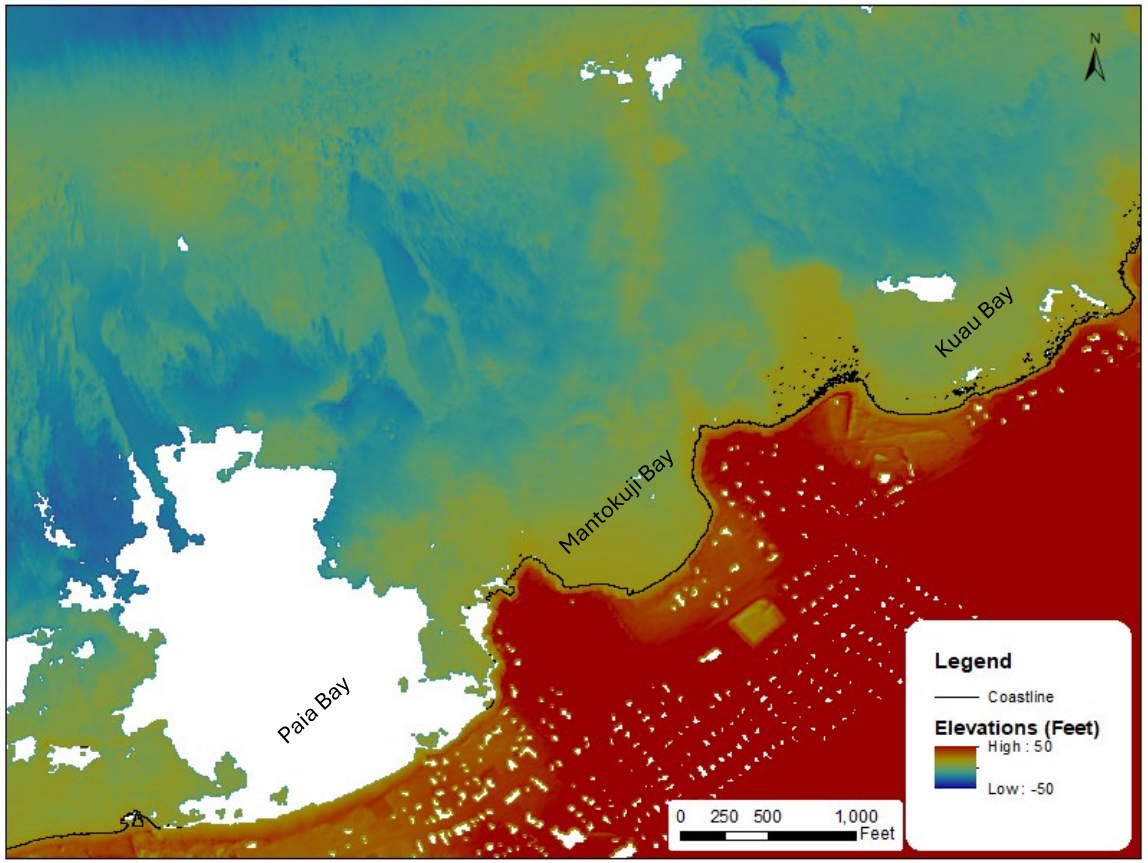
Goal:

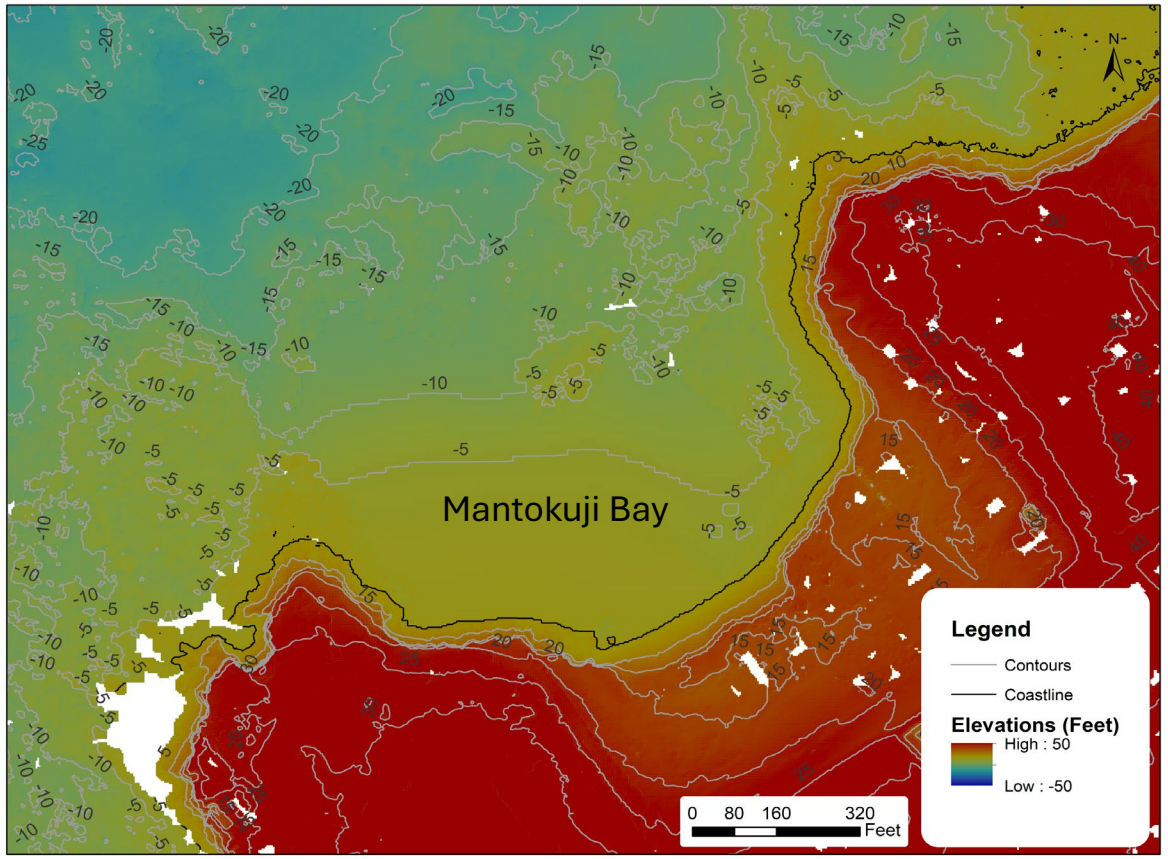
Gain insight on coastal dynamics and form a basis for engineering design layout.

Methods:

Existing topography datasets were acquired and merged to create a digital elevation model of the project site.

Topography Data





Results:

The elevation of the landform at the project site ranges from about 20 feet in the property to negative 15 feet in the ocean.
The area of Mantokuji Bay is about 11 acres, while the Mantokuji property is about 4 acres.

Ocean Current Tools

Purpose:

To understand the ocean current patterns within Mantokuji Bay.

Goal:

Provide basis for designing a solution to mitigate coastal erosion

Methods:

Deployed drogues and tracked them over time during two separate field days. Coconuts were used as drogues in this study because they were an environmentally friendly option for the data collection task.

TOC

Ocean Current Data

Results:

The predominate direction of the currents in Mantokuji Bay are east to west. Flow was quickest at the mouth of the bay. At Mantokuji Beach, flow was gradual in the offshore direction. No rip currents were observed in the bay.

Monitoring Tools

- **Purpose:**

  To track the changes in Mantokuji's shoreline features over time.

- **Goal:**

  Develop a dataset that may allow a better understanding of the dynamics in Mantokuji's coastal zone.

- **Methods:**

  After establishing power and data connections, two cameras were installed along the shoreline. The cameras consistently send pictures at a set interval to a cloud server. The photographs are compared over time at similar water levels using data pulled from the local NOAA tide measurements.

Field of view from the two cameras installed along the shoreline

Monitoring Data

Results:

The volume of sand on Mantokuji Beach varies as swell events interact with the shoreline. As the swells drop in size, changes in the amount of sand are observed on the beach. The ocean takes and deposits sand depending on the wave climate at the time.

- 4 -
CONCLUSION

CONCLUSION

The three pillars of the Climate Change Toolkit - the scientific and technical tools, teamwork collaboration, and community building actions - were applied to study the erosion impacts at Mantokuji Bay.

By applying these tools, we were able to collect meaningful data that furthers the understanding of the problem and brings awareness for community discussion and action.